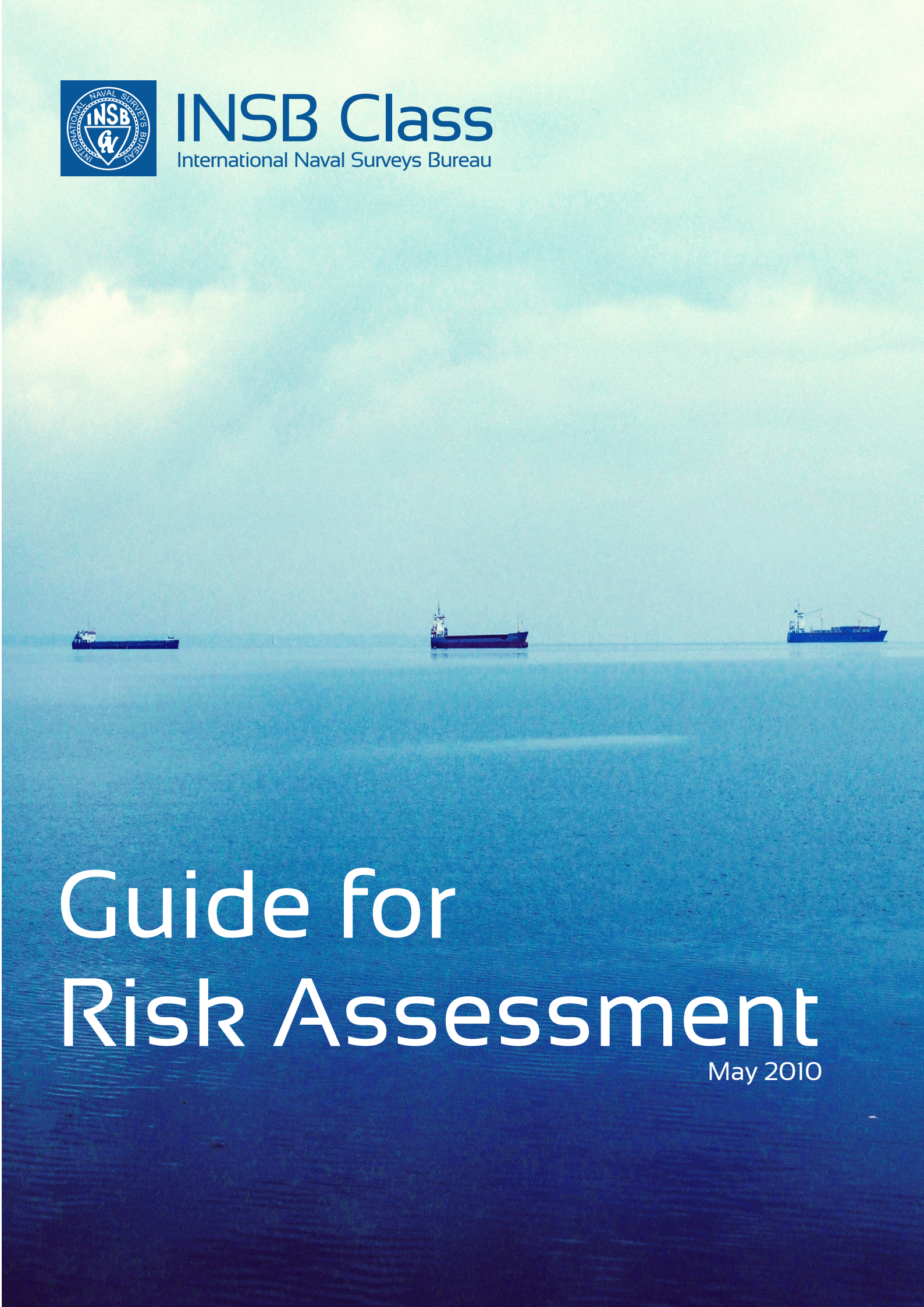
INSB Class
International Naval Surveys Bureau



Guide for Risk Assessment

May 2010

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Contents

1. General

From its very nature, there is no unique Risk Assessment methodology to be applied in any context. There are no fixed rules how risk assessment should be undertaken and the assessment depends on the type of the ship, the nature of operations and the type and extend of the hazards and risks.

1.1 Risk Assessment basic Terminology

- ***Accident:*** An unintended event involving fatality, injury, ship loss or damage, other property loss or damage, or environmental damage
- ***Consequence:*** The outcome of an accident
- ***Frequency:*** The number of occurrences per unit time (e.g. per year)
- ***Hazard:*** A potential to threaten human life, health, property or the environment
- ***Risk:*** The combination of the frequency and the severity of the consequence.

1.2 Risk Assessment basic principles and ISM Code

1.2.1 As defined in paragraph 1.2 of the ISM Code (objectives), the requirement for the assessment and management of risks is fundamental to the code.

1.2.2 The ISM Code does not specify any particular approach to the management of risk, and it is for the company to choose methods appropriate to its organizational structure, its ships and its trades. The methods may be more or less formal, but they must be systematic, in order assessment and response to be complete and effective and the entire process should be documented so as to provide evidence of the decision-making process.

1.2.3 The principle of Safety Management involves managing and controlling risks levels of hazards and keeping them within acceptable levels. This process involves seeking answers to following questions:

1. What could go wrong?
2. What happens if it goes wrong?
3. What are the chances to go wrong?
4. How could the chances/ effects be reduced?
5. What to do if it goes wrong?
6. How can we Manage risk levels?

1.2.4 The first two questions involve identifying the hazards and prioritizing them based on the consequences. The third question determines the probability of occurrence or the frequency of occurrence of the hazard, and question number four involves risk reduction. Question number five involves emergency preparedness. Finally question number six involves safety Management.

1.3 Risk Assessment (RA) and Risk Management (RM)

1.3.1 The purpose of the RA and RM is to minimize risk to personnel, property and the environment. In this respect, all activities that could adversely affect Company's operations and performance are evaluated and appropriate measures are taken to ensure that risk is either reduced or maintained at an acceptable level.

1.3.2 Risk is managed by identifying hazards, assessing consequences and probabilities and evaluating and implementing prevention and mitigation measures.

1.3.3 Risk Assessment requires:

- Job familiarity
- Practical experience with the job
- Information regarding incident/ operation / activity
- Active participation of persons running the risk
- Open mind for any suggestions
- Proper application of the RA methodology

1.4 Introducing risk assessment in the Company/fleet

In order a Company to introduce a structured risk assessment program the following stages are suggested:

- Development of a risk assessment methodology/procedure with relevant reports
- Communicate the new policy to the fleet and explain the need/benefits of same
- Training: through seminars and/or presentations and/or fleet circulars
- Identify who should carry out the risk assessments: it is not necessary to involve everyone participates in the operation to participate in the risk assessment of this operation. Usually used small teams but never only one person
- DPA (or risk expert) and/or Superintendents should advise the fleet of how risk assessments should be carried out onboard the vessel, by whom, when, how often
- Completed risk assessments should be submitted to the Company for analysis and review

2. Risk Assessment process

2.1. Although there are many different RA methodologies, in general a usual approach is as follows:

Step 1: Identification of shipboard operations / systems / tasks

Step 2: Identification of Hazards

Step 3: Identification of existing control measures

Step 4: Risk Evaluation

- Calculation of risk
- Probability (or frequency) Determination
- Consequence (or Severity) Assessment

Step 5: Risk Reduction

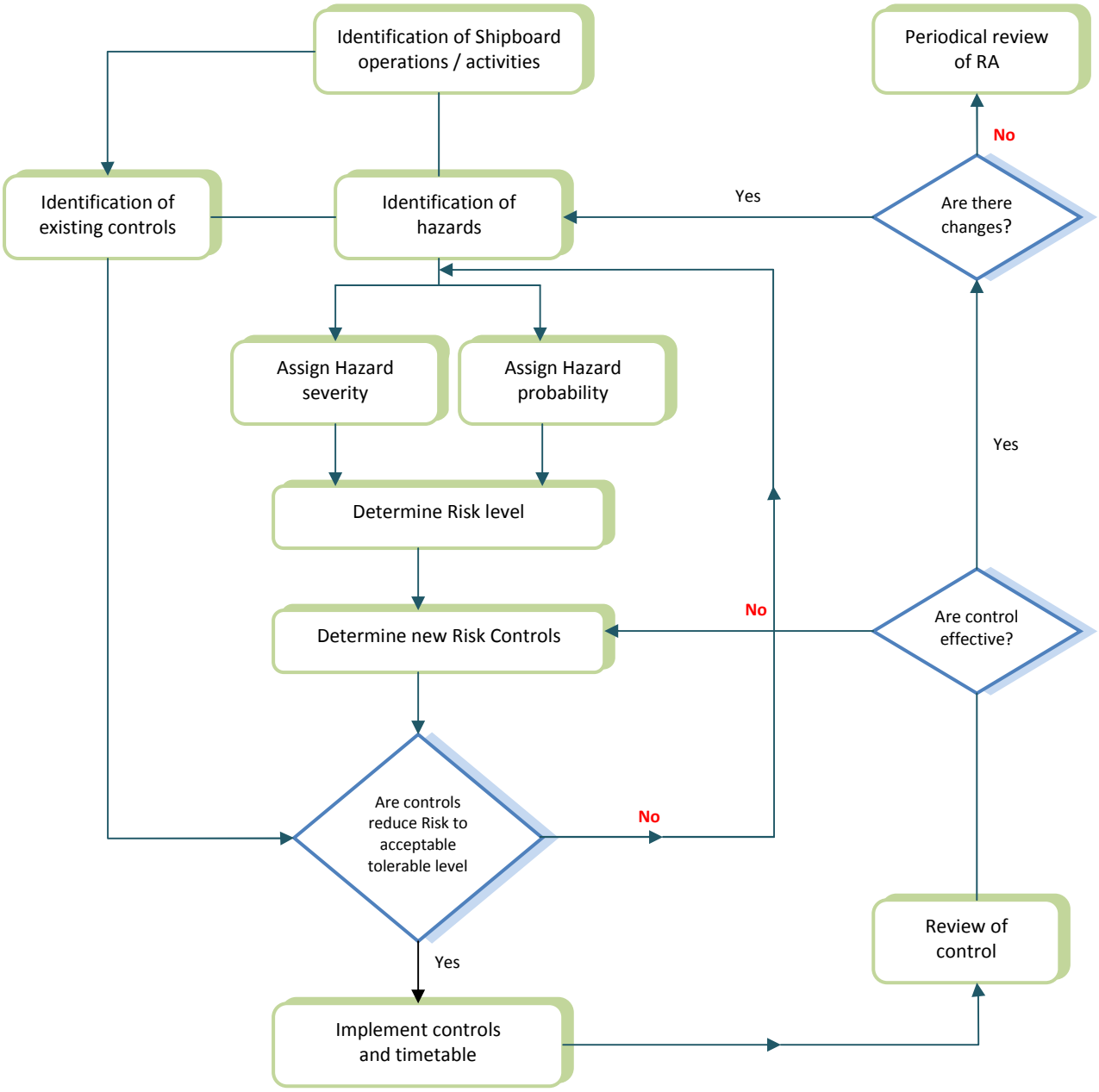
- Action and Timescale
- Identification and implementation of new Risk Control measures

Step 6: Review of risk assessment

- Evaluation of control measures
- Need for new risk assessment
- Periodical review of risk assessment
- Accidents / near misses

Guide for Risk Assessment

Risk assessment chart



2.2. Step 1 Identification of shipboard operations / tasks requiring RA

When to perform a risk assessment

2.2.1 RAs are conducted in order to identify and address potential hazards to personnel, property and the environment, for:

a. existing shipboard operations/tasks
b. in case of new operations/tasks
c. in case of non-routine tasks
d. in case of changes to procedures or equipment.
e. in case of incidents, accidents, serious near misses, etc.
f. prior to the introduction of new critical equipment or procedures.
g. for preparation of complex or high risk jobs and projects.

2.2.2 When deciding which operations/tasks to assess first, normally selected these which have the more potential of loss/harm to personnel, property and the environment, or to those related to the existing accident records. In practice the risks in the workplace should be assessed before work begins on any task which no valid risk assessment exists.

Grouping work activities

2.2.3 A useful approach is to identify separate work activities, to group them in a rational and manageable way and to gather the necessary information. Infrequent tasks/operations should also be included. Possible ways of grouping work activities:

a. department/location
b. stages of an operation/work
c. planned/unscheduled maintenance
d. defined tasks (routine/unroutine ones)

2.3. Step 2 Identification of Hazards

What is a hazard?

2.3.1 A hazard is simply a **situation/condition** which has the **capability to cause damage, harm or other loss.** A hazard can only be observed and recognized. Hazards are around us and cannot be taken away. Risk however can be identified, analyzed and dealt with.

Guide for Risk Assessment

2.3.2 The **hazard is the cause of an event/accident** therefore should not be confused with the event itself (e.g hazard: fog – event/accident: collision).

2.3.3 In identifying a hazard the type of harm and to whom/what has also to be identified.

Purpose

2.3.4 The purpose of this step is to identify and generate a prioritized list of hazards, specific to the problem under review. This purpose is achieved by the use of **standard techniques** to identify hazards, which can contribute to accidents, and by screening these hazards using a combination of available data and judgment.

Approach

2.3.5 The approach used for hazard identification generally comprises a combination of both creative and analytical techniques, the aim being to identify as many relevant hazards as possible. The creative element is to ensure that the process is proactive, and not confined only to hazards that have been materialized in the past. The analytical element ensures that previous experience is properly taken into account, and should make use of background information (for example applicable regulations and codes, available statistical data on accident categories and lists of hazards to personnel, hazardous substances, ignition sources, etc.)

2.3.6 Following are some **examples of hazards:**

- **Mechanical** (related to working equipment): misuse/defective equipment, power tools, lifting equipment, windlass, anchoring etc
- **Electrical** (electrocution, fire): high voltage, exposed/worn cables, not grounded equipment etc
- **Physical** (related to working environment conditions): weather, noise, vibration, cargo stowage/lashing, working alone/aloft, confined spaces, slippery surfaces, poor lighting etc
- **Radiation** (energy emission): heat radiation, extreme light etc
- **Substances**: Flammable, dangerous goods etc
- **Fire/explosion**: flammable cargoes, combustible materials, hot works etc
- **Psychological**: fatigue, claustrophobia, vertigo etc

2.3.7 Popular Techniques

The basic principle of these techniques is to provide a systematic approach for identifying potential hazards in complex systems. These techniques are based on a combination of applying past experience, accepting what is obvious, preparing a checklist of items that can go wrong in an activity and cross referencing with an established database of hazards.

Below Table summarizes some of the commonly used techniques to identify hazards.

Hazard risk analysis methods	Summary Of Method	More Common Uses
Hazard Identification Technique (HAZID)	HAZID is a general term used to describe an exercise whose goal is to identify hazards and associated events that have the potential to result in a significant consequence.	The HAZID technique can be applied to all or part of a facility or vessel or it can be applied to analyze operational procedures. Typically, the system being evaluated is divided into manageable parts, and the RA team is led (often with the use of checklists) to identify potential hazards associated with each part of the system.
Brainstorming	A team generates a list of potential hazards during an agreed period of time	Applicable to any type of system, process or activity
What-if analysis	It is a brainstorming approach that uses loosely structured questioning to: 1. postulate potential upsets that may result in mishaps or system performance problems; and 2. ensure appropriate safeguards are in place.	Applicable to any type of system, process or activity (especially when pertinent checklists of loss prevention requirements or best practices exist).
Fault Tree Analysis (FTA)	It is a tree-like diagram based upon the application of "and/or" logic used to identify alternative sequences of hardware faults and human errors that result in system failures or hazardous events. When quantified, fault trees allow system-failure probability or frequency to be calculated.	• Applicable for almost every type of analysis application, but most effectively used to address possible outcomes of initiating events for which multiple safeguards are in place as protective features. • Often used for analysis of vessel movement mishaps and propagation of fire/explosions or toxic releases. • Event charting is most commonly used when the loss scenario is relatively complicated, involving a significant chain of events and/or a number of underlying root causes.
Event Tree Analysis (ETA)	It is a tree-like diagram used to determine alternative potential scenarios arising from a particular hazardous event. It can be used quantitatively to determine the probability or frequency of different consequences arising from the hazardous event. ETA is an inductive analysis technique that graphically models (using decision trees) the possible outcomes of an initiating event capable of producing a mishap of interest.	
– Root Cause Analysis (RCA) – 5 Why's technique	RCA uses one or a combination of analysis tools to dissect how a mishap occurred (i.e. equipment failures, human errors, external events). The analysis continues to discover the underlying root causes of the key contributors to mishap and make recommendations for correcting them.	• Applicable to the investigation of any mishap or some identified deficiency in the field. • 5 Why's is most commonly used for more straightforward loss scenarios.

2.4 Step 3 Identification of existing controls/measures

2.4.1 Before the harmful effects of a hazard can be determined, existing controls/measures that may mitigate the effects of that hazards has to be taken into account.

2.4.2 During any operation, controls can be: procedural, human recourses, training, control systems, appropriate design and construction, maintenance, communication, use of proper equipment etc.

2.5 Step 4 Risk Evaluation

Note

2.5.1 The tables shown below, in this step, are in the form in which they most commonly appear, but they are not mandatory. The risk matrix may be expanded to include more rows and columns, depending on how finely the company wishes to distinguish the categories. The terms used for likelihood and consequence may be changed to assist understanding.

Qualitative and quantitative methods for determination of risk level

2.5.2 There are two main methods for determination of risk level, qualitative and quantitative. In qualitative risk assessment, someone is using personal judgment whereas in quantitative can actually be measured based on company and/or industry data.

Calculation of risk

2.5.3 **Risk** is normally evaluated as a function of the severity of the possible **Consequences (C)** for a hazard and the **Frequency/Probability** (**P**) of occurrence of that particular hazard. Usually is used a simple relation between C and P, to calculate the risk (R):

Risk (R) = Consequence (C) × Frequency (P) (R=C×P)

2.5.4 Given this knowledge, estimated risk of hazards can be used to make reliable decisions in terms of improving safety by reducing the risk and risks can be reduced by reducing the severity of the consequences, reducing the frequency/probability of occurrence or a combination of the two.

Probability (or frequency) Determination

2.5.5 Frequency analysis is used to estimate how likely it is that the various incidents or hazards will occur (i.e. the probability of occurrence). The probability is determined based on the sequence of events in the hypothetical scenario.

The Risk Matrix defines probability levels based on the frequency at which the hypothetical scenario is likely to occur as indicating in the following table:

Probability Descriptions and Frequencies	
Frequency classes	**Quantification**
Very likely - Possibility of repeated incidents	More often than every six months.
Likely - Possibility of isolated incidents	Once per 5 year - The scenario has occurred in the past and/or is expected to occur in the future.
Unlikely - Not likely to occur	Once per 10 years - The scenario is considered unlikely. It could happen, but it would be surprising if it did.
Very unlikely - Practically impossible	Once per 30 years or more.

In order to establish the likelihood of harm the adequacy of control measures already in place should be considered

Consequence (or Severity) Assessment

2.5.6 Consequences may be grouped into three general categories: health and safety of employees/public, environment, property. A severity level is assigned for each of the 3 categories based on the consequences specified in the hypothetical scenario.

Severity	Personnel Health / Safety	Environmental Impact	Property
1 Minor (Any failure that does not degrade the overall performance beyond acceptable limits).	Few minor injuries (Minor impact on personnel, temporary discomfort, first aid case, etc.).	Minimum pollution / Little or no response needed	Minimum cost / damage (Slight/Minor hull indents, equipment damage easy to repair by ship's force, etc.).
2 Moderate (Any failure that will degrade the system beyond acceptable limits but can be adequately counteracted or controlled by alternative means).	Number of minor injuries / Medical treatment for personnel	Little pollution / Limited response of short duration	Little cost or damage (Minor damages not affecting ship's structural integrity or seaworthiness. Damage to equipment/systems needing extensive repairs).
3 Extreme (Any failure that will degrade the system beyond acceptable limits and create a safety hazard).	Serious injury, fatalities to personnel	Major pollution / Full scale response	Extensive / high cost damage

Assessment of the level of the risk using risk criteria

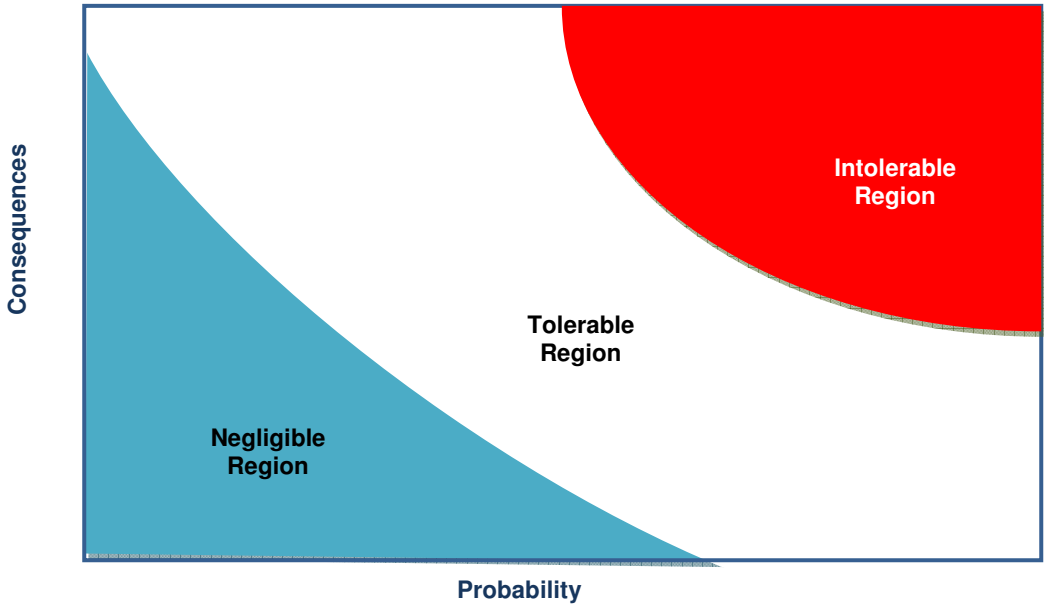
2.5.7 Level of risk is evaluate based on the severity and probability as estimated by the RA process and categorize their possible combinations to be High, Medium or Low risk within the Risk Matrix. Once the risk level has been determined, the response can be defined. Higher risk levels require a greater level of response.

High/Intolerable Risk: Goal is to take steps to reduce risk to at least a medium level.

Medium/ Tolerable Risk: Perform RA and identify risk control measures.

Low/Negligible Risk: Address as part of normal, on-going improvement processes.

Graphical presentation of risk regions



Qualitative risk table

2.5.8 Once the levels of likelihood and consequence have been determined, the level of risk can be found using, as example, the following qualitative risk table

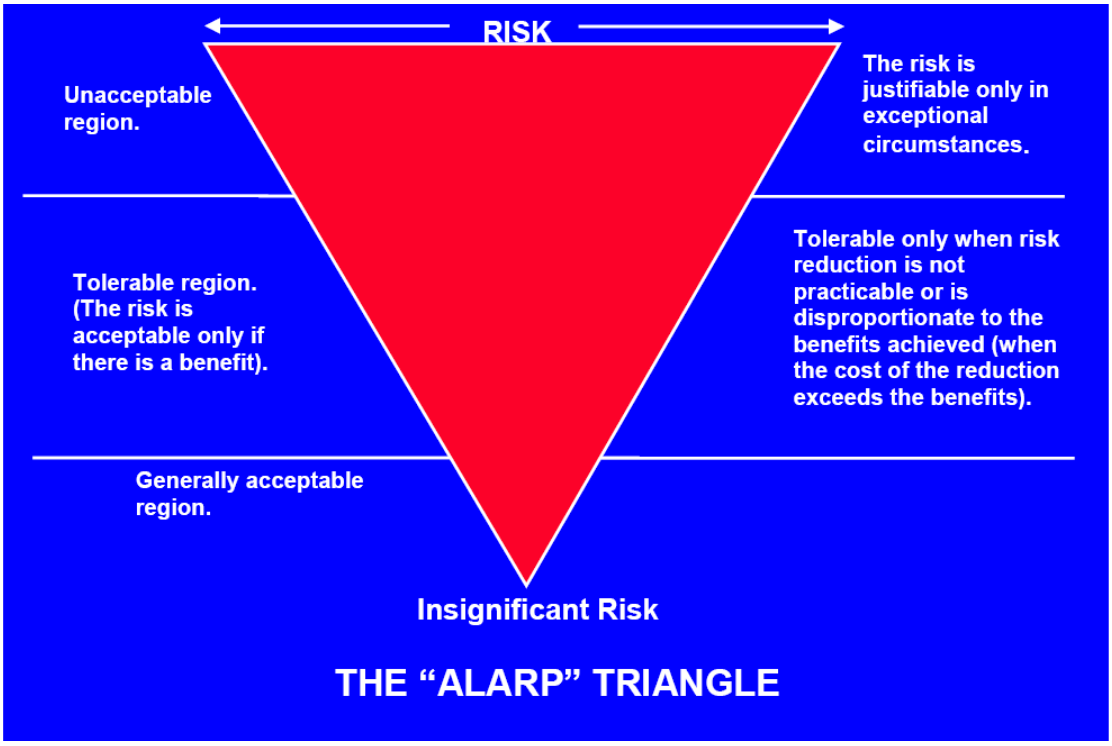
	Consequence		
Likelihood	Minor	Moderate	Extreme
Very unlikely	Low	Low	Medium
Unlikely	Low	Medium	Medium
Likely	Medium	Medium	**High**
Very Likely	Medium	**High**	**High**

Guide for Risk Assessment

2.6 Step 5 Risk Reduction

ALARP (As Low As Reasonable Practicable) Principle

2.6.1 The methods of reducing the risk level of a hazard can be put in one scale and balanced against efforts needed in another. This effort may be represented by money or time or a combination of the two. If it can be shown that there is a gross imbalance between the two, e.g. the reduction of risk level is insignificant compared to the cost of implementing the solution, it will not be reasonably practicable to go ahead.



Purpose

2.6.2 The purpose of this step is:

- Eliminate Hazards with intolerable risk at whatever cost. If this is not practicable abandoning the operation should be considered.
- Reducing the risk of those in ALARP region if it is cost effective. Higher costs could be considered acceptable if the risk is close to the intolerable region.
- Reducing the risk levels of those in the negligible region with minimal effort.

Action and Timescale

2.6.3 The below table indicates the actions required and the timescale for response in order to address and reduce the Risk. Risk Categories are the basis for deciding whether improved control measures are required and the timescale for action.

Risk Categories		Action And Timescale
LOW	Acceptable	No further additional controls / preventive and mitigative or alternative actions is necessary, but consideration should be given to cost-effective solutions or improvements that impose minimal or no additional cost. Monitoring is required to ensure that the controls are maintained.
MEDIUM	Tolerable	Efforts should be made to reduce risk, but the costs of prevention should be carefully measured and limited. Risk reduction measures should normally be implemented within a defined period of time.
HIGH	Intolerable	Work should not be started or continued until the risk level has been reduced and risk numbers enters the Yellow or the Green area. While the additional control measures should be cost-effective, the Company's duty to reduce the risk is absolute. If the control measures are not possible to reduce the risk, even with unlimited resources, then the work must not be started or must remain prohibited.

Identification and implementation of new Risk Control measures

2.6.4 The most important step in the RA process is the identification and implementation of risk control measures to reduce or eliminate the identified risks. Control measures can only be effective if they are closely linked to the causes. Once you know the causes, you know the needed measures. It is wrong policy to take measures without previously having identified the causes. However do not stay with general measures but make a clear planning, who, when, what etc.

2.6.5 Risk reduction policy should be applied in the following sequence:

- Try to remove/replace the hazard it self
- Eliminate the likelihood of the occurrence by taking away the causes in the first place
- Install rescue devices in your system to ensure an occurrence, once started, will stop timely
- Isolate the hazard source or reduce exposure time
- Take measures to reduce likelihood, usually related to organizational measures
- Protect the operator from the hazard
- Reduce the impact by providing PPE

Guide for Risk Assessment

- Ensure emergency response is efficient in case something goes wrong

The highest level of measure is to remove the hazard itself, whereas the lowest level is to reduce the effects of the accident as much as possible. The more you take measures close to the source the better.

2.6.6 Risk reduction methods could be categorized as:

- Management Method: Methods based on development of a safety culture, improved effectiveness of communication, training, etc.
- Engineering Method: Incorporate additional engineering features to enhance safety
- Operational method: Implementing/updating proper procedures
- Combination of all of above.

2.6.7 Following the selection of the appropriate new control measures, the Risk ranking process should be repeated in order to evaluate if the risk is reduced to a lower Category e.g. from Intolerable to Tolerable in case of implementing the selected new control measures. The process should be repeated again in order to reach the lowest possible Category.

2.7 Step 6 Review of assessment

Evaluation of control measures

2.7.1 In this step, implementation of the new control measures is followed up and recorded and evaluation of the controls should be made to ensure they remain in place and have the desired effect.

Need for new risk assessment

2.7.2 Risk assessment should not normally be carried out every time an operation/task takes place. The original risk assessment can be reviewed instead of performing a new one, provided that nothing has changed and the applicability of the existing procedures is ensured. However the risk assessment should be carried out if there changes in materials, equipment, operations/procedures, software etc.

Periodical review of risk assessment

2.7.3 Performed risk assessments should reviewed periodically to ensure the applicability of existing procedures/conditions and periodicity may vary depending on the hazard level of the operation/task/system.

Accidents / near misses

2.7.4 In cases of accidents or near misses, the risk assessment should be reviewed to determine if a control/measure failed, a control is missing or new hazards are present.

Comments

2.7.5 The risk assessment process never stops because the system will make use of previous experience, new measures will be based on improved measures and so on.

2.7.6 The risk assessments records should be filed and organized under the SMS filing system in order to be easily retrievable otherwise there will be the need of repetitive assessments of the same operation and on the other hand there will not be the necessary objective evidence as may be requested by auditors/PSC etc.

Guide for Risk Assessment
04 May 2010
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