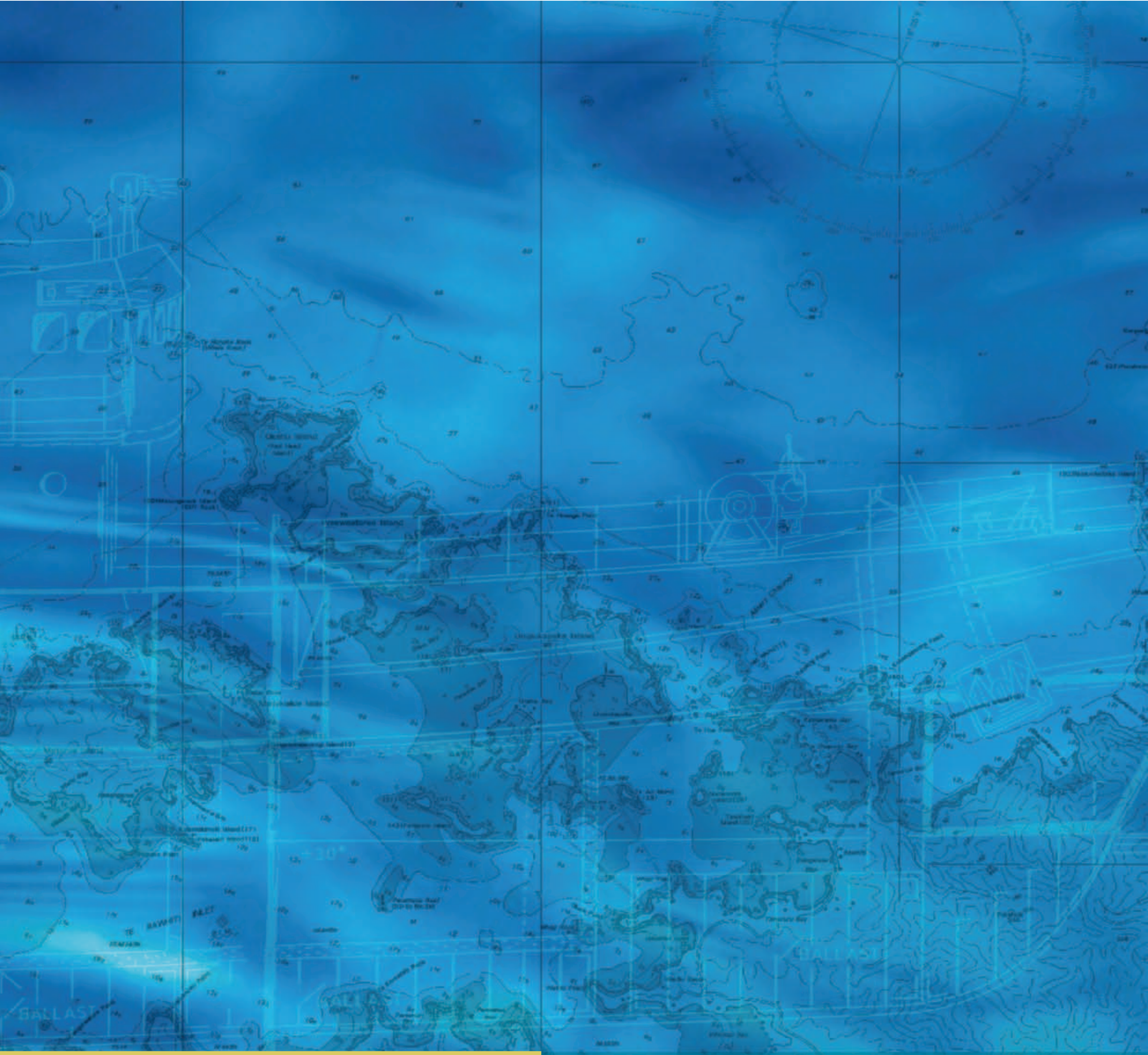

FINAL GUIDELINES FOR

Port & Harbour Risk Assessment and Safety Management Systems in New Zealand

KEEPING YOUR SEA SAFE FOR LIFE

Maritime Safety

MARITIME SAFETY AUTHORITY OF NEW ZEALAND

Kia Maanu Kia Ora

ISBN Number

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Preface

These guidelines are one of a series supporting the New Zealand Port & Habour Marine Safety Code. They provide detailed and, in some cases, technical guidance relating to the specific measures, identified in that Code, that fall to regional councils, port companies and other participants to implement in fulfilment of their duties and exercise of powers under the law.

The guidelines, as also the Code itself, are not statements and good practice intended to stand for all time. Rather, they are living documents to be revised in the light of the lessons drawn from experience, advances in technical knowledge and capability, and the ongoing imperative of continually improving safety management within our port and harbour system.

As at August 2004, the Code is supported by –
Guidelines for Port & Harbour Risk Assessment and Safety Management Systems in New Zealand
Guidelines for Providing Aids to Navigation in New Zealand
Guidelines of Good Practice for Hydrographic Surveys in New Zealand Ports & Harbours

Additional guidance documents are in preparation or planned. Support for participants when considering the relevance of various metrological and hydrographic occurrences will be available in a report on environmental factors affecting safe access and operations in ports and harbours, due to be published in September 2004. During the next year, MSA with be working with participants to produce guidelines for vessel traffic services as well as standards for harbourmasters. It is further proposed to adopt an existing standard for the use of tugs in ports published by the Nautical Institute.

Comments and queries relating to these guidelines, as well as any questions concerning the New Zealand Port & Harbour Marine Safety Code should be addressed to –

Nautical Analyst
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Copies of the guidelines and the Code are available from MSA free of charge. Electronic versions are available from www.msa.govt.nz.

Russell Kilvington
Director of Maritime Safety

August 2004

Introduction

This document provides guidance to those responsible for navigational safety within designated harbour areas. It is designed to provide important assistance to Regional Councils and Port Companies when undertaking a risk assessment of navigational activities and installing a safety management system in accordance with the requirements of the New Zealand Port & Harbour Marine Safety Code (the Code). The focus of these guidelines is on risk assessment and safety management to improve safety of vessel or craft movement and navigation within a harbour area as defined by the Code.

The definition of a Harbour, Port, Port Company and Regional Council is provided in the Code and therefore not repeated here, although a glossary of relevant terms for this document is provided at the end of this document. The detail to which these guidelines are followed needs to be assessed at the time of Code Application Assessment as defined by the Code. For example, there may be some waterways where a truncated or high-level risk assessment process may be required.

To introduce a section on risk assessment with a navigational safety management system may at first appear strange. However the agreed national standard set by the Code relies upon the principle that all regional councils and port companies will base their policies, and procedures relating to marine operations on a formal assessment of hazards and risks; and that they will maintain a formal Safety Management System to manage navigation, developed from the results of that risk assessment.

Any safety management system inherently needs an assessment of risk to inform it of safety priorities and the performance of risk management systems managing those priorities. **Figure 1** shows that one is part of the other. It also shows that risk assessment comprises several distinct activities. Since any system will be overlaid on existing risk management measures within the port or harbour, the true effectiveness of these needs to be taken into account at the assessment stage of the cycle.

The ability of the harbour organisational structure (and the organisations operating ports or terminals) to deliver existing risk management systems or introduce new and effective risk control measures is also a fundamental part of introducing the Code. This can be partly established from work associated with the risk assessment, provided the assessing team has the appropriate skill base or training. As a result of formalising their safety management system, a port or harbour may need to review or change management structure or roles and responsibilities in order for the organisation to focus its skill base appropriately on navigational safety management. As risk assessment, navigational safety management, organisational structure and associated roles are all key components of the safety system, serious thought should be given in the initial planning stage to the skill base needed to do the job. The need for outside help is partly a function of the size and diversity of a port or harbour's marine movement profile (leisure craft types, vessel types, trade types), but those managing small harbours would be well advised to at least seek help from larger neighbours if navigational risk assessment is breaking new ground for the port or harbour.

There is a New Zealand/Australian standard for risk management[1] which provides base information to set a common standard for assessments undertaken. These guidelines are founded on the New Zealand/Australian standard, but goes much further to provide a common set of risk criteria as a reference for the introduction of port and harbour risk assessment in New Zealand.

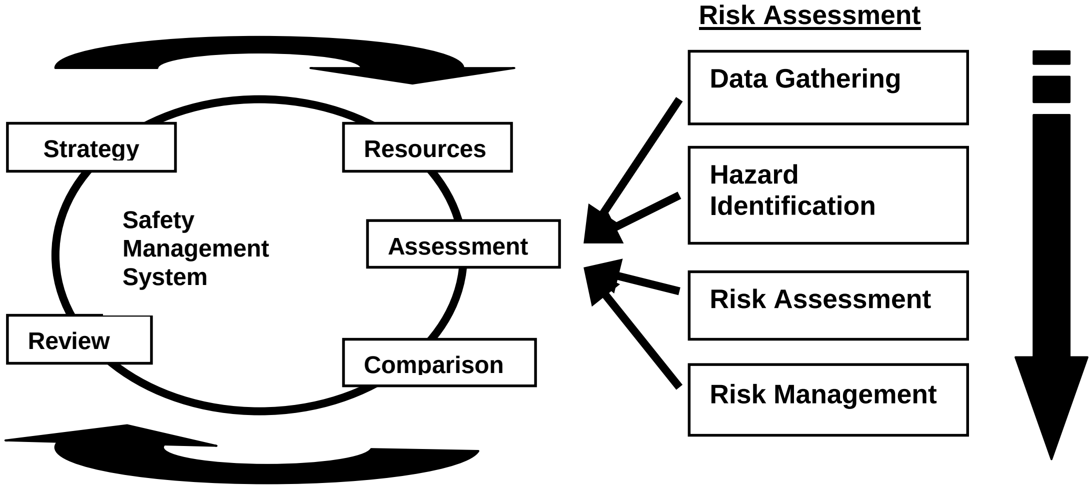

Figure 1: Relationship between Risk Assessment and the Safety Management System

In short:

- a risk assessment **defines** the risks;
- a safety management system **manages** the risks.

Safety management systems have to be maintained as a continuous cycle. Risk assessment is therefore recurrent. If a regional council or port company adopts formalised safety management for navigational safety, it is likely to begin with a new and comprehensive assessment of risk. This guide starts at that point in the cycle.

1.1 Risk Assessment

In the past, safety management and regulation was usually introduced as a result of an accident/incident or a series of accidents/incidents. It has now become necessary to take a proactive approach toward safety that aims to identify risks and then to control them. This has to be undertaken in a way that constantly updates identification and mitigation of risks in any process or organisation. In marine organisations interfacing with or influencing marine operations this has never been more important, due to the very high cost and wider implications of maritime accidents.

[1] AS/NZS 4360 1999 (2004 revision in draft)

The risk assessment has to start with identification of **hazards**. A **hazard** can be defined as something with the potential to cause harm to:

- People
- Environment
- Property
- Harbour stakeholders.

Once a hazard is identified, frequency and consequence data can be added, the result is **risk**.

Risk is a combination of:

1. The frequency (likelihood, probability or chance) of a **hazard** realisation;
2. The consequence (severity or impact) of the hazard reaching its potential.

In practice, **hazards** will normally have a range of consequences and associated probabilities.

In some quarters risk is viewed as a simple product of frequency and consequence, which is misinformed. The relationship between frequency and consequence is different across the range of possible accidents and their outcomes.

There are basically two types of risk assessment undertaken - qualitative and quantitative. The quantitative approach requires vast amounts of incident data across different sites and requires significant resources to establish a numerical evaluation of the level of risk. Techniques such as fault and event trees are used for quantification. It is used mostly in the nuclear and chemical industries and sometimes at offshore installations to demonstrate compliance with a prescribed safety margin or level of safety (the “safety case”). It is relatively expensive.

The qualitative approach uses risk in a comparative way to identify if one activity carries higher risk than another. In a port and harbour risk assessment, the application of risk in a carefully thought out comparative way allows identification of activities which result in higher levels of risk, without the need to determine the absolute value of the risk. This alone dramatically reduces the cost of the assessment and can provide the key information needed to establish safety priority and thus inform the initiation of a safety management system. It is beneficial for a regional council or port company to adopt this approach as it provides answers to determine the priority of risk control within the harbour or port. This allows a Port and Harbour Safety Management System to be introduced in manageable stages, concentrating first on those defences which control higher risks. The use of a risk matrix can also be easily integrated into a more sophisticated approach for larger ports to base their risk assessment on a per-movement basis. A useful way to compare risk levels is to base the risk assessment on a matrix approach as shown in **Figure 2**. This is a 5x5 matrix to provide a conceptual example – it is used later in these guidelines to derive the risk assessment criteria for a port or harbour risk assessment.

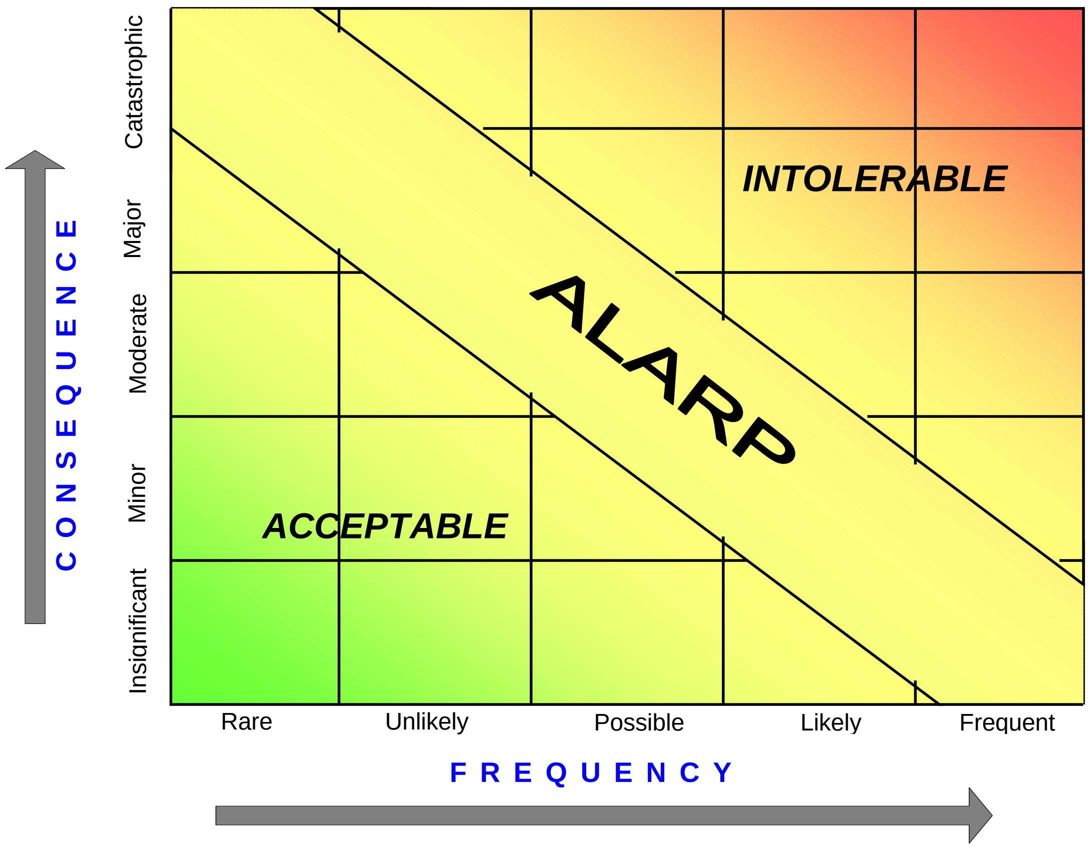

Figure 2: Example Risk Matrix

In conceptual terms, at the low end of the scale frequency is extremely remote (rare) and consequence insignificant. At this point, risk can be said to be in the acceptable region. At the high end of the matrix, where hazards are defined as frequent and the consequence catastrophic, then risk is termed intolerable. At some point in the matrix there is a reasonable balance between the cost of further investment in risk management in relation to the consequence of outcome and the additional risk reduction achieved by the further investment. This area is termed ALARP (As Low As Reasonably Practicable). ALARP is a useful concept and in a quantitative risk assessment, this can be established numerically. It is possible to define ALARP to be a line of cells in the risk matrix for a particular risk assessment. However for a qualitative risk assessment, which is what this guidance document recommends, the location of ALARP is more abstract. This means that expert judgement is needed to establish risk acceptability (ALARP), based partly on operational knowledge or evidence of incidents or near misses. An assessment of the worst credible outcome of a hazard realisation is also of assistance in considering ALARP.

2. RISK ASSESSMENT CRITERIA AND STRUCTURING

2.1 Introduction

This section introduces the risk criteria needed to undertake a port or harbour risk assessment consistently and provides advice on structuring the risk assessment. Section 3 then provides advice about how to structure and undertake the assessment. It is supported by a worked example in **Annex A** and **Annex B**, which shows an example of a completed process of hazard identification and risk scoring to provide a ranked output.

2.2 Port and Harbour Risk Assessment Criteria

The risk assessment criteria have been laid out in this section for guidance and to provide a consistent framework. They are recommended because they provide a consistency of standard for all ports and harbours. However, consideration should be given to modification of one scale should circumstances at a particular harbour or port demonstrate the need.

2.2.1 Frequency Criteria

When the frequency component of risk is considered, there is a choice between basing the scale on a per-movement basis or a simple per-annum basis. Where ports or harbours have a larger number of movements, a per-movement scale can be considered as this provides a simple set of criteria for reporting safety performance once the safety management system is established. There is risk assessment and safety management software available which can swap between a per-movement and a per-annum frequency scale at any stage.

Figure 3 provides the frequency scale recommended. Each of the Frequency categories represents a range.

Category	Description (AS/NZS 4360)	Definition
F1	Frequent	An event occurring once a week to once an operating year.
F2	Likely	An event occurring once a year to once every 10 operating years.
F3	Possible	An event occurring once every 10 operating years to once in 100 operating years.
F4	Unlikely	An event occurring less than once in 100 operating years.
F5	Rare	Considered to occur less than once in 1000 operating years (e.g. it may have occurred at a port or harbour elsewhere in the world).

Figure 3: Frequency Matrix for Use in Port and Harbour Risk Assessment

The use of a frequency matrix is a practical translation of the chance or probability of an event occurring in a set timescale. Like the consequence scale that appears later, the frequency scale is also logarithmic. The effect of a logarithmic scale is more readily appreciated in the case of a frequency scale. As the scale is rising by an order of magnitude at each change of frequency category, it is also widening by a similar amount (e.g. 0-1, 1-10, 10-100, 100-1000, etc.). This makes risk assessment quite a blunt instrument in the case of rare or low probability events, because the width of the scale is rising by an order of magnitude for each category across the scale. However, this approach allows risk assessment to provide more refinement when higher frequency events are considered, because the width of the scale is smaller.

In a port or harbour, the first three categories of frequency are easily understood. Category F4 represents a frequency suggesting an event which is unlikely to happen, but has been identified as a possibility. Changing conditions within the port or harbour, such as increased traffic volume or inexperienced crew may result in these hazards being more likely to occur. Category F5 caters for an event which is currently considered on the very limits of credibility. However, the associated consequence is so catastrophic that it needs to be included to take account of possible future changes in frequency. The F5 category also references events that may happen in harbours or ports elsewhere. The frequency scale adopts a commonly used standard, but first time users often consider the F5 category is irrelevant. It is needed, especially where risk assessment is being carried out at more than one port or harbour, because multiple operating years can occur in one place. Thus a regional council with a number of small harbours within its jurisdiction may wish to undertake one risk assessment across its area of responsibility by taking this approach.

2.2.2 Consequence Criteria Across Four Categories

Experience of applying risk assessment to navigation in ports, harbours and across marine operations generally has shown that the use of four categories of risk provides significant benefit, especially when a risk matrix approach is used. These are:

- Risks to **People**
- Risks to **Property**
- Risks to **Environment**
- Risks to **Harbour Stakeholders.**

With regard to the harbour stakeholder category, this reflects the impact on the wider interests of the harbour and its stakeholders. Thus, for example, the potential loss of trade from an incident is taken into account. Following a major grounding in any harbour, it is likely that loss of trade will occur for a considerable period of time due to complete or partial closure. In marginal trading locations, this can move the balance towards permanent closure.

Each scale should be assessed individually as each provides a measure of consequence impact associated with different types of loss. Thus, if any one risk scale is showing high levels of risk (e.g. environmental and property damage), then it is reasonable to conclude that risk control in that area is necessary. The reasoning behind this can be readily understood when considering an event such as grounding. There are few groundings that directly cause harm to people, yet the environmental and property damage that ensues can be catastrophic. If a “people safety” scale were used alone, then invalid conclusions would be drawn. This enables a more informed decision to be taken regarding the adequacy of existing risk control measures, and the need to make changes is then logically established or ruled out accordingly.

A consequence matrix based on the four different consequence categories is shown in **Figure 4**. Each scale has five levels to provide the data for an associated 5x5 risk matrix. The consequence matrix makes a connection between each scale on the tentative basis of cost. Cost is not referenced on the people scale, but there is equivalence between the people scale and the other scales. This is the cost that society is prepared to invest to prevent a statistical loss of life, but is for guidance only*. The same cost criteria are used by the International Maritime Organisation (IMO) within the Formal Safety Assessment (FSA) methodology.

It is worth noting that on a mathematical basis, like frequency, this scale is designed to be logarithmic.

Scale	People	Property	Environment	Harbour Stakeholders
C0	**Insignificant** Possible very minor injury (e.g. bruise).	**Insignificant** *(NZ$0-10,000).*	**Insignificant** Negligible environmental impact. Tier 1 may be declared but criteria not necessarily met. *(NZ$0-10,000).*	**Insignificant** *(NZ$0-10,000).*
C1	**Minor** Single slight injury.	**Minor** *(NZ$10K-100K).*	**Minor** Tier 1 to Tier 2 criteria reached. (small operational spill). *(NZ$10K-100K).*	**Minor** Bad local publicity or short-term loss of revenue, etc. *(NZ$10K-100K).*
C2	**Moderate** multiple minor or single major injury.	**Moderate** *(NZ$100K-1M).*	**Moderate** Tier 2 Spill criteria reached, capable of being limited to immediate area within harbour or port zone. *(NZ$100K-1M).*	**Moderate** Bad widespread publicity, temporary navigation closure or prolonged restriction of navigation *(NZ$100K-1M).*
C3	**Major** Multiple major injuries or single fatality.	**Major** *(NZ$1M-10M).*	**Major** Lower Tier 3 criteria reached, with pollution outside harbour or port zone expected. Chemical spillage or small gas release. Potential loss of environmental amenity. *(NZ$1M-10M).*	**Major** National Publicity. Harbour faces temporary closure of a navigation channel affecting movements to a port or ports for several days. Ensuing loss of trade. *(NZ$1M-10M).*
C4	**Catastrophic** Multiple fatalities.	**Catastrophic** *(NZ$10M+).*	**Catastrophic** Tier 3 criteria oil spill reached with support from international clean up funds. Widespread beach contamination or serious chemical/gas release. Significant threat to environmental amenity. *(NZ$10M+).*	**Catastrophic** International media publicity. Port closes, navigation seriously disrupted for an extended period. Serious and long term loss of trade. *(NZ$10M+).*

Figure 4: Consequence Matrix for use in Port and Harbour Risk Assessment

* Refer to "The Social Cost of Road Crashes and Injuries June 2001 Update", Land Transport Safety Authority

The "Property" consequence criteria, by necessity, consider the loss of a larger commercial vessel to be greater than the loss of a leisure cruiser or small craft. However, the loss of a smaller craft can mean loss of the operator's livelihood and this should be reflected in the "Harbour Stakeholder" consequence criteria selected. The loss of a small craft may also pose higher risk to human life and therefore the selection of "People" consequence criteria may increase in significance. Therefore the impact of a small craft loss is measured on more than one scale.

Notwithstanding this, when undertaking a risk assessment at any particular port or harbour, review of the criteria in each of the property consequence level can be considered.

2.2.3 Derived Risk Matrix

Having defined the categories in an understandable way, a numerical translation provides a risk matrix that can be used by any regional council or port company for its risk assessment. This is shown in **Figure 5**, below.

Consequence	C4	5	6	7	8	10
	C3	4	5	6	7	9
	C2	3	3	4	6	8
	C1	1	2	2	3	6
	C0	0	0	0	0	0
Frequency		F 5	F 4	F 3	F 2	F 1

Figure 5: Risk Matrix for use in Port and Harbour Risk Assessment.

A suggested definition of the numbers in the matrix is as follows:

0 & 1	Negligible Risk
2 & 3	Low risk
4 & 5	The extent of the As Low As Reasonably Practicable area (ALARP[2])
6	Heightened Risk
7 & 8	Significant Risk
9 & 10	High Risk.

2 ALARP does not necessarily mean that more cannot be done to reduce risk, especially if this involves introduction of changed and/or consistent working practices.

Risk Control Criteria can be applied to the different levels of risk. For example risks that are 7&8 should be reduced by risk control options becoming effective within two years. Those with scores of 9 or 10 require immediate attention. The concept of Control Adequacy Assessment, referenced later in this document, is a method by which implementation of risk management strategies can be managed and the ensuing risk control monitored for effectiveness.

The numerical matrix above is recommended as most off the shelf risk assessment software tools[3] use the same approach; the numerical system can also be applied to a spreadsheet. The use of numbers also allows the risk assessment to be sorted into a list in order of ranked priority, especially if an approach to the assessment considers the most likely event and the worst credible event. Most Likely and Worst Credible are covered further in section 3.1.3.

2.2.4 Using the Risk Matrix

The frequency matrix (Figure 3) and the consequence matrix (Figure 4) provide the reference data for the risk matrix (Figure 5). Thus a frequency score of *likely* (F2) and a consequence score of *moderate* on the people consequence scale (C2) would output a risk score of 6 in the risk matrix.

2.3 Structuring the Risk Assessment

A successful port or harbour risk assessment needs careful planning before the process commences. The first item to consider is the skill base available for the assessment.

2.3.1 Defining the Skill Base

The skill base is key to the success of the initial risk assessment and is key to the development of the port or harbour safety system that must follow. Those experienced in applying the theory of risk assessment, but with little maritime or port/harbour navigational or other such operational understanding may face an uphill struggle to produce a consistent assessment. This is especially true when considering what actions are recommended to manage operational risk arising from navigation or other operations in a port or harbour and its approaches. Modifications to pilotage requirements or training or limitation of draught at a berth may be necessary; the assessment team will need the overall credibility to make those judgements and recommendations. A port or harbour is a diverse subject for risk assessment, with many different navigational and operational activities to be taken into account. Each location also has its own trade profile, making even similar ports and harbours different when risk is considered. Some ports have a much greater flow of passengers and others are located close to sensitive coastal environments.

3 Software programs are available for port and harbour use that can undertake the risk assessment, provide ranking of risk and additionally provide periodic review of hazards for the harbour safety management system.

Different ship types have different vulnerabilities and the risk impact associated with a particular scenario differs - the subject of ship collision alone can be complex, as the orientation and interaction of vessels as they close dictates their ability to deliver impact energy into a structure, or to provide a glancing blow. Another example is the NABSA[4] berth. These are a feature of many small ports or harbours, the unprepared use of which can have different adverse outcomes in relation to vessel design.

A broad marine and operational knowledge is therefore needed, supported by risk assessment, business and environmental skills. For ports and harbours, people with backgrounds associated with shipping or in risk assessment training are valuable members of any assessment team.

In all but the very smallest ports or harbours the assessment also needs to harness the knowledge associated with different stakeholders in the port or harbour. The assessment skill-base must therefore provide facilitation and feedback skills for a series of meetings that can understand and differentiate between valid risks and the perceptions of some stakeholders.

2.3.2 Defining the Framework

The framework for any marine risk assessment logically needs to follow the established Formal Safety Assessment (FSA) marine incident categories that are relevant to assessment in a port or harbour. These are:

- Collision
- Contact (which can include a sub-category of Berthing Contact)
- Grounding
- Loss of Hull Integrity
- Fire/Explosion
- Equipment Failure (Often a cause of other accident categories)
- Personal Injury.

Differentiating between Collision and Contact as incident categories is important. The definition of Collision is obvious. Contact is associated with incidents involving the vessel striking something fixed, such as a navigation aid or heavy landing on a berth, or a bar harbour, or a bridge structure or deck. Contact is known as Allision in the United States of America and some other parts of the world.

The port or harbour then needs to be categorised into appropriate areas for the risk assessment. Areas are selected partly around natural topographical features, such as channel extents, but also very much around the marine activities associated with a particular area. Selection of areas is important if the Port and Harbour Safety Management System is considered. Under the Port and Harbour Safety Management System, risk can be expressed by area if wanted and risk management can also be targeted by area. Areas are depicted on the chart as Area A; Area B, etc, and for a key categorisation for the hazard identification process.

4 NABSA is an acronym for Not Afloat But Safely Aground and is used in some parts of the world to describe a berth in which the vessel is normally expected to take the bottom at some stage of the tidal cycle.

Vessel types then need to be defined associated with the trades of the port or harbour. When defining vessel types, it is appropriate to consider primary and secondary types. For example a primary category of “Tankers” can have sub-categories of LNG; Chemical (MARPOL Annex II); Product; Vegetable. Passenger vessels can also be categorised in the same way, as can leisure craft in a harbour with different leisure activities ongoing.

3. STAGES OF A RISK ASSESSMENT – DISSECTING THE TASK

Risk assessment techniques are fundamentally the same for large or small ports or harbours, although the execution and detail will vary considerably. For a large port or harbour, the task is large and, if done to a sufficient level of detail, complex. It is thus much better to insert a structure through the whole assessment from the beginning and carve the work needed into manageable packages. In a port or harbour risk assessment, the following five stages are appropriate:

- Stage 1 **Data Gathering and System Assessment**
- Stage 2 **Hazard Identification (HAZID Meeting)**
- Stage 3 **Risk Analysis**
- Stage 4 **Assessment of existing risk management strategies, development of new measures; Assessment of Control Adequacy Rating**
- Stage 5 **Managing and Treating the Risk via the Port and Harbour Safety Management System.**

In order to make the process work practically, consultation with port or harbour stakeholders needs to be undertaken in the beginning, but also needs to occur at critical stages through the process as shown in AS/NZ 4360. The risk assessment needs to evolve with a number of structured meetings and the most important of these is the HAZID meeting (HAZard IDentification Meeting).

3.1 Undertaking the Risk Assessment

3.1.1 Stage 1 - Data Gathering and system assessment

As well as assessing the current risk control measures in place, this stage allows any external members of the risk assessment team to undergo a familiarisation process and be placed in the necessary position to identify relevant hazards from their experience of port or harbour risk assessment. It comprises a review of any historical incident data and/or database, pilotage, the vessel traffic management that is in place, as well as any procedures or requirements managing navigation. This naturally entails meetings involving management and operational personnel (harbourmaster, marine officers, pilots, tugs, line handlers, etc.) within the port or harbour as well as regular users. Regular users should contribute to the process at an early stage, because they often hold detached but important information about the hazards in any particular port or harbour.

It is useful at this stage to consider the port or harbour layout as a gameboard. First the components of the gameboard can be determined, such as channels, cross currents, environmental conditions, berth orientations/locations, navigation aids (leads and lead sensitivity, marks and buoyage). Then the way in which the game is played on the gameboard can be assessed.

Information to take into account will include, but not be limited to:

- Vessel sizes and types using the port or harbour
- Nature of leisure activities
- Passenger movements
- Traffic density and types of traffic involved at busiest times or at key locations for crossing
- The tidal regime, wave height and periodicity
- Non tidal oceanography (long period waves; surging, etc.)
- Navigational channel width, depth and route/heading needed for each transit;
- Hydrographic information and sea bed morphology

- Weather limitations
- Types of berths/securing and fendering arrangements
- Types of cargoes being handled (Oil products; IMDG; chemicals in bulk; gasses; etc.)
- Disposition of navigational aids
- Communication or radar blackspots
- Pilotage system and pilotage criteria; training systems and competence assurance systems in place
- Status of operating manuals and limitations on movements
- Available incident and accident data.

The quality of the record of incident data will vary widely depending on the history of the port or harbour. At this stage, plotting incident data by location, even from anecdotal sources, simply as stars on a chart always reveals something about the key hazards of a port or harbour. Many harbour management systems have been developed partly as a result of lessons learned from incidents and accidents. Other requirements are normally based on the perceived threat to safety by key individuals in the management chain, as opposed to hazard identification involving those at the sharp end of operations. Neither of the two approaches to safety management will identify the full spectrum of actual risks that reside in a harbour and cannot compete with the holistic response to safety management that can arise out of a well planned risk assessment.

Consultation with regular users and organisations having interest in the port or harbour is an important task to undertake at this stage in order to identify the parameters of their involvement in the port and harbour. As users and organisations subsequently develop their own structure of safety management systems (see Stage 5) not only within individual organisations, but also between organisations, robust links between and across the risk areas identified will be created.

3.1.2 Stage 2 - Hazard Identification Process

The process of hazard identification is likely to begin soon after Stage 1 has commenced and a preliminary list should become available almost as a direct output from this stage. Hazard identification is, in many ways, the most critical of the steps involved in the risk assessment process. An overlooked hazard is more likely to introduce error into the overall risk assessment of a port or harbour, than an inaccurate assessment of frequency or consequence. In many cases, errors made in assessing consequence and frequency can cancel each other out over the full spectrum of incidents, whereas the omission of a hazard results in an underestimation of the overall risk profile. Moreover, important risk control may not be introduced to properly manage the risk, resulting in an accident waiting to happen.

The facilitator of a HAZID meeting is key to the successful delivery of the hazard information and the role is often combined with that of the chairman. There are few areas where the assessment can truly benefit from a specialist, but this is one of them. An experienced HAZID chairman can make a real difference in the delivery of information from participants. All ports and harbours intending to undertake their own risk assessments are strongly recommended to consider, as a minimum, using a specialist to facilitate their HAZID. All stakeholders should participate in the HAZID at some stage in its agenda. It is vital to involve regular harbour users at this stage.

The aim of the exercise is to identify all hazards; even those managed by existing risk control measures. Within this stage, one or more structured meetings (HAZID meetings) with those having experience of vessel movements and berthing in the location should be held. It is strongly advisable to have some form of independent attendance at the HAZID meeting, which could be expertise drawn from a neighbouring council or port company. This approach recognises that the people best placed to identify hazards are often personnel working within the port or harbour, but that a "new pair of eyes" also notices items of significance that are accepted as normal in the system. The benefits provided by those outside pair of eyes are very important to the success of the risk assessment. It is perhaps obvious that risk assessments undertaken totally in-house do not generally address all the issues, some of which will be related to problems that the organisation with responsibility has hesitation in addressing.

The HAZID process should be conducted on an Incident Category basis, across each area of the port or harbour. It should systematically consider vessel types, operations and interfaces appropriate to each area. The approach will be to undertake a general Hazard Identification on a geographical basis, followed by a number of smaller meetings concentrating on specific areas and assessment of specific operations.

Hazards should be identified initially on a generic basis and then added to in order to consider scenarios specific to different areas of the port or harbour.

3.1.2.1 One Person's Hazard is Another's Cause

Structuring the output of a HAZID needs a consistent approach. Hazards, causes and consequences can become confused and causes or consequences can also easily be stated as hazards. It is therefore essential that an organisation is able to identify hazards effectively and where a need for training is identified, this should be conducted at Stage 1 of the process.

It is also vital to identify hazards at an appropriate level of detail. An example of a hazard scenario is as follows:

<u>Scenario</u>: *A mooring rope breaks while a vessel is mooring alongside.*

If the incident category of Personal Injury is considered, it can be assumed the hazard is the rope parting. However, if the whole scenario of mooring is considered within the category of personal injury, parting of the rope will be a cause.

Incident Category	**Hazard**	**Cause(s)**	**Consequence(s)**
Personal Injury	Mooring vessels alongside the berth results in injury.	Using mooring bitts for more than one mooring line. Wet or slippery quay surfaces. Lack of communication between ship and shore. Trapping hands in mooring ropes. Too much load applied, parting of the rope.	Slip/Trip or fall. Minor Injury Serious injury by whipping mooring lines. Possible fatality.

Developing a hazard list in this generic way, in the first instance, enables the assessment to focus on one hazard for a wide topic. This ensures manageability of the risk assessment and provides a hazard list which reflects the diversity of activities in a port or harbour. For any marine risk assessment in general, it is better to consider hazards generically, rank them (to identify those that pose highest risk) and then to revisit the risk assessment in areas of high risk and consider more detailed hazards in those areas. This not only targets resources, but also targets later risk management attention.

It is important to note here that there are a number of possible consequences (or a range of outcomes) associated with this hazard.

An example hazard list is attached at **Annex A,** Tables A1 and A2. This also shows developed hazard data and risk scoring. An explanation of the worked example is presented at the beginning of the Annex.

3.1.3 Stage 3 - Risk Analysis

The potential for different organisations to produce different hazard and causal output from a HAZID meeting is obvious from the hazard example in paragraph 3.1.2.1. It is also a recognisable feature of marine incident investigation that there is often little in causation terms to differentiate between incidents resulting in a minor outcome to those in which a serious loss occurred. Because of this, for port and harbour risk assessment (and general marine use) the "most likely", "worst credible" approach was developed. The most likely outcome rating is obvious, but the worst credible scoring should be differentiated from the worst possible spectrum of outcomes. The frequency of incidents associated with the most likely outcome is often higher than that associated with the worst credible case. There can, however, be cases when frequency is low (rare), where because of the logarithmic scales used in a risk matrix, both outcomes are within the same frequency band. Where both "most likely" and "worst credible" scores end up in the same frequency band, risk control can only be recommended as it is a symptom that there is little to differentiate between a minor or a major event, should the hazard be realised.

Although a "most likely" and "worst credible" approach needs more data to score the hazards, the process can be assisted by using a spreadsheet or software to provide a ranking of hazards in order of risk. Assessing the risk in this way also helps a judgemental risk assessment as the "most likely" and "worst credible" scores provide a cross check of risk data for each hazard.

The frequency and consequence scoring criteria are shown in Figure 3 on page 8 and Figure 4 on page 10. The assessment of frequency and consequence should tend towards the historical evidence of incidents at a port or harbour, rather than completely unaided expert judgement. The risk scoring must also be the subject of a meeting involving a cross section of the same participants that were involved in the hazard identification exercise.

To populate a risk assessment, the most likely outcome of hazard realisation is assessed first against each of the consequence categories:

- Consequence to **People**
- Consequence to **Property**
- Consequence to **Environment**

- Consequence to **Harbour Stakeholders.**

Then the associated common frequency is added for the *most likely* case. The procedure is then repeated for the *worst credible* outcome.

The risk matrix **(Figure 5**, page 11**)** is then used, either manually or electronically, to identify the position of any risk within the matrix.

Using this four consequence approach to the risk assessment not only allows hazards to be assessed in relation to their impact on safety, but also on their impact on other areas vital to the continuing health of the port or harbour. Hazards providing high scores in a number of these measures will be obvious candidates for risk reduction in the next stage.

The worked example risk assessment at **Annex A** has been scored with frequency and consequence criteria at **Table A2.** This example is populated with risk numbers from the risk matrix and shows a hazard list ranked in order of risk. An A3 pull out is provided at the end of **Annex A** to assist with translating the data between **Table A1** and **Table A2**.

3.1.4 Stage 4 - Assessment of Existing Risk Management Strategies, Development of New Measures, Assessment of Control Adequacy Rating

The risk assessment process will output a prioritised list of hazards ranked by risk. The hazard identification process will also have identified causes (see worked example at **Annex A**).

Comparison of areas targeted by existing risk control with the risk profile will identify where additional risk management strategies can be considered, not only in areas where there may be gaps in existing risk management systems, but also where existing risk control measures may need radical overhaul, because of the hazard potential posed. Alternatively, there may be areas identified where the existing risk management system in place may benefit from a relaxation, allowing resources to be redirected into areas of greater risk.

Risk Control options are identified by reference to the key causes of highly ranked hazards. Common causes are often linked to a number of hazards. Using the causes as the reference material for a brainstorming exercise is recommended. Addressing causes of hazards in the risk control options results in solutions that address the underlying problems identified.

The brainstorming and identification of risk control options should be the subject of a further structured meeting involving key participants, with appropriate knowledge of the regulatory system available to the harbour and the organisation managing the port facility.

A simple list of risk controls relevant to the worked example can be seen at **Table B1**, **Annex B**. The risk controls have been mapped against the hazards that they address.

In general, ports and harbours around the globe have invested heavily in technical control systems (hardware solutions). This mirrors what has happened in many areas of shipping regulation. As the port safety system, like many shipping systems, relies very much on individual competence, the mechanisms that provide the greatest safety payback are often left untapped by hardware systems. It is widely accepted that 80% of marine accidents are the result of human error. It surely follows that paying attention to human and organisational performance in the development of risk management solutions provides real risk benefit at low cost. Organisational performance can be improved by reviewing roles and structure as well as by developing operational guidance that is clear and useable by those who influence the safety margin associated with marine operations.

When risk management options are complex, such as new radar sites or leads, and the risk benefit is unclear, cost benefit analysis techniques can be used to provide powerful information to support recommendations.

3.1.4.1 Control Adequacy Rating

All safety management systems must have a starting point for assessment purposes. They need to rely on a number of risk controls that have been recently introduced, or controls that are planned for introduction over a forthcoming period of time. The Control Adequacy Rating is a simple scoring process to assess how effective a package of risk control is at managing key risks. An assessment of Control Adequacy is made for key hazards posing high risk or with severe consequences of outcome. The rating is normally a judgemental score between 1 and 10, the value of which reflects the perceived status of the risk control at the time of assessment. A lower score identifies that the assessors recognise that the package of risk control can be improved, but that this cannot happen overnight. As confidence in the risk control package improves, the Control Adequacy Rating will rise. The Control Adequacy Rating recognises that it is impossible for all risk control to be instantly available and working 100%; some items may need to be budgeted for over more than one financial year. The Control Adequacy Rating is targeted at the upper end of the risk spectrum and facilitates continuous improvement of important risk defences.

Suggested descriptors for control adequacy rating are provided in **Figure 6** below.

1	2	3	4	5	6	7	8	9	10
Nothing is in place	Very little is in place		Improvements in progress		Reasonable measures are in place			Everything practicable is in place	

Figure 6: Adequacy of Existing Controls

4. MANAGING AND TREATING THE RISK VIA THE PORT AND HARBOUR SAFETY MANAGEMENT SYSTEM

4.1 Introduction

By this stage the regional council or port company will have the prioritised information, based on risk assessment, that it needs to introduce a safety management system which provides risk control where it is needed most. The key roles needed by the organisation to manage navigational safety should then be considered.

Many ports and harbours embarking on this process for the first time will already have some form of safety system in place, comprising components working in isolation. For example some form of implicit safety policy can normally be identified for different areas of the port or harbour. These are often hidden away and not immediately recognisable as such. In these cases the risk assessment is applied to add value to the existing system, informing it for development into a co-ordinated system managing risk.

Practical guidance about the structure and content of a safety management system is provided at **Annex C**. The rest of this section is dedicated to key issues needing to be considered during the installation of the safety management system.

4.1.1 The Port and Harbour Safety Management System

The successful introduction of a working Port and Harbour Safety Management System is not a small task and the time-scales needed to achieve this should not be underestimated. From experience of harbours and ports generally, the process often involves organisational change which will only occur if undertaken in a measured and planned way. **Figure 7** shows a simplified model of relevant components of a Port and Harbour Safety Management System.

Policy is set at the top of the organisation, with identified roles and responsibilities to discharge the policy being designed next. The new or changed risk control options and procedures originating out of the risk assessment process then follow. A key component is intelligence, which is kept refreshed by ongoing consultation with users and from the results of audit or review. Feedback from users of the safety management system significantly enhances intelligence, but only if the climate within or between organisations facilitates the information flow. If the feedback information flow is good, then the safety management system can provide an open and proactive feed-forward flow of information to all.

Figure 7: **Components of a Safety Management System for a Port or Harbour**

4.2 Safety Management System Challenges

The output of the risk analysis may lead to a change in the priority of safety policies or development of new safety policy areas. The introduction of new roles and new responsibilities to deliver those policy areas may also need to be considered, as well as the most appropriate organisation to do so. The risk assessment will have identified the types of safety management systems that are needed with respect to those that are already in place. This is where organisational factors immediately begin to surface as described in **Figure 8** below. When recognising that a harbour will be home to a number of organisations, issues such as different remits or cultures, aims and objectives are more difficult to solve. The Port Safety Management System needs be part of the Harbour Safety Management System, butachieving this takes time. Harbours that have achieved this find common objectives and reasons for working together to a common goal of safety management.

Common problems faced by organisations operating ports and harbours, before effective safety management is installed:	• Dilution of skills as experienced personnel are replaced by inexperienced personnel.
	• Changes in the demand on personnel in that tasks become significantly more frequent or more complex.
	• Insufficient exposure to certain types of tasks so that skills are not maintained adequately.
	• Complacency and misplaced confidence because of the lack of serious incidents.
	• Commercial pressures potentially resulting in compromises in established working practices.
	• Resistance & awareness to new environmental monitoring and forecasting systems, or the results of other new research.
	• Deterioration in the quality or availability of critical equipment.

Figure 8: **Organisational factors that must be changed or avoided by the Port or Harbour safety management system**

All of these factors can, in different ways, be linked to historic problems with the management function and organisational decision-making. Typically the introduction of a port or harbour safety management system would therefore routinely seek to review, uncover and address problems such as those shown in **Figure 9**. These examples all influence the likelihood of error occurring at the operational end, and all have been identified within organisations operating ports and harbours.

Organisation & safety culture	**Support for those at the 'sharp end'**
Poorly defined roles & responsibilities	Poor training
Unclear operational policy and objectives	Inaccurate or unrealistic procedures
Poor communication systems	Commercial pressures to take short cuts
Little workforce involvement or participation in decision making	Poor information flow
Autocratic management style, etc., etc.	Inadequate equipment, etc., etc.

Figure 9: Conditions Increasing Likelihood of Error

4.2.1 Introducing and Making Procedures work

All organisations have procedures, and an effective Port and Harbour Safety Management System is dramatically improved once these are effective. Implicit procedures will only be consistent once they are explicit. Central to the quality and acceptance of written procedures is the process via which they are developed. Experience demonstrates that the close involvement and participation of the ultimate users is essential to ensure technical quality of procedures, and the subsequent commitment to their use. Procedures developed in a technical vacuum, without the practical input of those who operate at the sharp end, are often inaccurate and unrealistic. Moreover, such procedures often encourage and subsequently legitimise routine violations and short-cuts.

Such violations, where individuals deliberately take actions or decisions different from those set out in training or existing procedures, are often quoted as one of the most common root causes of incidents within and outside of the marine industry. However, there is now a much greater understanding of the factors that increase the likelihood of procedural violations. Indeed, there is also a significant body of evidence that compliance with procedures is influenced by a wide range of factors over and above the acknowledged problems of inaccuracy and poor presentation. Much of this evidence has come from detailed investigations which have followed major accidents. These have demonstrated that, contrary to the common belief that the failure to use or comply with procedures is essentially an individual problem, many factors are under management control or are strongly influenced by what has become known as the 'organisational culture'.

For example, these factors include:

a) Absence of understanding or feedback on the consequences of violating procedures
b) Long term divergence between specified operating procedures and operating practices
c) Impractical or inaccurate operating procedures
d) Peer pressure to conform to existing 'norms' of behaviour
e) Lack of knowledge of why procedures are important.
f) A perception that an individual's status or superior experience negates the need to follow procedures.

It is important to recognise that training and procedures are essentially complementary methods of developing and sustaining best practice. Where written procedures are not in regular use, as is the case for the bulk of the work carried out within the marine industry, there is an implicit assumption that the skills and knowledge embedded in the procedure have been provided in initial training, and are regularly maintained via appropriate refresher training. In a good system close technical links would be apparent between agreed operating procedures, training and competence assessment.

4.3 The Key to the Safety Management Solution– The Harbour Master

A harbour system relies on a number of organisations to interface and work together and developing and maintaining a consistent safety standard for the harbour as an organisation takes time and effort. The industry is by its nature highly dependent on the quality of individual performance. Organisations needing to support the competence of individuals need to ensure that they have some key components in place and working effectively, including:

a) Systems which ensure the selection of competent personnel
b) Training support which ensures the development and maintenance of necessary competencies
c) Operating procedures which effectively address known areas of risk
d) A working regime which ensures adequate exposure to the full range of operational tasks
e) An operating environment and communication system which ensures that relevant operational experience is shared throughout the workforce
f) An audit system which ensures that individual performance standards are maintained.

Over and above these systems and procedural requirements, organisations that have achieved high levels of safety performance have typically embraced the following cultural changes:

a) Evidence of real workforce involvement in decision making
b) A less autocratic and more 'facilitative' management style
c) Consistency of purpose
d) Good communications and sharing of information
e) Influence based on competence rather than status or position
f) High level of interdependence and mutual respect amongst the workforce
g) Learning and improvement as central organisational features
h) Internal processes which are dynamic and responsive
i) Open attitude to new technology and continuous development.

For the marine industry, which has typically been highly compartmentalised and status orientated, the above represents significant cultural and organisational challenges. In any harbour system this concept has to reach across more than one organisation, making organisational interfaces and working relationships important. In the New Zealand harbour system, where the harbour master may not be directly attached to the port operations associated with the movement of craft/vessels or their safety and security whilst alongside, the person in that role becomes a *very* responsible and key player. In conceptual terms the New Zealand harbour master becomes the essence keeping the system together, sometimes across more than one port or harbour. Careful thought needs to be given to the organisational support of this role as the safety management system is designed.

4.4 Safety Management System Review and Audit

No safety management system is complete without a process of audit and regular review. These items are fundamental parts of the feedback system and it is feedback that provides the safety management system with its intelligence (**Figure 6**). The review process looks at the structure and functionality of the system to assist its development, whilst an audit checks out the day to day running of the system and the "buy in" by users. With the review comes the opportunity to review procedures in light of new data, information, new research, new products, new environmental monitoring or forecasting techniques.

A successful safety management system will evolve and be modified with the changing trade profile in the port or harbour and it will be a remit of the audit function to establish that this is happening. A review is recommended after the first six months of operation and it should be audited on an annual basis after that. The safety management system should have internal audits and external audits. A review of the key risks should also be undertaken on a regular basis. The frequency of review would vary in relation to the position of the hazard in the risk ranking made for the port or harbour. In the early stages of the safety management system a review of risks should be completed within three years of the safety management system's introduction. The process to drive the review of risks can be automated in a similar way to planned maintenance by the use of risk management software.

GLOSSARY

1. Accident	An occurrence that involves a vessel and in which— (a) A person is seriously harmed as a result of: (i) Being on the vessel; or (ii) Direct contact with any part of the vessel, including any part that has become detached from the vessel; or (iii) Direct exposure to the wash of the vessel or interaction (other than direct contact) between 2 vessels; or (iv) Being involved in the salvage of any vessel— except where the injuries are self-inflicted or inflicted by other persons, or when injuries are to stowaways hiding outside the areas normally available to passengers and crew; or (b) The vessel sustains damage or structural failure that— (i) Adversely affects the structural strength, performance, or seaworthiness of the vessel; or (ii) Would normally require major repair or replacement of the affected component; or (iii) Poses a threat to the safety of people on board the vessel; or (c) There is a complete or partial failure of machinery or equipment that affects the seaworthiness of the vessel; or (d) There is a loss of, or damage to, or movement of, or change in the state of, the cargo of the vessel which poses a risk to the vessel or other vessels; or (e) There is a significant loss of, or significant damage to, property (not being the cargo carried by the vessel) or the property of any person (whether or not on board the vessel), whether or not the loss or damage arises from an interaction between 2 vessels; or (f) There is a loss or escape of any substance or thing that— (i) May result, or has resulted, in serious harm to any person; or (ii) May pose a risk, or has resulted in damage, to the vessel or other vessels; or (iii) May pose a risk, or has resulted in damage, to any property (whether or not on board the vessel); or (g) A person is lost at sea (whether or not subsequently found) or is missing; or (h) The vessel is foundering, capsizing, being abandoned, stranding, missing, or has foundered, capsized, been abandoned, stranded, been in a collision, or has had a major fire on board.
2. Allision	See definition for Contact.
3. ALARP	As Low As Reasonably Practicable. A concept where the balance between risk, cost and safety margin is reasonably achieved.
4. Collision	An event where two navigating vessels or craft suffer an impact with each other.
5. Contact	An event where a vessel or craft strikes something fixed, such as a navigation aid

	or a heavy landing on a berth, or a bridge structure or deck. Contact is known as **Allision** in the United States of America and some other parts of the world.
6. Consequence	The outcome of hazard realisation.
7. Frequency	The potential rate at which a hazard may be realised. Sometimes referred to as likelihood or probability.
8. FSA	Formal Safety Assessment - IMO agreed risk methodology.
9. Hazard	Something with the potential to cause harm to: • Human Life • Property • Environment • Harbour Stakeholders.
10. HAZID	HAZard IDentification meeting. Structured meeting to achieve maximum information flow about hazards, causes and consequences.
11. Incident	Any occurrence, other than an accident, that is associated with the operation of a vessel and affects or could affect the safety of operation.
12. Incident Category	A method of categorising different events into, for example Collisions, Contacts or Groundings, for use in the risk assessment.
13. IMDG	International Maritime Dangerous Goods Code. A code which sets out packaging and separation requirements for smaller quantities of hazardous goods carried on board vessels, generally container or RoRo vessels.
14. IMO	International Maritime Organisation. London based, United Nations organisation responsible for setting international standards for shipping by the use of international maritime conventions.
15. Marine Ops.	Any aspect of navigating a vessel or craft to a berth, marina or mooring, maintaining its berthing safety and navigating a vessel or craft towards harbour or bylaw limits. Safety of cargo operations become included where they have potential to affect the navigational safety of the vessel or craft.
16. NABSA	An acronym for Not Afloat But Safely Aground. Used in many parts of the world to describe a berth in which the vessel is normally expected to take the bottom at some stage on the ebb tide.
17. Navigational	A vessel or craft is said to be navigating if it is able to transit for a distance of about two kilometres under its own power or using environmental conditions. **Navigational Safety Management** is the system of criteria, standards and competence that maintain the ability of a vessel or craft to navigate safely in confined waters such as are found in harbour areas.
18. Risk	A combination of: i) The frequency (likelihood, probability or chance) of a hazard realisation ii) The consequence (severity or impact) of the hazard reaching its potential.
19. SMS	Safety Management System.
20. VTS	Vessel Traffic Services.

A N N E X   A

TABLE A1:	Hazard Identification Worksheet Derived Hazard List with Frequency and Consequence Scores.
TABLE A2:	Hazard Worksheet Example of Ranked Hazards with Risk Matrix Scoring

Supporting Notes to the Worked Example

Table A1 shows a completed hazard list, which has been scored with frequency and consequence data relating to both the most likely and worst credible outcomes. A folded A3 pullout is at the end of the Annex so that the scoring can be referenced to the frequency and consequence criteria in chapter 2.

Table A2 follows Table A1 in the Annex. It shows the resultant risk matrix scoring across the four categories of consequence. The folded A3 pullout also contains the risk matrix, which can be used to reference the conversion of the frequency and consequence data in Table A1 to the risk data in Table A2. Table A1 has the hazards numbered in the order in which they were identified. Table A2 presents the hazards in the order of risk ranking. In both tables, hazards have been given the same unique number.

The example has been developed to assist the user and is not based on any port or harbour anywhere. It was developed in a spreadsheet, which was also used to provide the ranking of hazards (Table A2). With reference to Table A1, the hazard data has first been identified in relation to incident categories (e.g. Collision, Grounding) and then the area (i.e. geographic location) of the imaginary port in which the hazard could be realised is recorded (e.g. area A, B), and the vessel type or types affected by that particular hazard.

The hazard is given a unique title, which helps to avoid duplication, after which detail to describe the hazard is added. The causes are then considered separately. Most likely and worst credible consequences are next described, providing clarity for the consequence scoring.

The scoring process is entered into the data sheet next. The frequency scoring for most likely and worst credible has been highlighted by a yellow background. The frequency is derived from incident and near miss information or from operational experience in the port or harbour. The consequence scoring is entered in relation to the consequence categories of people, property, environment and port/harbour business. The most likely data set is entered first, followed by the worst credible data set.

The frequency and consequence data are then translated into the risk matrix scores shown in Table A2. The hazards in this worked example have then been ranked in order of risk, based upon the scoring data entered in Table A2.

Software is available to automate the process of risk assessment, however the data sheets shown in the worked example can also be readily created on a spreadsheet. If a spreadsheet is used, a second working sheet can be added and populated in parallel. A spreadsheet calculation can also be used for the ranking process using a data sort facility available in most common spreadsheet applications.

Once the risks are scored, the process of risk mitigation can begin. The first candidates for this are the hazards showing the highest risk ranking. The causal information is used to develop new or improve existing risk management systems. The Port and Harbour Safety Management System is thus provided with an informed starting point for its introduction.

Table A1: Derived Hazard List with Frequency and Consequence Scores

Hazard No.	Category	Area	Vessel Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Credible Consequence	Hazard Assessment: Most Likely					Worst Credible					Remarks
									People	Property	Environment	Stakeholders' Business	Frequency	People	Property	Environment	Stakeholders	Frequency	
1	Contact	D	All vessels	Inner harbour quays	Contact with jetty during berthing operation	Mechanical failure (steering or main engine). Vessel blackout. Misjudgement by pilot/master. Failure to appreciate weather or tidal effects. Failure to appreciate vessel power to weight ratio (bulk carriers).	Minor damage to bow or side plating of vessel. Minor damage to quay or fendering system.	Serious damage to side shell plating of vessel. Serious damage to quay/fenders.	0	1	0	1	1	0	3	0	3	2	Overhang of bow could topple cranes if too close to quay edge.
2	Personal injury	A	All vessels	Port approaches	Pilot boarding in port approaches	Vessel unable to make a suitable lee. Swell/weather boarding criteria exceeded. Pilot boat coxswain error. Pilot ladder incorrectly rigged. Incorrect clothing (PPE) worn by pilot.	Pilot sustains minor injury, bruising	Pilot falls onto pilot vessel or into the water. Rescue of casualty required. Fatality.	1	0	0	0	1	2	0	0	2	2	Scored in consideration that 1 or more times in ten years a pilot will fall onto the pilot boat and sustain serious injury (not a fatality). If fatality considered the frequency would drop to 3.
3	Grounding	A	All vessels	Grounding on Monks Bank	Grounding on Monks Bank during pilotage of deep draught vessel	Incorrect assessment taken of vessel's draught and squat during underkeel clearance calculations. Vessel transiting over bank too fast (increased squat). Incorrect chart datum assessed (hydrographic survey outdated). Bank shifted during inclement weather.	Indentation of bottom hull plating	Breach of hull plating, resulting in sinking (increased draught). Tugs required to pull vessel clear.	0	2	0	1	2	0	3	0	3	3	Extent of grounding damage is dependent on vessel's speed.

Hazard No.	Category	Area	Vessel Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Credible Consequence	Hazard Assessment – Most Likely – People	Hazard Assessment – Most Likely – Property	Hazard Assessment – Most Likely – Environment	Hazard Assessment – Most Likely – Stakeholders' Business	Hazard Assessment – Most Likely – Frequency	Hazard Assessment – Worst Credible – People	Hazard Assessment – Worst Credible – Property	Hazard Assessment – Worst Credible – Environment	Hazard Assessment – Worst Credible – Stakeholders	Hazard Assessment – Worst Credible – Frequency	Remarks
4	Collision	A	General cargo vessel	Collision in port approaches	Collision between one inbound, one outbound vessel (other than LNG) in the vicinity of Stubbs Bank	Non-compliance with collision regulations. Human error, improper lookout, lack of communication, radio channel congestion, equipment breakdown, incomplete passage plan, Third party vessel interfering with planned manoeuvres. Local congestion, difficulty in communication, manoeuvring to (dis) embark pilot, absence of VTS control. Multiple vessel convergence, especially in poor visibility. Non-collreg passing arrangements between vessels (e.g. green to green) - particularly if not appreciated by surrounding traffic.	Avoiding action fails resulting in glancing blow with moderate damage to one or both vessels. Delay to berthing.	Serious damage to vessels (T-Bone collision) Breach of hull integrity. Vessel(s) stranded. Port closure	0	3	0	3	3	1	4	4	4	4	Sub-standard crews of vessels required to be identified by Pilot during Pilot/Master exchange.
5	Collision	C	Tug	Collision when making fast forward tugs	Forward tug over-run by vessel during transit	Power failure on tug. Misjudgement by tugmaster. Poor forward visibility on inbound vessel.	Minor damage to tug/stem of vessel.	Tug holed in engine room. Sinks. Fatalities	1	1	0	0	4	4	3	2	3	4	Bow wave of vessel may interact with forward tug when making fast. Tugs normally make fast when vessel proceeding approximately 6 knots.

Hazard No.	Category	Area	Vessel Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Credible Consequence	Hazard Assessment – Most Likely: People	Most Likely: Property	Most Likely: Environment	Most Likely: Stakeholders' Business	Most Likely: Frequency	Worst Credible: People	Worst Credible: Property	Worst Credible: Environment	Worst Credible: Stakeholders	Worst Credible: Frequency	Remarks
6	Grounding	C	General cargo	Grounding during port transit	Vessel grounds during transit inward or outward	Channel is generally narrow, particularly off Seaway Island quay; this would be exacerbated if vessels were alongside that jetty. Initial lack of familiarity with vessel type - handling characteristics. Misjudgement. Lack of support from bridge team (passage plan and effective position monitoring). Inadequate Master/pilot exchange of information. Adverse weather conditions. Fishing vessel/leisure vessel impedes passage. Vessel fails to negotiate turn at riding buoy (e.g. due to steering or power failure). Tug not on station at Barber Point (to assist vessel at turn if required).	Damage to shell plating - possible water ingress and increase of draught. Berthing delay.	Major hull damage. Vessel stranded. Port closure. Possible loss of cargo if machinery disabled or extended stranding.	0	3	0	3	4	0	4	4	4	4	High water berthing only, therefore less risk of grounding.
7	Collision	B	LNG	Collision in port approaches	Vessel in collision during approach to port entrance	Generic - misjudgement by either vessel. Coastal traffic bound to and from other ports conflicting offshore. Difficulty in boarding pilot (weather conditions, ship rolling, access arrangements, etc.). Port traffic conflicting in final approach area - e.g. outbound vessel from East Channel fishing vessel/leisure vessel impedes manoeuvre. Vessel needs sea room to burn off excess cargo boil-off.	Avoiding action fails resulting in glancing blow with moderate damage to one or both vessels. No loss of cargo containment. Delay to berthing.	Severe damage to one or both vessels. Pollution and/or loss of cargo containment on LNG carrier. Fire/explosion. Loss of life.	1	2	0	1	3	4	4	4	4	4	Hazard taken to apply generally before pilot boards.

Hazard No.	Category	Area	Vessel Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Credible Consequence	Hazard Assessment: Most Likely – People	Most Likely – Property	Most Likely – Environment	Most Likely – Stakeholders' Business	Most Likely – Frequency	Worst Credible – People	Worst Credible – Property	Worst Credible – Environment	Worst Credible – Stakeholders	Worst Credible – Frequency	Remarks
8	Grounding	B		Grounding in port approaches	Vessel grounds in the port approach area off entrance to West Channel	Strong tidal set across entrance of West Channel. Late pilot boarding - e.g. due to difficulties boarding (weather, access arrangements, etc.). Vessel stands in too close prior to pilot boarding. Initial lack of familiarity with vessel type - handling characteristics. Lack of support from bridge team (passage plan and effective position monitoring). Inadequate Master pilot exchange. Loss of directional control of (active) escort tug. Misjudgement. Adverse weather conditions. Fishing vessel/leisure vessel impedes passage of inbound gas vessel.	Major damage to vessel. Partial flooding and increase in draught. Stranding. Possible loss of cargo to atmosphere. Lightering may be required to refloat vessel.	Loss of vessel and escape of cargo. Fire/explosion.	0	3	4	3	4	0	4	4	4	4	Policy is to build up experience in active towing but presently most escorting is passive with negligible effectiveness in the event of power/steering failure. Tugs are commonly released outbound before the vessel clears mid channel rock. Tidal set less of an influence because of more limited draught, when compared with a VLCC. Possible increased risk berthing bows east late on tide, but last time of entry would be about 2 hours before low water.

Hazard No.	Category	Area	Vessel Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Credible Consequence	Hazard Assessment: Most Likely – People	Most Likely – Property	Most Likely – Environment	Most Likely – Stakeholders' Business	Most Likely – Frequency	Worst Credible – People	Worst Credible – Property	Worst Credible – Environment	Worst Credible – Stakeholders	Worst Credible – Frequency	Remarks
9	Grounding	B	Aggre-gate dredger	Grounding in bridge approaches	Vessel grounds close to bridge (approaches)	Misjudgement exiting bend. Vessel equipment failure/malfunction (navigational, propulsion, steering, auxiliary, tugs). Human error (pilot, PEC, VTS, tug master). Environmental conditions (poor visibility, high current flow, unpredicted current eddies, channel size/depth). Unexpected windage effects. Vessel handling characteristics. Interaction, large vessel with bridge pier. (Increased squat) Positional error on exiting turn (proceeding upstream). Lack of way through water (loss of steerage) - large vessels, tide astern. Result of avoiding action (e.g. small craft or vessel exiting Galleons Point Marina, pier obscuration). Communication problems (unclear instructions, poor communication ability) Navigational failure (markers, lights) Organisational/procedural failure. Night vision (mistaken identity of nav-lights by bridge (or shore) lights). Interaction (piers causing small vessels to use centre span)	Temporary grounding	Blockage of nav channel in way of bridge span	0	0	0	0	3	1	2	3	3	4	No Remarks

Hazard No.	Category	Area	Vessel Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Credible Consequence	Hazard Assessment										Remarks
									Most Likely					Worst Credible					
									People	Property	Environment	Stakeholders' Business	Frequency	People	Property	Environment	Stakeholders	Frequency	
10	Collision	B	Bulk carrier	Danforth Bridge - Collision: large vessel with small craft	Large vessel (e.g. handysize bulk carrier) in conflict with workboat or small craft.	Vessel equipment failure/malfunction (navigational, propulsion, steering, auxiliary, tugs). human error (pilot, tug master). Failure to follow collision regulations. Environmental conditions (poor visibility, high current flow, unpredicted current eddies, channel size/depth). Reduced visibility.	Glancing blow	Serious damage to small craft, possible total loss.	2	2	0	1	2	4	4	2	3	3	Due to the availability of two side channels in addition to the main channel, risk of collision could be reduced.
11	Contact	B	General cargo	Danforth Bridge - Vessel contact with pier	Contact with bridge, pier or fendering	Vessel equipment failure/malfunction (navigational, port VTS, propulsion, steering, auxiliary, tugs). Human error (pilot, PEC, VTS, tug master). Environmental conditions (poor visibility, high current flow, channel size/depth).	Contact with pier - minor damage to hull plating.	Loss of hull integrity, rapid water ingress over more than one compartment. Blockage in main navigation channel. Port closure (up to 7 days).	1	2	0	0	1	4	4	3	5	3	Separate channels both sides of the main channel could still be used for smaller vessel traffic in the event of the main channel blocked by a sunken vessel, reducing the risk of a full port closure. The side channels also present an escape route for small craft.

End of Table A1

Table A2: Example of Ranked Hazards with Risk Matrix Scoring

Hazard No.	Rank No.	Category	Area	Ship Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely	Worst Credible	Assessed Risk: Most Likely				Assessed Risk: Worst Credible				Remarks
										People	Property	Environment	Stakeholders	People	Property	Environment	Stakeholders	
11	1	Contact	B	General cargo	Danforth Bridge - Vessel contact with pier	Contact with bridge, pier or fendering	Vessel equipment failure/malfunction (navigational, port VTS, propulsion, steering, auxiliary, tugs). Human error (pilot, PEC, VTS, tug master). Environmental conditions (poor visibility, high current flow, channel size/depth).	Contact with pier - minor damage to hull plating.	Loss of hull integrity, Rapid water ingress over more than one compartment. Blockage in main navigation channel. Port closure (up to 7 days).	6	8	0	0	7	7	6	8	Separate channels both sides of the main channel could still be used for smaller vessel traffic in the event of the main channel blocked by a sunken vessel, reducing the risk of a full port closure. The side channels also present an escape route for small craft.
10	2	Collision	B	Bulk carrier	Danforth Bridge - Collision: large vessel with small craft	Large vessel (e.g. handysize bulk carrier) in conflict with workboat or small craft	Vessel equipment failure/malfunction (navigational, propulsion, steering, auxiliary, tugs). Human error (pilot, tug master). Failure to follow collision regulations. Environmental conditions (poor visibility, high current flow, unpredicted current eddies, channel size/depth). Reduced visibility.	Glancing blow	Serious damage to small craft, possible total loss.	6	6	0	3	7	7	4	6	Due to the availability of two side channels in addition to the main channel, risk of collision could be reduced.

Hazard No.	Rank No.	Category	Area	Ship Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely	Worst Credible	Assessed Risk: Most Likely – People	Most Likely – Property	Most Likely – Environment	Most Likely – Stakeholders	Worst Credible – People	Worst Credible – Property	Worst Credible – Environment	Worst Credible – Stakeholders	Remarks
8	3	Grounding	B	LNG	Grounding in port approach	Vessel grounds in the port approach area off entrance to West Channel	Strong tidal set across entrance of West Channel. Late pilot boarding - e.g. due to difficulties boarding (weather, access arrangements, etc). Vessel stands in too close prior to pilot boarding. Initial lack of familiarity with vessel type - handling characteristics. Lack of support from bridge team (passage plan and effective position monitoring). Inadequate Master:pilot exchange. Loss of directional control of (active) escort tug. Misjudgement. Adverse weather conditions. Fishing vessel/leisure vessel impedes passage of inbound gas vessel.	Major damage to vessel. Partial flooding and increase in draught. Stranding. Possible loss of cargo to atmosphere. Lightering may be required to refloat vessel.	Loss of vessel and escape of cargo. Fire/explosion	0	5	6	5	0	6	6	6	Policy is to build up experience in active towing but presently most escorting is passive with negligible effectiveness in the event of power / steering failure. Tugs are commonly released outbound before the vessel clears mid channel rock. Tidal set less of an influence because of more limited draught, when compared with a VLCC. Possible increased risk berthing bows east late on tide, but last time of entry would be about 2 hours before low water.
1	4	Contact	D	All vessels	Inner harbour quays	Contact with jetty during berthing operation	Mechanical failure (steering or main engine). Vessel blackout. Misjudgement by pilot/master. Failure to appreciate weather or tidal effects. Failure to appreciate vessel power to weight ratio (bulk carriers).	Minor damage to bow or side plating of vessel Minor damage to quay or fendering system	Serious damage to side shell plating of vessel Serious damage to quay/fenders.	0	6	0	6	0	7	0	7	Overhang of bow could topple cranes if too close to quay edge.

Hazard No.	Rank No.	Category	Area	Ship Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely	Worst Credible	Assessed Risk: Most Likely: People	Most Likely: Property	Most Likely: Environment	Most Likely: Stakeholders	Worst Credible: People	Worst Credible: Property	Worst Credible: Environment	Worst Credible: Stakeholders	Remarks
4	5	Collision	A	General cargo vessel	Collision in port approach	Collision between one inbound, one outbound vessel (other than LNG) in the vicinity of Stubbs Bank	Non-compliance with collision regulations. Human error, improper lookout, lack of communication, radio channel congestion, equipment breakdown, incomplete passage Plan. Third party vessel interfering with planned manoeuvres. Local congestion, difficulty in communication, manoeuvring to (dis)embark pilot, absence of VTS control. Multiple vessel convergence - poor visibility.	Avoiding action fails resulting in glancing blow with moderate damage to one or both vessels. Delay to berthing.	Serious damage to vessels (T-Bone collision) Breach of hull integrity. Vessel (s) stranded. Port closure	0	6	0	6	2	6	6	6	Sub standard crews of vessels required to be identified by pilot during pilot/master exchange.
7	6	Collision	B	LNG	Collision in port approach	LNG vessel in collision during approach to port entrance	Generic misjudgement by either vessel. Coastal traffic bound to and from other ports conflicting offshore. Difficulty in boarding pilot (weather conditions, ship rolling, access arrangements, etc.). Port traffic conflicting in final approach area - e.g. outbound vessel from East Channel fishing vessel/leisure vessel impedes manoeuvre. Vessel needs sea room to burn off excess cargo boil-off.	Avoiding action fails resulting in glancing blow with moderate damage to one or both vessels. No loss of cargo containment. Delay to berthing.	Severe damage to one or both vessels. Pollution and/or loss of cargo containment on LNG carrier. Fire/explosion. Loss of life.	2	4	0	2	6	6	6	6	Hazard taken to apply generally before pilot boards.

Hazard No.	Rank No.	Category	Area	Ship Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely	Worst Credible	Assessed Risk – Most Likely: People	Most Likely: Property	Most Likely: Environment	Most Likely: Stakeholders	Worst Credible: People	Worst Credible: Property	Worst Credible: Environment	Worst Credible: Stakeholders	Remarks
6	7	Grounding	C	General cargo	Grounding during port transit	Vessel grounds during transit inward or outward	Channel is generally narrow, particularly off Seaway Island quay; this would be exacerbated if vessels were alongside that jetty. Initial lack of familiarity with vessel type - handling characteristics. Misjudgement. Lack of support from bridge team (passage plan and effective position monitoring). Inadequate master/pilot exchange of information. Adverse weather conditions. Fishing vessel/leisure vessel impedes passage. Vessel fails to negotiate turn at Riding Buoy (e.g. due steering or power failure). Tug not on station at Barber Point (to assist vessel at turn if required).	Damage to shell plating - possible water ingress and increase of draught. Berthing delay.	Major hull damage. Vessel stranded. Port closure. Possible loss of cargo if machinery disabled or extended stranding.	0	5	0	5	0	6	6	6	High water berthing only therefore less risk of grounding.
3	8	Grounding	A	All vessels	Grounding on Monks Bank	Grounding on Monks Bank during pilotage of deep draught vessel	Incorrect assessment taken of vessel's draught and squat during underkeel clearance calculations. Vessel transiting over bank too fast (squat). Incorrect chart datum assessed (hydrographic survey out-dated). Bank shifted during inclement weather.	Indentation of bottom hull plating	Breach of hull plating, resulting in increased draught requiring tugs to pull vessel clear.	0	6	0	3	0	6	0	6	Extent of grounding damage is dependent on vessel's speed.
2	9	Personal injury	A	All vessels	Port approach	Pilot boarding in port approaches	Vessel unable to make a suitable lee. Swell/weather boarding criteria exceeded. Pilot boat coxswain error. Pilot ladder incorrectly rigged. Incorrect clothing (PPE) worn by pilot.	Pilot sustains minor injury, bruising	Pilot falls onto pilot vessel or into the water. Rescue of casualty required. Fatality	6	0	0	0	6	0	0	6	Scored in consideration that 1 or more times in ten years a pilot will fall onto the pilot boat and sustain serious injury (not a fatality). If fatality considered, the frequency would drop to 3.

Hazard No.	Rank No.	Category	Area	Ship Type	Hazard Title	Hazard Detail	Possible Causes	Most Likely	Worst Credible	Assessed Risk: Most Likely: People	Assessed Risk: Most Likely: Property	Assessed Risk: Most Likely: Environment	Assessed Risk: Most Likely: Stakeholders	Assessed Risk: Worst Credible: People	Assessed Risk: Worst Credible: Property	Assessed Risk: Worst Credible: Environment	Assessed Risk: Worst Credible: Stakeholders	Remarks
5	10	Collision	C	Tug	Collision when making fast forward tugs	Forward tug over-run by vessel during transit	Power failure on tug. Misjudgement by tugmaster. Poor forward visibility on inbound vessel.	Minor damage to tug/stem of vessel.	Tug holed in engine room. Sinks. Fatalities.	2	2	0	0	6	5	3	5	Bow wave of vessel may interact with forward tug when making fast. Tugs normally make fast when vessel proceeding approximately 6 knots.
9	11	Grounding	B	Aggre-gate dredger	Grounding in bridge approach	Vessel grounds close to bridge (approaches)	Misjudgement exiting bend. Vessel equipment failure/malfunction (navigational, propulsion, steering, auxiliary, tugs). Human error (pilot, PEC, VTS, tug master). Environmental conditions (poor visibility, high current flow, unpredicted current eddies, channel size/depth). Unexpected windage effects. Interaction, large vessel with bridge pier. (Increased squat.) Positional error on exiting turn (proceeding upstream). Result of avoiding action (e.g. small craft or vessel exiting Galleons Point. Navigational failure (markers, lights). Organisational/procedural failure. Night vision (mistaken identity of nav-lights by bridge (or shore) lights). Interaction (piers causing small vessels to use centre span).	Temporary grounding	Blockage of nav channel in way of bridge span.	0	0	0	0	2	3	5	5	No Remarks

End of Table A2

A3 Pull-out for Reference

This part of this page is intentionally left blank.
Place "Hazard Identification Worksheet" or "Hazard Worksheet" here to match information below.

DEFINITIONS

Frequency

F1	Frequent	One or more times in 1 year.
F2	Likely	One event in 1-10 years.
F3	Possible	One event in 10-100 years.
F4	Unlikely	An event in less than 100 years.
F5	Rare	An event in less than 1,000 years.

Consequence

Scale	People	Property	Environment	Harbour Stakeholders
C0	Insignificant	Insignificant	Insignificant	Insignificant
C1	Minor	Minor	Minor	Minor
C2	Moderate	Moderate	Moderate	Moderate
C3	Major	Major	Major	Major
C4	Catastrophic	Catastrophic	Catastrophic	Catastrophic

Risk Matrix

CONSEQUENCE						
	C4	5	6	7	8	10
	C3	4	5	6	7	9
	C2	3	3	4	6	8
	C1	1	2	2	3	6
	C0	0	0	0	0	0
Frequency		F5	F4	F3	F2	F1

ANNEX B

Risk Control Options Mapped to Hazards

Table B1: Risk Control Referenced to Hazards in Annex A

Risk Control	Title	Description	Risk Control applies to Hazard No:										
			1	2	3	4	5	6	7	8	9	10	11
1	Pilot expertise/training	Pilots are trained to national standards and system of competence confirmation to be introduced.	☑	☑	☐	☐	☑	☑	☐	☑	☐	☑	☑
2	Tug master's expertise	Tug Masters to be experienced before appointment and pilots and tug exchange visits are to occur.	☑	☐	☐	☐	☑	☐	☐	☐	☑	☐	☑
3	Anemometer	Wind speed indication and information from Port Traffic Service.	☑	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑
4	Leading line	Leading Line assists in maintaining position in the channel.	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☑
5	Bridge procedures - passage plans	Vessels produce passage plans for transit.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑
6	Two side channels	Small vessel can navigate in side channels reducing risk of collision.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐
7	IPRCS (CollRegs)	International Regulations for the Prevention of Collisions at Sea.	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	☐
8	Master expertise/training	Masters and deck officers are trained to STCW standards.	☐	☑	☐	☐	☐	☐	☐	☑	☑	☐	☐
9	Notices to Mariners - No. 1 of 2000	Small vessels required to give clear passage to large commercial vessels in port approaches.	☐	☑	☑	☐	☐	☐	☐	☑	☐	☐	☐
10	Inadequate UKC	Underkeel clearance not properly calculated or insufficient squat allowance.	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐
11	High water berthing only	Vessels only berth at high water, increasing underkeel clearance and effective channel width.	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐
12	Tug available to hold vessel alongside.	Tug available to assist berthing vessel alongside.	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑
13	Port passage plans	Passage plans prepared and promulgated by port (on website) to assist masters in planning correct approach.	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐
14	Pilot boarding position	Pilot boarding position to be moved well to seaward of abort point for channel entrance.	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐
15	Control of vessel movements	Port will introduce management of vessel movements (small craft) in channel approaches.	☐	☐	☐	☐	☐	☑	☑	☑	☐	☐	☐
16	Pilot coxswain expertise	Coxswains well trained and experienced in serving ships offshore,	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐
17	PEC holder competence	PECs to be trained and examined to new pilotage procedures.	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐

A N N E X C

Safety Management Systems
Guidance for Preparation

Table of Contents

Introductory Notes

Use of This Document

This Annex is set out as a framework for compiling Harbour Safety Management Systems in accordance with the requirements of the New Zealand Port and Harbour Marine Safety Code. It may also be used for compiling Port Safety Management Systems, with appropriate changes.

This Annex uses a framework of recommended headings and subheadings and contains advice as to appropriate content under each heading. Where possible, the Annex also contains examples. Although Annex C contains generic ideas which a port or harbour may decide to adopt, they are mainly intended to indicate the type and depth of detail required – **this Annex is neither intended to be exhaustive nor definitive, highly detailed or weighty;** instead it is an overarching summary document – made available for general information - which can help a port or harbour set out its policies in full. It can also help when summarising the organisation, responsibilities and procedures of a safety management system by describing and outlining - concisely - the function of each role within the system.

Notes

In this Annex:

1. The term “the Code” refers throughout to the New Zealand Port and Harbour Marine Safety Code.

2. The term “near miss” means any occurrence that, under slightly different circumstances could have given rise to an incident. Damage may have been avoided by a random combination of circumstances (luck) or purposeful intervention (recovery). It includes situations where all available safeguards were defeated but no actual loss occurred.

3. The term “harbour management” refers collectively to the activities required to maintain the port or harbour in a safe and suitable condition for navigation - i.e. “fit for use” - by ordinary users of the port. It typically includes but is not necessarily limited to dredging, surveying, provision and maintenance of aids to navigation, removal of wreck and other debris, promulgation of port user information, maintenance of quays, bollards, fenders, etc.

4. The term “Marine Services” refers to the provision of commercial or other services within the port or harbour and includes the operation of pilot boats, work boats, harbour launches, barges (non and self-propelled), floating cranes and fenders, mooring gangs, etc.

1. EXAMPLE SAFETY MANAGEMENT SYSTEM MANUAL

1.1 Introduction

ADVICE:

This section clearly sets out the purpose of the manual, which is to describe the overall framework for the management and co-ordination of all marine activities necessary for navigational safety.

The text confirms that the Safety Management System arrangements set out in the manual comply with the NZ Port and Harbour Marine Safety Code (and any other relevant legislation).

The body(ies) responsible for maintaining the design, overall content and subsequent management of the SMS are identified, and also the body(ies) responsible for approval of such arrangements.

1.2 Port and Harbour Marine Safety Code Requirements

ADVICE:

The SMS procedures and guidelines should fulfil the requirements of the Port and Harbour Marine Safety Code. This section sets out the policy areas where the SMS affects and interacts with port and harbour operations including:

- Making risk control the basis of all relevant marine activities, procedures and regulations applied to or required of port and harbour users
- Using risk assessment to identify the requirement for navigation aids (refer to the Guidelines for the Management of Aids to Navigation in NZ)
- Applying risk assessment to all harbour works
- Maintaining systems to implement the findings of risk assessments
- Maintaining appropriate plans and procedures for emergency response and associated training/exercises
- Using verification/audit systems.

Important policy areas of specific relevance to the port are also identified - for example:

- Identifying and designating safe pilot boarding and landing areas
- Applying and adhering to current pilot transfer arrangement regulations
- Reporting deficiencies on visiting vessels
- Providing procedural advice for giving directions in relation to dangerous vessels or substances.

The Regional Council or Port Company should specify how frequently it intends to undertake a formal review of how it meets the requirements of the Port and Harbour Marine Safety Code (e.g. a full review every three years).

1.3 System Components

ADVICE:

The focus of the harbour's safety management system (and that of any port company operating within it) should are clearly identified. As a guide, this will normally include, but not be limited to:

- Traffic management
- Pilotage
- Harbour management
- Tugs and towage
- Harbour craft (pilot boats, workboats), etc.
- Leisure users.

The items that comprise the system are then identified. This will include documents (including electronic documents such as databases and risk management software), systems and procedures, such as:

- SMS Manual (this document)
- Policies
- Code application assessment
- Memoranda of understanding
- Risk assessment and risk control measures, including:
  - > Navigation safety bylaws
  - > General directions (if appropriate)
  - > Pilotage directions
  - > Notices to mariners
  - > Passage plans
  - > Standard operating procedures
  - > Accident, incident and near miss investigation systems
  - > Emergency response plans
- Rolling SMS action plan
- Obtaining contributions to the SMS development process by stakeholders
- Audit and review.

2. POLICY

A D V I C E :

The Harbour Safety Policy may consist of a number of policy element, including complementary marine operational policies that describe the arrangements that have been established to monitor and manage the safety of marine operations.

The Code requires that the Regional Council or Port Company exercise their statutory and regulatory duties through the auspices of its safety management system. The overall safety policy therefore addresses all areas where such duties apply including:

- General policy
  - > Statement of commitment
  - > Enforcement
  - > Conflicts of interest
- Navigational safety policy
  - > Supporting marine policies
    - - Pilotage
    - - Harbour management
    - - Traffic management/control (VTS)
    - - Tugs and towage
- Other policies
  - > Marine services and harbour craft operations
  - > Health and safety (of marine operations)
  - > Control of dangerous goods and substances
  - > Protection of the environment

The links between policy, organisational structure and administration of the Safety Management System are illustrated in Figure 1 below.

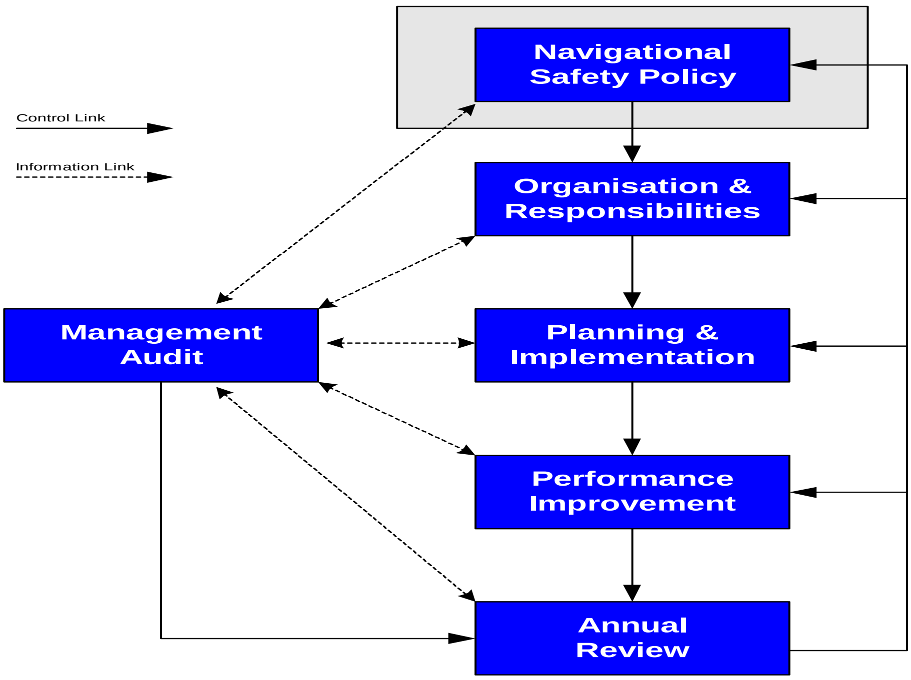

Figure 1: Example Links Within the Safety Management System

2.1 Policy Development & Communication

ADVICE:

The Harbour Safety Policy is developed by the Harbourmaster in conjunction with any port company within the relevant area of jurisdiction. This section summarises how policy has been developed, approved and promulgated for use in the port or harbour. It also includes reference to appropriate risk assessment, stakeholder input and review processes to update and promote the development of the safety management system.

Key policies usually define key performance indicators (e.g. incidents – frequency and severity) and defined targets (e.g. zero incidents).

2.2 General Policy

2.2.1 Statement of Commitment

ADVICE:

This section sets out the harbour or port's intentions and commitment to safety in meeting legislative responsibilities. The policy contains an unequivocal commitment to comply with the requirements of the NZ Port and Harbour Marine Safety Code by:

- Regulating marine operations in a way that safeguards the harbour, its users and stakeholders, the public and the environment
- Ensuring that relevant assets of the harbour are managed safety and efficiently
- Ensuring the provision of adequate resources (including staff training) to discharge its navigational safety obligations
- the methods through which it obtains stakeholders, input on matters of navigational safety and receives and disseminates information to and from users of the waterway.

This commitment is likely to be undersigned by the Chief Executive of the Regional Council (Territorial Authority) and Port Company.

2.2.2 Enforcement

ADVICE:

This section describes the means by which local enforcement will be discharged to influence compliance with:

- Bylaws
- Pilotage directions
- General directions
- Special directions
- Other powers, e.g. s650E Local Government Act 1974.

The resources that are available for this function are also identified.

2.2.3 Conflicts of Interest

A D V I C E :

Where a regional council is a shareholder or has equivalent commercial interests in a port company within the area referred to by the SMS Manual, the policy statement identifies the measures and systems adopted to ensure that commercial pressures do not interfere with the effective discharge of the public interest and navigational safety duties.

2.3 Navigational Safety Policy

A D V I C E :

This section takes the form of a declaration of the overall navigational safety policy objectives. Typical stated objectives might include the following:

- Comply with all legal duties and responsibilities for the regulation of vessel traffic and the safety of navigation
- Develop and maintain an effective Safety Management System based on the continuing assessment and mitigation of risk
- Maintain access to port services, by ensuring the provision of appropriate pilotage, traffic management, towage, and berthing services
- Develop a consensus for safe navigation through stakeholder input
- Ensure that suitable anchorages, mooring locations and the best channels for navigation, are determined, marked, monitored and maintained
- Sustain its harbour management functions in respect of hydrographic surveying, navigation, dredging, and the provision and maintenance of navigation aids
- Remove sunken vessels and other obstructions that are, or may become, an impediment to safe navigation
- Promulgate relevant navigational, tidal and weather information to all port users as determined by the risk assessment
- Facilitate the leisure use of the port, maintaining and protecting the rights of the public to access its waters for leisure use, whilst complying with the various navigational safety measures that may be in force
- Create awareness and motivation of all port users with respect to safety and the protection of the environment
- Publish and maintain contingency plans to cover emergency situations relating to the safety of life, property or the environment
- Maintain appropriate emergency and oil spill response capabilities
- Ensure that all port or harbour operational staff are trained to recognised standards and have appropriate experience for their roles and duties
- Ensure that working craft, including tugs, pilot boats and work boats are fit for their purpose and operated to appropriate safety standards
- Review regularly duties and powers required to support and maintain an up-to-date set of bylaws in respect of navigational safety and enforce them so as to effectively regulate and facilitate harbour use
- Keep under review the cost effectiveness of modern technology for harbour monitoring.

2.4 Supporting Marine Policies

A D V I C E :

Within the overall Harbour Safety Policy, and particularly for larger ports and harbours, separate specific policies are usually developed for complex "key operational areas" such as pilotage and harbour management. They may also be developed for other key areas including traffic management (VTS), towage, harbour craft, and leisure use of the port or harbour. If such separate supporting policies are not produced, the appropriate detail is included in the main navigational safety policy.

It is recommended that written standard operating procedures be developed to support the implementation and delivery of each supporting marine policy.

2.4.1 Pilotage

A D V I C E :

A typical pilotage policy would usually cover the following:

- To ensure that pilots are recruited, trained, examined and authorised to the required industry standards and in compliance with current pilotage legislation
- To examine masters and mates of vessels regularly using the port, for pilotage exemption certificates (PECs)
- To promote a close and integrated working relationship between pilots, PEC holders, port control and the Maritime Safety Authority;
- To promote the use of port passage plans by vessels using the harbour and the generation of generic port passage plans to assist masters in producing specific plans
- To periodically review, in liaison with the Maritime Safety Authority, the requirements for compulsory pilotage, reporting requirements and boarding and landing areas
- To regularly review, in liaison with the Maritime Safety Authority, the pilotage service and exemption system to ensure that they continue to reflect the requirements of the port with regard to the safety of navigation
- To develop and maintain pilotage procedures to achieve the objectives set out in this subsection.

*Note: The Safety Management System Manual identifies safe pilot boarding and landing areas. The pilotage policy (or the main safety policy if no separate pilotage policy is published) should include a commitment to this.

The overall pattern of each supporting marine policy is usually the same – provision of services and facilities, maintenance of them, means of monitoring their performance and periodic review processes.

2.4.2 Harbour Management Policy

ADVICE:

The Harbour Management Policy (or main Navigational Safety Policy if no separate Harbour Management Policy is published) is similarly structured and includes the measures adopted to find, mark and monitor an appropriate navigational channel(s) in the harbour as described in the Code, including, but not limited to:

- The policy on dredging and maintenance of channel depths
- The frequency of routine surveys and the criteria giving rise to special surveys
- The methods and frequency of disseminating the information found to port users;
- The provision and maintenance of adequate navigation aids, consistent with port user requirements to facilitate safe navigation within the harbour and its approaches
- The commitment to keep channels clear of wrecks, obstructions or other dangers
- Developing procedures to achieve the objectives of this policy.

2.4.3 Traffic Management Policy

ADVICE:

The policy on traffic management/control/VTS will vary widely between ports harbours. This section clearly describes what is aimed for in terms of traffic management, where appropriate making reference to national guidelines and IALA standards. It also describes how this will be achieved, both in terms of resources and method e.g. by the provision of suitable equipment, training of marine operators to appropriate standards (for example, IALA V-103 standard etc.) and the delegation of the Harbourmaster’s authority.

2.4.4 Towage Policy

ADVICE:

If the risk assessment determines a requirement for tug assistance, towage guidelines will be produced. Their purpose is to determine the provision of adequate towage capacity in the harbour for the expected requirements of port users, and that tugs have appropriately trained and qualified crew.

Towage policy contains a commitment to develop and maintain towage guidelines by the port companies, port users, towage providers and pilots. It also states the basis on which towage is provided in the harbour, the criteria for determining the adequacy of towage capacity and the process through which the Harbourmaster will approve the Towage guidelines.

2.5 Other Policies

ADVICE:

Separate policies may be similarly developed for other areas including:

- Marine services and harbour craft operations
- Health and safety (of marine operations)
- Control of dangerous goods and substances
- Protection of the environment
- Leisure users.

3. ORGANISATION & INDIVIDUALS

3.1 Functional Structure for the Management of Navigational Safety

ADVICE:

This section shows the functional structure for the management of navigational safety within the harbour or port. The highest tier of management in the regional council (a person referred to in the Code) is clearly identified, together with the lines of authority and reporting. A family tree illustration is often useful to show an organisational structure for a medium or large harbour with the Harbourmaster as the designated person of the Regional Council and the Port Safety Officer as designated person of the Port Company.

In smaller harbours and ports, some of roles will be combined but an illustration allows all stakeholders to understand the relationships between key individuals and organisations.

3.2 Individual Accountability and Responsibilities

ADVICE:

This section should set out the safety management functions of the personnel or departments identified in the organisational diagram referred to in the functional structure for the management of navigational safety mentioned above. The individuals referred to should at least include:

- The Chief Executive
- Harbourmaster
- Designated Person (DP)
- Others who have roles/responsibilities relevant to the Safety Management System.

3.3 Duties of the Organisation

A D V I C E :

The duties of the Regional Council or Port Company relevant to Safety Management are then to be described, as in the following typical example:

- To discharge the duties and exercise the powers given to it, both directly and by delegation, as it's considers appropriate
- To discharge the function of duty holder as defined in the Port and Harbour Marine Safety Code by ensuring compliance with the Code, and the safe management of navigation
- To ensure that adequate financial, material and personnel resources are available for the discharge of its duties under the Code
- To seek and adopt appropriate powers for the effective enforcement of procedures identified under the requirements of the Code
- To approve the strategy, policies, plans and budgets together with strategic objectives
- To review performance against its strategic and operational objectives, plans and budgets.

The relevant (safety management) functions of committees and subcommittees or other consultative groups with executive powers are similarly listed.

3.4 Memoranda of Understanding and Delegations

A D V I C E :

Examples of areas that (if applicable) will be covered by memoranda are:

- Arrangements for incorporation of port safety management systems into the regional council harbour safety management system
- Responsibility for hydrographic surveying
- Responsibility for the provision and maintenance of navigational aids
- Arrangements for traffic management services.

The Code requires that each instrument of delegation or memorandum of understanding be included in Safety Management System documentation. Any relevant instruments or memoranda of understanding are therefore referred to in this section and included in a suitable appendix to the Safety Management System Manual.

4. IMPLEMENTATION

4.1 Code Application Assessment

ADVICE:

The first priority of the regional council is to develop a harbour management system for any port areas with pilotage limits within the region. However once this is complete, or for regional councils without pilotage limits in their region, the next step is to undertake a Code Application Assessment (high level risk assessment).

The Harbourmaster is required to undertake a Code Application Assessment (high level risk assessment) to determine to which operations and in which areas of the Authority's jurisdiction the Code will apply.

The results of the Code Application Assessment are described in this section, together with the reasoning and any other relevant information.

4.2 Port or Harbour Risk Assessment

ADVICE:

The methodology of the port or harbour risk assessment process is described in this section, including any differences to the methodology described in the guidelines that precede this Annex. Appendix A of this Annex (i.e. Annex C) contains an example.

The results of the risk assessment is also summarised in this section in general terms, indicating where the highest levels of identified risk occurred.

Copies of the current risk assessment should be appended to the SMS Manual as per the example shown in Annex A of this Guideline.

4.3 Port or Harbour Safety Plan

ADVICE:

The port or harbour safety plan describes how the risks identified in the risk assessment will be controlled or managed and by whom.

Copies of the current "risk control options mapped to hazards" document should be appended to the SMS Manual as per the example shown in Annex B of this Guideline.

4.4 Rolling SMS Action Plan

A D V I C E :

To support strategic safety objectives, the Harbourmaster, in consultation with port staff and users will usually set particular objectives at the operational level. These are intended to promote and sustain the development of the SMS *and are set out in this section. Typical objectives could include but not be limited to:*

- Ensuring all reasonably practicable steps are taken to identify the hazards and risks arising from operational activities
- Reducing risks to as low as is reasonably practicable
- Ensuring conformance with applicable port and maritime legislation, the port or harbour's navigational safety and marine policies and associated operating procedures
- Periodically reviewing data gathered from audits, inspections, incidents and any concerns raised to evaluate and determine where improvements and changes need to be made
- Implementing employee competence training and SMS awareness programmes.

The above may be implemented by means of a 'Rolling SMS Action Plan' for the continuous monitoring of objectives and recommendations requiring implementation.

5. RISK MANAGEMENT SYSTEMS

A D V I C E :

Any safety management system is underpinned by operating procedures and standard working practices. This section outlines the procedures and working practices currently in place in the port to control and minimise risk in marine operations.

5.1 Standard Operating Procedures

A D V I C E :

Outlines of the scope of the port or harbour's main operating procedures are included here. Typically, these will include, but not be limited to, the following key areas:

- Traffic management or control
- Pilotage
- Use of passage plans (for piloted and non-piloted vessels)
- Tugs and towage
- Harbour management
- Provision of berths and berthing procedures
- Dredging operations and maintenance works
- Workboats and pilotboats
- Control of dangerous goods and substances.

Some examples of typical standard working procedures/practices are contained in Appendix B.

5.2 Standard Working Practices

A D V I C E :

Standard working practices will apply across a range of activities, and not only those covered by the above procedures. Typical examples of where standard working practices are likely to be adopted include general systems of work, permit to work systems, protection of the environment and communication pathways. Some examples of typical standard working procedures/practices are contained in Appendix B.

5.3 Emergency Response

A D V I C E :

The port or harbour Emergency Response Plan for safety and environmental accidents and incidents is summarised in this section and usually included as an Appendix and an explanation is provided describing how the Emergency Response Plan integrates with adjacent local and national bodies, commercial organisations, voluntary groups, etc.

5.4 Accident, Incident and Near Miss Investigation and Records

A D V I C E :

This section outlines the system adopted for recording and investigating accidents, incidents and near misses, the action taken to prevent recurrence and promulgating the lessons learned. It also identifies the post holder responsible for these functions.

6. TRAINING

ADVICE:

Training is a key element within the SMS. The principles the organisation follows in the training of personnel should be explained in this section. Areas covered include:

- Safety induction
- Identification of competency requirements (based on task assignments)
- Identification of needed skills (based on personnel assessments)
- Provision of suitable training (externally sourced or in-house)
- Personnel ability/performance appraisal systems
- Competence and training records.

7. AUDIT & REVIEW

7.1 Audit

ADVICE:

The auditing process of the SMS aims to provide input into the system ensuring continuous development by independent feedback.

The objectives and an outline of the procedures to be followed for the audit of the safety management system should be referenced in this section. The following list contains typical examples of audit objectives:

- To determine if the SMS is being operated in accordance with the port's navigational safety policy and, the provisions of the Port and Harbour Marine Safety Code
- To monitor the overall effectiveness of the system
- To support the continuous improvement in navigational safety performance.
- To confirm that SMS procedures are understood and being actioned by those involved
- To determine whether the port's marine operations and navigational safety and security procedures remain appropriate and effective, thus comprising effective SMS components.

7.2 Risk Assessment Data/Archive

A D V I C E :

The regional council and/or the port company will maintain a record of all identified hazards, together with the associated risk control measures employed to mitigate those hazards.

This section outlines the system adopted in the port or harbour for managing data, including the methods and frequency of review of both hazards and risk controls.

Whilst it may be possible in small ports to operate a paper-based system, it is usual for this data to be kept in the form of an electronic database; which is sufficiently comprehensive, easily updated and queried (with output reports). This approach is generally used to achieve a robust self-audit trail.

7.3 SMS Review

A D V I C E :

The identification and assessment of navigational hazards is central to the effective maintenance of the SMS. In general, the review of hazards and control measures will be initiated by one of the following:

1) Planned (periodic) review of established hazards and risk controls
2) Investigation of an incident or near miss
3) Risk assessment of a new or significantly changed trade or marine operation.

In this section, the system implemented is outlined for the continuing review of both new and existing hazards and their preventative control measures in each of these circumstances. In each case, the method of undertaking the review should be identified and in the case of planned reviews, the frequency should be described.

Appendix A

SMS Risk Assessment Statement

Risk Assessment (Example of Methodology)

The Port and Harbour Marine Safety Code requires that the safety management system be based on risk assessment. This is also the principle that underpins the safety culture necessary to achieve incident-free operation.

The risk assessment process systematically identifies the hazards and consequences, which may occur, or arise from, the activities of the harbour. The scope is all encompassing and includes navigational, geographical, weather, operational, and vessel-related activities.

The initial risk assessments were obtained from the results of the study carried out in [*the year it was done*]. These risk assessments reside in a hazard management system database; they are subject to periodic review and continuous audit – both facilities being built into the software. The risk assessments will be maintained and amended in response to evolving changes within the harbour.

Purpose

To assess the risk of a given hazard developing its potential for harm, in terms of consequence to life, property, the environment or harbour stakeholders. The assessed risk can then be considered in relation to any measures already in place to control it and additional risk control measures can be considered, if necessary, in order to bring the risk to a condition known as "As Low As Reasonably Practicable" (ALARP).

Method

- Identify hazards and possible consequences by means of personnel interviews, consultation with relevant stakeholders, review of incident data and "HAZID" workshops.
- Evaluate the risk associated with the hazard in terms of frequency (likelihood) and consequence to life, property the environment and the harbour in both the most likely and worst credible scenarios, using the criteria set out below.
- Identify and evaluate measures (risk controls) currently in place. Risk control measures include both those that prevent or reduce the probability of occurrence and those that mitigate the consequences if they do occur.
- Assess whether measures currently in place are adequate for the control of the risk (ALARP) and if not, identify and evaluate further potential risk control (prevention and mitigation) options.
- Implement selected risk control measures as necessary to bring the risk to the ALARP condition.
- Monitor activities to ensure that the measures implemented do reduce risk and enable relevant objectives to be met.

Appendix B

Examples of General SMS Procedures

SMS Documentation Management Procedure (Example)

Purpose

The purpose of the documentation and record system is to record the current status of:

- Safety policy objectives and plans
- Key roles and responsibilities, authority and lines of communication
- Standard operating procedures and work instructions for critical activities and tasks
- Risk assessments and risk control
- Emergency response plans, and the means of responding to incidents and potential emergency situations.

Its purpose is also to make the above information available and comprehensible to all personnel who require it.

Method

Identify all documents comprising the Safety Management System with appropriate notation. The system must be clear, concise and user-friendly.

Distribution of NSMS documents should only be via controlled copies and a register should be maintained. Document holders must confirm receipt. Procedures must be in place for the amendment of controlled copies and include verification that amendments have been carried out by the document holder.

Key Performance Indicators

- Establishment of workable distribution, filing and indexing system.
- Personnel awareness of system (Appraisal).
- Evidence of ongoing development of the system.

Defined Targets

- Maintenance of the integrity of the system.
- Only have controlled copies in circulation.
- Full understanding of the system by users.

SMS Safety Reports Procedure (Example)

Purpose
To provide the port with a regular report on the safety performance of the harbour and the effectiveness of the Safety Management System.

Method
An annual safety report shall be compiled by the Harbourmaster which should include statistics and supporting information on incidents or near misses during the past year, including:

- Collision/contact
- Fire/explosion
- Vessel grounding
- Loss of vessel stability, hull integrity
- Pollution/environmental incidents
- Dangerous occurrences and near misses.
- Accidents and lost time injuries.

The report should also include references to current defects affecting marine safety and the results of Audits by the designated person.