Key Principles for Marine Safety Risk Management
Foreword

Connection to the New Zealand Port & Harbour Marine Safety Code

This document is designed to be read alongside the New Zealand Port & Harbour Marine Safety Code 2020 (the Code), particularly in relation to the development and maintenance of marine safety management systems and associated management of risks.

The Code and the principles for marine safety risk management are additional to the legislative requirements of the Maritime Transport Act 1994 and other legislation. The Code documents provide good practice standards.

Under the Code, risk management is a shared responsibility. It involves harbourmasters and regional councils, port and facility operators, Maritime NZ and harbour users.

This document supports people with risk management responsibilities, with a focus on acting consistently under the Code. It is relevant to decision makers and people applying risk management tools or procedures, and contains:

- information on marine accidents that risk management seeks to avoid
- guiding principles on application of risk management, and
- recommended common terminology.

These three topics (marine accidents, guiding principles and terminology) are all relevant to people working on marine risk management. The focus of this document is acting consistently under the Code rather than prescribing practice that will necessarily differ across regions. Examples are given to illustrate the principles. Importantly, it is not a step by step guide to risk assessments and risk management.

The principles are designed to assist those involved in Code peer reviews, and support rich and effective conversations on risk management. For example, common use of risk management terminology will assist understanding of, and use of, documents prepared under the Code.

Giving effect to the principles can occur alongside the methodology for risk management being employed by ports and harbours. Wide scale restructuring of existing systems and processes is neither expected nor desired.

A move away from prescriptive guidelines

The approach set out in this document – principle based – is a change of direction from the previous technical guideline under the Code. There are no templates and the legislative requirements are not set out in detail.
The document may raise questions about different methodologies. This is the intention. Putting the principles into practice may lead to insights into strengths and weaknesses of risk management tools.

Success with risk management will increase if those involved question and explore the use of available tools, beyond what is standard practice.

Because this is a change of approach, this document will need to be reviewed regularly—at least every two years. It is important to capture experience, lessons learned and reflections as they relate to marine risk management.

The Code Working Group believes that for every port and harbour the local circumstances, knowledge and available resources will influence how the principles are put into practice. Sharing experiences will continue to be important.

**Capability**

The expectation is that those with responsibilities for safety management plans and associated risk management have an understanding of, and experience with, processes, relevant guidance and available methodologies. Employers have a corresponding responsibility for training and support.

Code members (councils, ports and Maritime NZ) have demonstrated a commitment to preventing events and incidents that have the potential to cause harm from occurring. An associated objective is ensuring sufficient capability to respond adequately if prevention is unsuccessful. The principles and associated marine examples outlined in this document support these outcomes.
Acknowledgements

We would like to sincerely thank the following people and organisations who contributed significantly to the preparation of this document for the NZ Port & Harbour Marine Safety Code: Sean Patterson (Maritime NZ); Luke Grogan (Marlborough District Council); Ruth Parris (Napier Port); Josh Rodgers (CentrePort); Kathy Perreau (contract technical writer); David Mulholland (Maritime NZ). We acknowledge also a number of people and organisations outside Code membership who provided useful feedback during the development stages of this document.
1. Overview

This principles document supports the New Zealand Port & Harbour Marine Safety Code 2020 (the Code). It is relevant to decision makers and people applying risk management tools or procedures – usually marine operations managers and harbourmasters.

In line with the Code, the scope of the document is wider than navigation and includes ship to shore activities. Commercial and recreational activities are relevant, and geographic areas extend to inland and coastal waters as appropriate.

An emphasis on principles for risk management endorses a systems thinking approach and highlights the complexity of risk in the marine environment.

The focus is on what is common to port and harbour safety management rather than what is different. Differences might include local circumstances and the choice of methodology for risk analysis.

Common elements covered are:

- marine accidents we want to avoid
- the principles to guide thinking and decisions on risk, and
- use of risk terms and language.

Structure

Chapter 2 reflects on the nature of maritime sector accidents – the learning opportunities, societal views and the level of tolerance for incidents that result in harm or property loss.

Chapter 3 sets out six principles that people working under the Code are expected to act consistently with – the principles reflect good practice.

Chapter 4 describes commonly used terms in risk management, with a particular focus on the risk assessment process, an integral part of risk management.

Chapter 5 reflects on the causes of accidents in the marine environment, and the complexity and the value of taking a systems thinking approach.

The material builds on the ISO 31000 international standard Risk Management - Guidelines, providing a risk framework for the New Zealand marine context.

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1 For example, within 0.5 NM of New Zealand’s offshore Islands.

2 A holistic approach to analysis that focuses on the way that a system’s constituent parts interrelate and how systems work over time and within the context of larger systems.
2. Avoiding Marine Accidents

The maritime sector has a long history. Experience of events and accidents over many years provides valuable information, knowledge and lessons.

Changing societal views reflected in management practices and regulatory system requirements indicate that the tolerance for marine incidents and accidents that cause harm is reducing.

In the worst cases, significant personal, social, environmental and economic harm results. Society has no tolerance for such outcomes and will hold to account persons or organisations deemed responsible. Within the maritime sector, consequences include damaged reputations, financial liability and criminal prosecution.

Worst case marine accidents (sometimes termed maximum credible events, worst credible events or similar) are often described as high consequence low probability events or ‘high-low events’.

‘High-low’ events pose a particular challenge in risk assessment as the likelihood of such events is highly uncertain and difficult, if not impossible, to precisely determine. In contrast, quantifying the consequences of a high low event is relatively straightforward.

Care should be taken when applying ‘heat maps’ or other methodologies reliant on the ‘risk = likelihood x consequence’ formula to ‘high-low’ events as the uncertainty associated with the assessment of likelihood may lead to misleading risk scores and hence sub-optimal risk assessment outcomes and decisions. It should also be noted that risk scores of any particular incident are not comparable between different ports and harbours.

One pragmatic approach to this problem is to accept that ‘high-low’ events are possible in any port and harbour and must be controlled as far as reasonably practicable. Focus can then shift to a practical assessment and evaluation of the controls necessary to prevent worst case events.

Using this approach, risk managers are still faced with the challenge of determining a ‘reasonably practicable’ level of effort to control ‘high-low’ risks. However, through processes such as Code SMS self-assessments and Code SMS peer reviews, Code members can work to assist, support and validate the risk manager’s decisions.

For example, there are well defined categories for most marine accident and incident scenarios.

Table 1 provides a list of categories of risks and events that marine risk management aims to avoid. These events have the potential to occur in any port or harbour, or along coastal routes, and apply to recreational or commercial vessels. However, for each geographic area, there needs to be consideration of the applicability and relevance of the event categories and potential scale of consequences.
People involved in marine safety risk management should consider this list.

Table 1: Marine risks and events to consider

<table>
<thead>
<tr>
<th>Marine risks/events</th>
<th>Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collision</td>
<td>Involves two or more ships/vessels</td>
</tr>
<tr>
<td>Grounding</td>
<td>Unintended grounding, and includes foundering, noting causes include loss of stability, dangerous list/heel angle, bilging and sinking</td>
</tr>
<tr>
<td>Contact</td>
<td>Involving a fixed object and includes uncontrolled berthing. But, loss of mooring is covered separately</td>
</tr>
<tr>
<td>Loss of stability</td>
<td>May be given less attention where there is less ability to influence loading and related matters</td>
</tr>
<tr>
<td>Fire/explosion</td>
<td>On or near vessels, including when alongside</td>
</tr>
<tr>
<td>Oil spill</td>
<td>Also includes other significant pollutants (chemicals etc.)</td>
</tr>
<tr>
<td>Weather event</td>
<td>As relevant to the safety of property and persons</td>
</tr>
<tr>
<td>Mooring breakout</td>
<td>Potentially includes swing moorings as well as alongside port/wharf</td>
</tr>
</tbody>
</table>

The list is neither exclusive nor exhaustive

This list is not exclusive as marine events do not always occur in distinct packages: multiple events may arise in a single circumstance. Also, the outcome from one event can be a contributing factor for another event – e.g. foundering may result in pollution. Even so, there is value in separating out these outcomes, so each is given due attention and aligns with categories in the port and harbour incident and accident registers.

Neither is the list exhaustive. It should be adjusted to suit the specific context of the port or harbour. Elements may be added or removed. However, if a harbormaster or port manager considers any one of the risks listed is not relevant to their area, that decision should be explained in their Safety Management System.

Complex relationships

The items in the list are connected. Multiple factors impact on risks and on related factors. Achieving the best understanding of risk and related complexity commonly requires a systems approach (refer to Chapter 5, page 24).
Using the example of collision, as Figure 1 shows, pilotage is just one of many factors that would be explored as part of assessing the risk of collision; and pilotage itself has subcategories of interrelated factors.

**Variation and comparisons across New Zealand**

The consequences associated with events listed in Table 1 can vary greatly. Each event will be seen through the lens of local conditions: hydrography, traffic patterns etc., and the risks considered need to be both credible and of relevance to the local circumstances.

Nevertheless, information about the scale of these risks, risk controls, incidents and variations around New Zealand can be collated and shared to the benefit of those involved in the risk management process.
3. **Principles of Marine Risk Management: to guide thinking and decisions**

People working under the Code are expected to act consistently with these principles as they reflect good practice.

**Principle 1 - Local Context** - Risk management processes should be relevant for the geographic area and associated use and circumstances

**Principle 2 - Tailored Risk Assessment** - The form and effort of risk assessment should be tailored to match the extent and significance of the risk

**Principle 3 - Collaboration** - Risk assessments and decisions should involve people with the skills, experience and knowledge of the matter and risk being discussed

**Principle 4 - Evidence Based** - Risk assessments should use timely, relevant and trusted (best available) information, and make the most of both quantitative and qualitative data sources

**Principle 5 - Continuous Review and Updating** - A good practice safety management system incorporates a review of risk assessments, and includes reviews of the associated prioritisation of risks and action plans

**Principle 6 - Social Licence** - Good practice risk management gives due consideration to community expectations about safety and what is acceptable.
**Principle 1 - Local Context**

**Risk management processes and risk criteria should be relevant for the geographic area and associated use and circumstances**

Understanding the local context and setting the associated risk criteria are the preparatory stages, before undertaking a formal risk assessment. Tailoring the approach starts here.

Determine for the local situation:

- the purpose of undertaking a risk assessment
- relevant geographic and business areas – physical scope and regulatory environment
- communities of interest (commercial, public, users) to be considered
- what methodologies will be used, and
- how to assess current practices, procedures, equipment, responsibilities.

**Consider the purpose of the assessment**

Local context may include:

- intensive port operations with traffic management and large commercial vessels
- competing recreational uses (yachts, jet skis, fishers, swimmers etc.)
- significant seasonal changes affecting weather and water users
- isolated water spaces away from settlements and associated support (emergency services, etc.) and
- significant changes, or continuity, in personnel and operating systems.

**Table 2: Harbourmaster led example: Understanding local context**

<table>
<thead>
<tr>
<th>Factors affecting risk</th>
<th>Other matters giving context</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of events– incidents, accidents etc. (national and international lessons)</td>
<td>Legislative responsibilities</td>
</tr>
<tr>
<td>Existing documented risk assessment</td>
<td>Relationship to other ports and harbours – ie flow-on issues/ diverted vessels</td>
</tr>
<tr>
<td>Programmes to remove or reduce sources of risks and mitigate consequences</td>
<td>Whether the area of responsibility is unusual/special</td>
</tr>
<tr>
<td>Weather information</td>
<td>Public Interest</td>
</tr>
<tr>
<td>Changing conditions</td>
<td>Future developments/trends</td>
</tr>
<tr>
<td>Level of use and environs</td>
<td>Business priorities</td>
</tr>
<tr>
<td>Topography and hydrology of the area - tides, sand banks, currents etc.</td>
<td></td>
</tr>
</tbody>
</table>
Review the list of events to avoid

Refer to Table 1 page 4 (collision, contact, etc.). Some events may be considered unlikely to occur within a region. But, if they have high consequences, it is a societal and organisational expectation that the risk management will be done appropriately.

Develop risk criteria

The risk criteria will help decide what actions are taken, using the findings of risk analysis. Commonly, for marine risk management the criteria cannot be used as inflexible rules, rather they give guidance on what events or risks are acceptable or tolerable (and not). In marine safety, use of numerical risk criteria\(^3\) is not common because of uncertainty of some inputs, although it may be helpful in some circumstances.

It is expected that for signatories to the Code:

- The safety objectives of the port facility, harbour or area (as applicable) are clearly defined
- The risk criteria established:
  - use tailored descriptions of what marine risks are to be avoided for the local context (they are written at a high level in Table 1)
  - set detail on acceptable (or conversely not acceptable) consequences
  - consider maximum credible events, and
  - as appropriate, note risk sources within scope (or out of scope) of action.
- Discussion and agreement on the criteria specifically involves the management teams (for ports and harbours)
- Agreed risk criteria are written in the Safety Management System
- It is clear what will happen (in terms of risk management) when an event occurs that falls outside the criteria.

\(^3\) An example of a numerical criterion would be one described as ‘grounding with catastrophic effects must have a frequency less than \(10^{-9}\) per harbour visit’
**Principle 2 – Tailoring the Risk Assessment Process**

The form and effort of risk assessment should be tailored to match the extent and significance of the risk.

The scope of formal risk assessments must be broad enough to capture the important factors, but not so broad that the process is inefficient. It must be fit for purpose.

There is therefore a potential spectrum of effort for conducting risk assessments. Figure 2 illustrates the concept of a spectrum of effort. The following discussion considers when intensive assessments might be appropriate.

**Figure 2: Illustrative spectrum of effort for risk assessments**

<table>
<thead>
<tr>
<th>Lighter</th>
<th>Medium</th>
<th>Intensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited consultation – key affected parties</td>
<td>Use of deep dive methodology</td>
<td>Extensive consultation</td>
</tr>
<tr>
<td>Record discussion &amp; decisions</td>
<td>Extensive consultation</td>
<td>Higher resource needs</td>
</tr>
<tr>
<td>Set appropriate review date</td>
<td>Review regularly</td>
<td></td>
</tr>
</tbody>
</table>

In choosing from the range of risk assessment methodologies, consider the priorities, the experience of those undertaking the process, how much stakeholder engagement is useful (and possible), as well as available resources and other constraints.

Considering four key questions helps determine the necessary form and intensity:

1. What do you know about the potential **level of harm and expectations** about marine activities – the social licence to operate, acceptability of accidents and potential for harm and loss? Review the list of marine risks and events in Table 1. Is there an expectation that the risk assessment must be comprehensive in some areas?

2. To what extent is a particular marine risk commonly discussed and there is good **knowledge** of factors that might cause it and the risk controls?

   *The risks associated with pilots accessing a vessel to provide pilotage services, and necessary controls to decrease the likelihood of harm, are well known. This means a lighter risk assessment may be sufficient such as a documented decision during a monthly safety meeting with the marine team.*

3. Does **legislation** require or signal that a risk needs to be specifically managed and hence a comprehensive risk assessment is appropriate? In general, a level of due diligence is required, utilising judgement and experience.

   *The risk of oil spill is highlighted in the Maritime Transport Act as a priority for risk assessments.*
Some marine activities trigger a form of risk assessment as part of the process to get approval – for example a proposal for a structure on the sea bed within a harbour or proposal to run an ocean swim event.

4. Will the risk assessment help identify ways to reduce the likelihood or extent of harm and loss, or would there be no ability to act to control the risks? Specifically, is it under your organisation’s control and ability to make change?

*Ship anchors are believed to be scouring the seabed and causing harm to the marine environment. An intensive risk assessment may identify a risk of certain benthic species becoming extinct, but such a risk assessment is not likely to be the responsibility of the harbourmaster or marine manager (albeit, it may be of interest to wider council or port management). Alternatively, exploring the risks associated with changing sand banks is much more relevant to port and harbour responsibilities.*

In Figure 3 these four questions are depicted as a series of lenses, read from left to right.

**Figure 3: Illustrative lenses which can assist in determining your approach**

- Characteristics that would indicate a more detailed risk assessment is required
  - Low tolerance for identified risk or consequences
  - Unknown, uncertainty, new information
  - Required or priority
  - Explore options / feasibility

- LEVEL OF HARM / EXPECTATIONS
  - Accepted risks
  - Risk well understood and stable
  - Low priority / activity has own assessment
  - Limited influence, or practical means of control

- KNOWLEDGE
  - Required or priority

- LEGISLATION
  - Limited influence, or practical means of control

- ABILITY TO ACT
  - No characteristic of the system lends itself to detailed analysis

Lighter risk assessment may be appropriate. **Note: although a comprehensive risk assessment may not be necessary, this does not mean that risk controls and risk decisions are any less important.**

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4 The Resource Management Act 1991 process may trigger a risk assessment as part of a resource consent – e.g. use of coastal water space.
**Decision making**

Determine how and who will evaluate the information from the analysis of risks, evaluate options and make decisions on what is implemented. Be clear about agreed responsibilities. Who is accountable? Who can influence?

The decision maker(s) will use the agreed risk criteria in their evaluation.

Confirm who signs off the risk assessment.

**Documentation**

The level of documentation needs to be fit-for-purpose.

When deciding form and detail, consider:

- who is the audience
- how common is the risk, associated controls and responses
- range of decisions - responsibilities, priority actions, funding
- what information is sensitive – it may need a different form
- what information will be reviewed and revised most often - make that easy
- where will specific responsibilities (review, dynamic risk assessment, instigating means of control etc.) be set out?

Elements of risk assessment will be included in Safety Management Systems. But, information related to risk management may also be in job descriptions, business plans and policy documents.

**Preparing material for chosen methodology**

There are many options for risk assessment techniques and methodologies. Appendix 1 gives some suggestions.

Prior to using the chosen methods, identify the factors and terms to be used. Agree on categories.

Examples of terms and factors include:

- consistent naming of relevant geographic areas
- descriptions of consequences - scale of harm, loss and damage affecting people, environment and property, and associated level of certainty – to allow comparisons
- grouping of types of incidents/events - technical failure, grounding etc. (A finer level of categorisation may be needed for priority areas)
- likelihood of events – noting it can be a challenge to assign even a qualitative likelihood. The assumptions and the evidence base behind an assigned factor should be transparent.

Use terms and categories relevant to the local context. But, also consider the benefit in being able to compare material, findings and assessments with others.
**Principle 3 - Collaboration**

**Risk assessments and decisions should involve people with the skills, experience and knowledge of the matter and risk being discussed**

Because risk assessments range in scope, different parties will add value to the process. Consider, who will:

- understand the factors that create the risk, including likelihood, variations and monitoring tools
- be involved in likely or potential risk controls
- know the legislative responsibilities
- pay for changes or new systems, practices or measures
- be considering similar issues, or have already experienced a relevant event
- have a stake in the outcome of a risk assessment (both negatively or positively impacted)
- provide refreshing, alternative perspectives.

Table 3 is an example of the range of people potentially involved in a risk assessment undertaken by a port manager.

**Table 3: Port manager intensive risk assessment and who would likely be involved**

<table>
<thead>
<tr>
<th>Port manager’s intensive port risk assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expected to involve:</strong></td>
</tr>
<tr>
<td>- Harbourmaster (or delegated person)</td>
</tr>
<tr>
<td>- Pilots</td>
</tr>
<tr>
<td>- Regular operators/ relevant</td>
</tr>
<tr>
<td>community advocacy groups/ residents</td>
</tr>
<tr>
<td>- Facility users and workers (including</td>
</tr>
<tr>
<td>seasonal)</td>
</tr>
<tr>
<td>- Maritime New Zealand (relevant official/Maritime Officer)</td>
</tr>
<tr>
<td>- Port Facility Security Officer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>May involve (depending on scope):</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interest groups and individuals</strong></td>
</tr>
<tr>
<td>- Local Iwi / runanga</td>
</tr>
<tr>
<td>- Companies/individuals contracted to</td>
</tr>
<tr>
<td>work in port operations</td>
</tr>
<tr>
<td>- City/District council (land use and</td>
</tr>
<tr>
<td>infrastructure)</td>
</tr>
<tr>
<td>- Event operators (e.g. yacht races,</td>
</tr>
<tr>
<td>sea swims)</td>
</tr>
<tr>
<td>- Fire and Emergency New Zealand</td>
</tr>
<tr>
<td>- NZ Defence Force, if relevant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical expertise on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Weather</td>
</tr>
<tr>
<td>- Regional council staff with responsibility for air and water discharge</td>
</tr>
<tr>
<td>- Hydrographic information (LINZ)</td>
</tr>
<tr>
<td>- Behaviours that affect risk – unconscious bias, bridge management etc.</td>
</tr>
<tr>
<td>- Relevant natural hazards (tsunami, climate change)</td>
</tr>
<tr>
<td>- Specialised risk source areas: fire, oil spill, emerging technologies</td>
</tr>
</tbody>
</table>
### Port manager’s intensive port risk assessment

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Other government agencies</td>
<td>Regulation (e.g. maritime rule) and policies</td>
</tr>
<tr>
<td>Regional CDEM Group</td>
<td></td>
</tr>
<tr>
<td>representative</td>
<td></td>
</tr>
</tbody>
</table>

### Facilitators

- Facilitator – recording, thinking out of box, supporting conversations etc.
- People with expertise in specific methodologies
Principle 4 – Evidence Based

Risk assessments should use timely, relevant and trusted (best available) information, and make the most of both quantitative and qualitative data sources.

Information on marine risks and events is arguably not as comprehensive or consistently recorded as for land transport and aviation. But, that does not mean that the information used in risk assessments can be given lower priority. In fact, it is the reverse.

Harbourmasters and port managers commonly have their own records as well as good access to other data sets. There is historical data, experience, stakeholder feedback, observation and forecasts. Long standing pilots and port managers/employees are commonly important sources of information. External agencies can also assist in ensuring the most up-to-date information is used – see Table 4 for the main sources.

Table 4: Data sets and sources that may be used in marine risk assessments

<table>
<thead>
<tr>
<th>Data set</th>
<th>Produced / held by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents, incidents and near misses recorded in the water space concerned</td>
<td>Port Authority</td>
</tr>
<tr>
<td>Bylaws/Maritime Rules/RMA infringements</td>
<td>Regional councils (commonly good places to start)</td>
</tr>
<tr>
<td></td>
<td>Harbormasters</td>
</tr>
<tr>
<td></td>
<td>Maritime New Zealand</td>
</tr>
<tr>
<td>Incidents etc., elsewhere in New Zealand, and internationally, that are relevant</td>
<td>Maritime New Zealand</td>
</tr>
<tr>
<td></td>
<td>NZ Police</td>
</tr>
<tr>
<td></td>
<td>Coastguard</td>
</tr>
<tr>
<td>Review of any relevant emergency management exercises</td>
<td>CDEM Group / Coastguard / Fire and Emergency NZ</td>
</tr>
<tr>
<td>Traffic - AIS, PPU/ECDIS tracks</td>
<td>Various, including Port Authorities (or pilotage provider), MARICO, OMC and Trelleborg</td>
</tr>
<tr>
<td>Accidents investigated</td>
<td>TAIC / Maritime NZ / NZ Police</td>
</tr>
<tr>
<td>Annual SMS self-assessment and Code SMS Review Report</td>
<td>Own review and those shared by others, Code Secretariat</td>
</tr>
<tr>
<td>Existing practices and procedures in place to control different risk, for example:</td>
<td>Harbormaster</td>
</tr>
<tr>
<td>- Aids to navigation schedules</td>
<td>Council</td>
</tr>
<tr>
<td>- SOPs</td>
<td>Marine facilities and operators</td>
</tr>
<tr>
<td>- training</td>
<td></td>
</tr>
<tr>
<td>- job descriptions</td>
<td></td>
</tr>
<tr>
<td>Information on existing and emerging control factors</td>
<td>Industry/Advocacy/ Academic Groups</td>
</tr>
<tr>
<td></td>
<td>Harbormasters</td>
</tr>
<tr>
<td>Data set</td>
<td>Produced / held by</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Technology and research associated with the marine environment e.g. use of AIS, fire suppression chemicals</td>
<td>Pilotage providers, Hydrographic society</td>
</tr>
<tr>
<td>Information on local topography:</td>
<td>GNS</td>
</tr>
<tr>
<td>- hydrographic</td>
<td>Councils (regional and district)</td>
</tr>
<tr>
<td>- tidal data</td>
<td>LINZ</td>
</tr>
<tr>
<td>- planned developments</td>
<td></td>
</tr>
<tr>
<td>Community and user views</td>
<td>Local surveys</td>
</tr>
<tr>
<td>Insurers</td>
<td>Local insurers and commentators</td>
</tr>
<tr>
<td>Planned maritime events - data set/calendar</td>
<td>Shipping schedules, Water sports calendars</td>
</tr>
</tbody>
</table>

Good practice in use and collection of information, consistent with Code expectations, requires that those responsible:

- ensure port authorities and harbourmasters keep accurate and clear records of accidents, incidents, mishaps, and (where relevant) near misses
- consider the limitations of data and alternative perspectives (including of experts)
- share evidence and lessons in a timely fashion
- conduct good peer review of data and associated risk assessments
- consider the wider system of risk sources, incidents and responses, not just evidence for a linear relationship between the factor causing the change and the effect. [See Chapter 5 Accident Causation]
- collect and describe evidence in a way that enables comparisons across time and in different circumstances
- undergo both annual SMS self-assessments and scheduled Code SMS reviews
- engage experts and external audits where appropriate.
Principle 5 – Continuous Review and Updating

A good practice safety management system incorporates a review of risk assessments, and includes reviews of the associated prioritisation of risks and action plans.

Reviews can look at suitability, adequateness and/or effectiveness.

As part of any risk assessment there needs to be a record of the agreed actions (including how often there will be a review), scope and responsibilities. It should also be agreed when a review should be triggered outside regular cycles. **As a minimum, there should be an annual review of the port or harbour risk assessments under the Code.**

The necessity and regularity of a formal documented review is also influenced by:

- legislative requirements or directives
- an event (including an accident, risk control failure etc.) that triggers thinking about a risk or control
- new information about a risk source or the consequences of an event
- new information about technology or effectiveness of other risk controls
- change in personnel or the introduction of a new operation or procedure
- change in the risk attitude of the organisation, stakeholders or public
- whether a risk is stable or dynamic (e.g. AtoN failing versus strength of weather events).

The review may be a conversation of affected parties, including stakeholders – if so, record it and the decision. It may be a review of the complete process – investigation through to prioritisation of all risk sources in an area – or a more tailored review of a selected matter.

Regardless of the form of the review, the objective of review processes is to:

- make effective use of resources and personnel
- take human and cultural matters, as well as physical and natural environment elements, into account
- include new and existing evidence-based information
- be iterative and responsive to change
- facilitate continual improvement and enhancement of marine safety
- ensure Code consistency and good practice systems are maintained.

Be clear and record whose responsibility it is to oversee a review cycle and escalate the need for reviews. Budget for regular reviews.
**Principle 6 – Social Licence**

Good practice risk management gives due consideration to community expectations about safety and what is acceptable

More often than not, ports and harbours are working under a “social licence" to operate. That licence may have conditions associated with it and the risk management approach needs to anticipate and manage them. Unacceptable events were introduced in Table 1 (page 5). Loss of life, damage to the environment and incidents involving large vessels are particularly unacceptable. The level of social licence is commonly reflected in the relevant legislation that regulates behaviour and sets penalties.

Just because a technical assessment showed all the safety management controls were in place and worked, doesn’t make an event resulting in death, serious injury, loss of property, or environmental damage any more acceptable.

The principle of social licence is supported by:

- consistently applying the principles of local context, tailoring the risk assessment approach, collaboration, evidence based and continuous review
- being very clear in the Safety Management System what the main risks are - to personal safety, property and environment
- being transparent as to what residual risk of an activity or an event is being accepted as now controlled as much as is reasonably practicable
- clearly targeting risks and maritime events that are not acceptable – noting the community may put a higher value on use of control measures that eliminate or isolate the risk than procedures and assessments
- clear communication to the public and media
- including responsibility for the next generation.

Matters to consider, when conducting risk assessments and making decisions on safety and action plans, which increase the profile of social licence, are:

- the culture and risk attitude of those involved (both in the factors potentially causing harm and dealing with the impacts)
- changing attitudes in society
- proliferation of social media, cell phones, and “influencers".
Emerging in the mid-1990s the term **social licence** expressed the extent to which a business had the support of the community, political environment, advocacy groups and media. It describes acceptability – the ability to operate legitimately in society. Acceptability may range from “totally unacceptable”, through “tolerated” and “neutral”, to “active support”. The level of acceptability is commonly reflected in regulatory standards and prosecutions. But, community perspectives are also important.

The concept includes the extent to which certain things and values are protected. The scope is wide, covering the effect on people (directly or indirectly), the natural environment, economy, property and reputation. It does not have a technical definition. Arguably, referring to social licence or related terms is likely to engage the public and stakeholders in a more productive discussion of marine safety matters than a technical assessment of risk likelihood and consequences would.
4. Common Use of Risk Terms

This chapter describes terms associated with risk, with marine examples.

The risk assessment process is used as a way to step through technical stages in sequence, although stages may be repeated or occur in different forms throughout the process.

As set out in ISO 31000, risk assessment is integral to risk management. Processes that support risk assessment include: establishing the context; risk treatment; communication and consultation; and monitoring and review.

Why is common terminology helpful?

Effective risk conversations between port authorities, councils, government agencies, stakeholders and the public need a common understanding of processes and terms. Other people may not use terms in the same way, or with the same meaning, as you. Don’t assume. Check.

The Generic Risk Assessment Process

Risk assessment is a process. Through it: data and information is collected; sources of risk and related factors are identified; there is analysis (including of vulnerability, consequences and relationships); risks are defined; and control options are assessed.

Figure 4: Schematic of the risk assessment process – actions and outputs
Formal versus dynamic risk assessment

Alongside formal, documented risk assessments there is dynamic ‘on-the-job’ risk assessment. The latter is a way of thinking that helps the individual assess a new, unanticipated, changing or unfolding situation, including during incidents. The responsibility for dynamic risk assessment may be with a specific role: harbourmaster, pilot, master, etc.

Formal risk assessments should identify where dynamic risk assessment is required, or expected, and record any specific responsibilities.

Also, the risks identified, and relevant outcomes (including risk controls) from dynamic risk assessments, should be incorporated into the formal risk management process. Reviews of the formal risk assessments can be a means of doing this.

Identification Stage

At this stage the factors that could cause or influence harm or loss are identified. Factors are wide ranging and they interact. As well as natural, technological, vessel, human and infrastructure parts of the system, factors also include policy, training, procedures, and managerial processes.

The identification stage also involves asking what events you want to avoid (see page 4).

Terminology used in the marine environment include ‘event’ (and ‘accident’, ‘incident’ and ‘mishap’), the concept of ‘maximum credible event’, ‘hazard’, ‘natural hazard’ and ‘risk source’. In this document “risk source” is preferred over “hazard” – see below.

Definition of terms

An event is an occurrence or change in a set of circumstances. It may refer to something that might happen or has happened (depending on whether the discussion is about a future scenario or not).

It is common in marine safety discussions to class events as accidents, incidents or mishaps. These terms are defined in the Maritime Transport Act 1994 for the purposes of reporting events. The definitions each describe a level of harm.

Maximum credible event is a hypothesised worst-case event for the geographical area being considered that can be used as a scenario. The scenario may have a very low likelihood but must be realistic.5

A hazard or risk source is any source of potential damage or harm to something or someone. In the context of the marine environment identification of potential harm considers:

- people in or around the marine environment (this includes: crew, passengers, swimmers, users of recreational craft, divers, linesmen, etc.)
- the natural environment (water quality, ecosystem, habitat, wildlife - on shore or offshore)
- property (marine facilities, cargo, structures, vessels)
- impact on reputation.

5 A term commonly used in Civil Defence Emergency Management planning and risk assessment.
A **natural hazard** is a potentially damaging event with a geological, weather, hydrological or solar source.

The term **risk source** is a more neutral term than ‘hazard’. It has the same meaning as ‘hazard’ – i.e. an element which alone or in combination has the potential to give rise to risk – but is preferred because it is less emotive.

**Analysis Stage**

The analysis stage takes the list of identified risk sources and other factors and further explores how they might cause harm or loss, and if they do, considers how bad it will be. The result is the identification and exploration of risks.

Analysis of risk does not necessarily require determining likelihood or assigning a probable consequence (severity of harm or loss) – see definitions below. The process of information collection and having conversations is what is important. Different risk assessment models give weight to different factors.

Terms covered below are: ‘risk’ (including ‘emergent risk’); ‘likelihood’; ‘consequence’; and ‘risk score’. This document does not use the term ‘threat’, although it is used in some methodologies. (If used as part of a risk assessment, be clear – the threat of what?)

**Definition of terms**

**Risk** is the chance, or probability, that something (person, natural environment or property) will actually be harmed or be adversely impacted as a result of one or more factors. So the potential for harm or loss might exist, but the **likelihood** of it occurring might be low or high, depending on circumstances.

*Rough sea state with adverse weather (a natural hazard) occurs when a vessel with unreliable propulsion intends to berth at a port facility. This set of circumstances increases the likelihood that coming alongside will result in uncontrolled contact with the wharf (the event or incident).*

*The rough sea state and the vessel’s unreliable propulsion are the risk sources or contributing factors.*

*This risk scenario might also be discussed at a finer or different detail. In that case, the same terms are attached to different elements.*

*The event could be contact between a vessel berthing and the wharf and the risk is that the contact results in the hull integrity being lost and oil being discharged. (In this example likelihood varies depending on type of vessel, sea conditions, etc.)*

An **emergent risk** is a risk that develops because different risks interact. It is most commonly used in methodologies and risk assessments that view the risk environment as complex and non-linear (also see Chapter 5, Accident Causation).
A marine example of an emergent risk, that is also not well understood, might be the risk of an accident involving a jet ski operating in a harbour. The risk is affected by lack of regulatory control of jet skis interacting with a greater number being used and potentially poor jet ski use decisions.

**Likelihood** is commonly used to describe the chance of something happening - how common, or unusual, or likely. If sufficient data is available it may be determined quantitatively (e.g. a percentage, once in a 50-year event) or when data is not available or applicable, through to more qualitative means such as expert opinion (e.g. a high/medium/low chance of occurring or almost certain/likely/unlikely etc.)

*Under the example (above) of a ship with unreliable propulsion berthing, likelihood of uncontrolled contact with the wharf will be affected by normal operating parameters, tug availability, tug capacity, pilot experience, pilot well-being, weather monitoring etc.*

Likelihood may also be replaced with the terms frequency or probability. In this document, likelihood is used for consistency.

**Consequence** is an assessment of how bad it can be. Some risk assessment tools focus on considering a range of consequences – from mild to severe. A consequence can be certain or uncertain. It might be expressed quantitatively or qualitatively.

*The consequences of a vessel grounding vary from a light touch (with minimal harm) to total loss of the vessel and a new source of risk for other vessels using the area.*

**Risk score** is a way of scoring or ranking risks to support the next stage – evaluation. It is used in some methodologies. For example, a risk might have a score of “high” if a risk matrix is used to rank risks, after mapping risk consequences and likelihood. The benefit of a risk score needs to be considered in light of the local context, including risk criteria and underlying assumptions. It may help prioritise what risks will be addressed and how.

**Evaluation Stage**

The evaluation stage involves looking at the information from analysis and determining if there are actions that can or should be taken, and who should be responsible.

The main terms used are ‘risk treatment’, ‘risk control’, ‘risk criteria’ and ‘residual risk’.
**Definition of terms**

*Risk treatment* is the decision about the approach to be taken. Treatment might involve modifying the risk and putting in place risk controls or accepting the level of risk (the *residual risk*) and focusing on response and recovery measures.

Control of risk or a *risk control* is one or more measure(s) that modify a risk.

A control might be a new or improved process, policy, device or practice. A control might simply maintain a level of risk. It might also be a key factor to the risk’s reduction (it then becomes a contributing factor if it fails). Table 5 sets out some common groupings and categories of controls.

**Table 5: Terms used when describing marine risk controls**

<table>
<thead>
<tr>
<th>Risk control</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Ashore</td>
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<tr>
<td></td>
<td>On-water</td>
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</table>

<table>
<thead>
<tr>
<th>Hierarchy</th>
<th>Eliminate – remove or avoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intention and Mechanisms)</td>
<td>Substitute - replace with ‘lower risk’ item or process</td>
</tr>
</tbody>
</table>

*Reduce or Isolate* risk:
- Engineering Controls [equipment, barriers, warning systems etc.]
- Procedural Controls [signage, administrative systems] and includes:
  - Improve personnel capability
  - Ergonomics - designing workplaces, products and systems with a focus on the end user
  - Setting out responsibilities, design procedures
- Personal Protective Equipment

<table>
<thead>
<tr>
<th>Timing</th>
<th>Pre-event action</th>
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<tbody>
<tr>
<td></td>
<td>Response/recovery stage</td>
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</table>

*Risk criteria* provide a base upon which to evaluate the conclusions of the analysis through describing what is acceptable/tolerable, or conversely, unacceptable/intolerable. (Also see page 8).

*Residual risk* is the risk that remains after risk treatment has been applied. (Risk treatment having reduced the likelihood of the event happening).
5. Marine Accident Causation

Understanding the reasons for accidents and the contributing factors is important for successful prevention. Whether simple or complex relationships are involved influences the form of risk assessment and usefulness of different tools.

A number of conceptual models exist.

Marine accidents are commonly complex and non-linear. Generally, there is no one factor or situation that is responsible for harm, loss or damage and contributing factors may have occurred in years past.

Systems thinking is critical in this context, hence it is a theme behind the risk management principles and aligns with the Code.

Linear models – helpful in some circumstances

There are simple accident models:

- one factor leads to another, and potentially another, in domino fashion, and ends with harm or loss
- the Swiss cheese model – the risk is that all those holes line up.

In such a simple, linear model, preventing the accident might be achieved by removing any one of the contributing factors.

Figure 5: Simple linear model

A vessel underway collides with a vessel at anchor resulting in harm to both vessels

The conditions leading to the incident are: low visibility (it occurs at night), equipment failure (GPS not working) and human error (no look out). Plus, there is an exacerbating factor of high speed.
Small vessel breaks from a swing mooring

The conditions leading to the incident are: high winds, moorings over-tensioned, moorings in poor condition and no one on watch.

The examples above are arguably simple linear events because a number of actions would have stopped the accident occurring. But, they also have complex features. For example, why did equipment fail and why no look out?

Marine accidents are commonly complex and non-linear

Complex (non-linear) models for accidents recognise:

- interacting variables means multiple scenarios
- real world environments where there are multiple factors and uncertainty
- emergent risks compound the consequences
- removing one factor doesn’t necessarily prevent the accident (although it may change another factor).

Figure 1 (page 4) illustrated that factors in marine risk management are interrelated and have several layers. It explored as part of assessing the risk of collision; and pilotage itself has sub-categories of interrelated factors. Each affect the likelihood, and consequences, of collision. They are also potentially areas of risk control.

Marine example requiring a systems approach

*Mooring failure in commercial port*

- Multiple factors affecting the risk source: crew training, hours of rest, condition of mooring lines, budget constraints, shipboard management practices, shore side management practices, tugs, provision of port information, weather forecasting, real-time weather data, hydrographic data (if relevant), port state control, previous port, lighting, linesman’s concerns, business/operational pressures, etc.
- Wide range of vulnerability and consequences: multiple scenarios of what happens, from no damage, starts engines, returns alongside, to runs aground, collision, oil spill, etc.
- Complex interactions: between the vessel, decision makers, and the physical environment
- Unknowns, including: Master new to vessel, recent crew change and crew unfamiliar with state of moorings
- There is a residual risk that cannot be removed as mooring cannot be avoided – ports are used by large commercial vessels, including ones that have not visited before.

There is variation in effectiveness of control factors: some minimise or remove risk sources (e.g. highlighted factors related to collision – that pilotage is just one of many factors that would be experienced pilot, maintenance of moorings and up to date hydrographic data), but there are always factors on the day that can reduce their effectiveness.
A balanced approach

Linear models are still valid and used. But, utilising a systems approach can help identify factors that can be more removed from the actual event than the primary contributor.

The complexity in events emphasises the need to follow the principles in this document. It also supports using a mix of risk assessment tools.
APPENDIX 1: Risk Management Tools

This table lists some known tools and methodologies.

Source: Adapted from American Bureau of Shipping

<table>
<thead>
<tr>
<th>Risk Assessment Technique</th>
<th>Where potentially applicable in Risk Assessment Process</th>
<th>Identification</th>
<th>Analysis</th>
<th>Evaluation</th>
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<tbody>
<tr>
<td></td>
<td><em>(level of applicability, but will depend on circumstances)</em></td>
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<tr>
<td>Actor Maps</td>
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<td>ALARP</td>
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<td>BowTie analysis</td>
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<td>Change Analysis</td>
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<td>Checklist Analysis</td>
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<td>Consequence and Confidence Assessment</td>
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<td>Event Tree Analysis</td>
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<td>Explosion Hazard Analysis</td>
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<td>Failure Modes and Effects Analysis (FEMA)</td>
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<td>Fault Tree Analysis</td>
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<td>Fire Hazard Analysis</td>
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<td>Formal Safety Assessment</td>
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<td>Gas Dispersion Analysis</td>
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<td>Hazard Identification Technique (HAZID)</td>
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<tr>
<td>Hazard and Operability Analysis (HAZOP)</td>
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<td>Human Reliability Analysis</td>
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<tr>
<td>ICAM (Incident Cause Analysis Method) root cause investigation</td>
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<td>Layer of Protection Analysis (LOPA)</td>
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<td>PreventiMap</td>
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<td>Probabilistic Risk Assessment</td>
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<td>Reliability Centred Maintenance</td>
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<td>Safety Integrity Level Assessment</td>
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<tr>
<td>What-if Analysis (SWIFT = Structured “what if”)</td>
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</table>
APPENDIX 2: Abbreviations and References

Abbreviations used:

**AIS** - Automatic Identification System (used for vessels and aids to navigation)

**AtoN** - Aids to Navigation

**Code** - New Zealand Port and Harbour Marine Safety Code 2020

**CDEM** - Civil Defence Emergency Management

**CPD** - Continuing Professional Development

**ECDIS** - Electronic Chart Display and Information Systems

**GNS** - GNS Science is a New Zealand Crown Research Institute. It focuses on geology, geophysics, and nuclear science.

**LINZ** - Land Information New Zealand (which incorporates the New Zealand Hydrographic Authority)

**PHMSC** - Port & Harbour Marine Safety Code 2020

**PPU** - Portable Pilot Unit

**RMA** - Resource Management Act 1991

**SOPs** - Standard Operating Procedures

**SMS** - Safety Management System

**TAIC** - Transport Accident Investigation Commission

Reference documents

- ISO 31000 Risk Management Guidelines