*Integrated **Environmental** Management Information Series*

Risk Management 23

Department of
Environmental Affairs and Tourism

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Information Series 23:	Risk Management

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When referencing this document, it should be cited as follows:
DEAT (2006) Risk Management, Integrated Environmental Management Information Series 23, Department of Environmental Affairs and Tourism (DEAT), Pretoria

ISBN
0-9585084-2-9

PREFACE

This document is one of a series of overview information reports on the concepts of, and approaches to integrated environmental management (IEM). IEM is a key instrument of South Africa's National Environmental Management Act (NEMA). South Africa's NEMA promotes the integrated environmental management of activities that may have a significant effect (positive or negative) on the environment. IEM provides the overarching framework for the integration of environmental assessment and management principles into environmental decision-making. It includes the use of several environmental assessment and management tools that are appropriate for the various levels of decision-making. The overall aim of this document series is to provide general information on techniques, tools and processes for environmental assessment and management. The material in this document draws upon experience and knowledge from South African practitioners and authorities, and published literature on international best practice. This document is aimed at a broad readership, which includes government authorities (who are responsible for reviewing and commenting on environmental reports and interacting in environmental processes), environmental professionals (who undertake or are involved in environmental assessments as part of their professional practice), academics (who are interested and active in the environmental assessment field from a research, teaching and training perspective), non-governmental organizations (NGOs) and interested persons. It is hoped that this document will also be of interest to practitioners, government authorities and academics from around the world.

Although this series is focused on environmental aspects, the aim of this document is to promote the understanding that the effective identification and management of risks in business operations and activities may have a significant effect (positive or negative) on the environment. To achieve this understanding it is necessary to become familiar with the concepts of, and approaches to risk assessment and the risk management process.

The application of the risk management processes provides an overall framework for the identification, evaluation, control and review of risks, which may not only impact on normal business decision-making, but also on environmental decision-making.

This document has been designed for use in South Africa and it cannot reflect all the specific requirements, practices and procedures of risk and environmental assessment in other countries. This document and this series of documents are not meant to encompass every possible concept, consideration, issue or process in the range of risk and environmental assessment and management tools. Consider using this series of documents as a generic reference, with the understanding that it may be revised and supplemented by detailed guideline documents, as deemed necessary.

NOTE

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ACKNOWLEDGEMENTS

We wish to thank the following individuals and organizations for their contributions to this study.

Principal Author:	Leighton Bennett of Benrisk Consulting cc
Project Managers:	Reuben Heydenrych of Strategic Environmental Focus and Anben Pillay (DEAT)
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Peer Review:	Prof. Robert Vivian
Departmental Review:	Amanda Britz, Danie Smit and Johan Benade (DEAT)

All sources used have been acknowledged by means of complete references.

SUMMARY

The purpose of this document is to provide information for all stakeholders who are required to make decisions related to hazard and exposure risks and their management, such that the risk impact on any business's operations or activities, and on the environment in which they operate, can be mitigated.

The need to address risk is also enshrined in the Code of Corporate Practices and Conduct described in the King II report published by the South African Institute of Directors in 2002. This report highlights risk management as a core element of corporate governance for the business community in South Africa.

This document describes the concepts, principles and tools used in a universally accepted and generic methodology to identify, assess and manage a wide range of risks through a user-friendly Risk Management Process. This process has four process steps, namely the risk assessment, risk control, risk financing and risk review steps. Generally, management of risk is effective only if the root causes of the risk are properly identified, evaluated and defined (i.e. if the risk is assessed) so that suitable risk control measures can be applied to eliminate or mitigate the risk magnitude to an acceptable level.

This process fosters the concept of reducing risk to an acceptable level on an ongoing and continual risk improvement basis, as advocated by management system standards for environmental management (ISO 14001), quality (ISO 9000) and health and safety management (OHSAS 18000).

The Risk Management Process itself is a generic process for the assessment and management of all types of risk, including environmental risk. The Risk Management Process is similar to the EIA processes, but is generally applied to a broader scope of risk concerns, including not only the environment, but also other concerns such as safety, financial, legal, etc.

1 PURPOSE OF THIS DOCUMENT

The purpose of this document is to add a supplementary methodology process to the existing Integrated Environmental Management Information Series of documents, which can be used to identify, assess and control all the various types of risks that are not normally managed by the traditional tools of integrated environmental management such as environmental impact assessment.

This document focuses on providing a generic methodology to assess the nature of a spectrum of possible risks and to provide practical methods to manage these risks. The document contains a description of the concepts, principles and tools of understanding risks, performing risk assessments for generic risk situations according to a process used locally and internationally, applying changes to control and manage risks to acceptable risk levels and where necessary establishing risk funding provisions to pay for risk incident losses.

The document provides examples of various methods and tools that can be used in the assessment of risk. The risk management framework used is a generic approach that can be applied in the integrated environmental management field. It should be noted that this guide is not intended to be a detailed user's guide, but rather to convey the overall approach to assessing risk and managing risk in a broad context.

This document does not attempt to propose a new set of risk management principles and tools, but rather aims to synthesize and present the accepted and current thinking as an additional information resource to the Integrated Environmental Management Information Series of documents. There are business operations and processes that due to inadequate operation, poor maintenance, hazardous materials, etc constitute serious potential risks to the environment.

CONTENTS

TABLES

FIGURES

2 WHAT IS RISK?

2.1 Introduction

Consider these incidents, the Y2K computer risk, the terrorist attacks at the World Trade Centre, the risks leading to the Piper Alpha oil platform or the Flixborough petrochemical plant disaster, the risk of toxic chemical discharge like that at Bhopal or the risk of shipping disasters to sea life (Torrey Canyon or Exonn Valdez), the fall of Enron and the Barings Bank, or the radiation exposure from the Chernobyl nuclear power plant.

There is no sector of life, business, the economy or the environment that is immune to risk. However, before any risk can be managed or controlled one needs to know what are the nature, the likelihood of occurrence and the magnitude of the risks. The Risk Management Process is an effective tool for identifying, evaluating and controlling risks.

These are the incidents that hit the global news headlines, but how many risk related incidents are not newsworthy, yet they cause serious harm, damage, disruption to business operations and often to the surrounding environment. Small or minor risk incidents involving people, equipment, processes, materials, the environment and finances occur daily, each causing some harm, damage, loss or disruption.

What can be done to mitigate the impact of such incidents? We need to correctly identify risks through applying risk assessment methods, followed by introducing effective risk control measures to control and manage the risks in the long term. This approach introduces the concept of applying a risk management process, which has four main steps, with functional process stages within each step.

2.2 The concept of risk

In general, a risk refers broadly to situations where the outcomes are uncertain. The term “Risk” is described in two ways in the Concise Oxford dictionary:

* Firstly, risk is described as a hazard or a chance of bad consequences, loss, etc, and
* Secondly as an exposure or a chance of injury or loss.

Therefore, both the hazard and exposure descriptions are relevant risk dimensions in terms of parameters used in the identification of risks.

Risk in the Dictionary of Insurance (Bennett 2004) is described in three ways:

* Firstly, as the possibility or chance of harm, injury or damage, which is influenced by hazards present in the situation.
* Secondly, it is the subject matter insured or the peril insured against and
* Thirdly, as an insurance company’s risk which is the uncertainty regarding the cost of a particular claim and depends in the underwriting risk and the timing risk or both.

Valsamakis *et al* (2005) define risk as the variation of the actual outcome from the expected outcome, which implies the presence of uncertainty. This definition indicates that there is an uncertainty surrounding the outcome of an event and about the degree of uncertainty of the actual outcome that is expected.

Furthermore one could consider uncertainty in the context of two dimensions, namely a range of possible outcomes and the probability of an outcome occurring.

- A range of possible outcomes:
  There are a few situations where a range of possibilities is very narrow. For example, in tossing a coin one thinks of two outcomes, heads or tails, but the possibility of the coin landing on its edge or rolling away and becoming lost is very remote.

  However, with other risks, possible outcomes can be hard to foresee, as the possible range of impact outcomes can be more or less infinite. Environmental impacts are a good example of this, as some outcomes may be unpredictable or indirect, as is the case with secondary or synergistic impacts.

- The probability of an outcome occurring:
  Probability means the chance that a particular outcome will occur. In some cases this is easier to predict, like rolling dice where the odds of a particular number coming up are 1 in 6 or 16.75 percent. In other cases it may not be possible to calculate a probability exactly, in which case it will be only an estimate. Normally insufficient information is available to determine the probability of some events, like earthquakes or volcanic eruptions.

From the above descriptions of risk, it is obvious that the intangible and subjective concept of risk will be viewed differently by different people and can be used in different contexts:

- In a safety context, risk refers to a chance of loss measured in economic, severity or human injury terms.
- In a risk identification context, risk can be viewed as a Hazard and/or an Exposure, where hazard is a physical or chemical condition or practice with the potential for causing harm, and exposure is a condition or practice of being unprotected from or being subjected to potential harm.
- In a context of pure risk, risk means a chance of loss or no loss, but no gain (e.g. a fire or theft loss).
- In a context of speculative risk, risk means a chance of loss, no loss or a chance of a gain (e.g. in gambling, money market activities, etc).
- In insurance terms the risk is the insured or the risk liability exposure to an insurance company.
- In environmental risk terms, this risk is a pure risk impacting upon the environment in which humans, animals and plant life exist within a micro environment (relating to the occupational hygiene aspects of a workplace) and macro environment (with a broad sustainability focus).

2.3 Types of risk

Irrespective of what risk context or definition is used, there is a need to know what type of risk is anticipated and to rationalise it as far as possible relative to the nature of the business or operations.

The IRMSA Enterprise Risk Management Code of Practice (2004) identifies a spectrum of risks that could be encountered when operating an enterprise or business, namely:

Strategic risk	A group of risks impacting on the strategy and long-term plans of an organisation
Value-based risk	Risks that impact on the worth of something in monetary terms
Process-based risk	Risks that impact on the method of doing things in an operational or activity sense
Information-based risk	Risk that impact on the information available for decision making
People-based risk	Risks arising from people related activities or the lack thereof
Environmental risks	Risks that impact on or impair the micro and macro environmental conditions
Compliance risks	Risks that arise from either compliance or non-compliance of legal and other compliance related requirements
Asset risks	Risks that impact on the cash, investments and property owned by an organisation or entity

Obviously there are a number of different risk approaches one could use to classify risks and perform a risk assessment, so it is important to select and plan what approach to use, to provide and achieve the desired outcome results.

Table 1 below presents Waring's (1998) list of the pure and speculative risks as hazards and threat risks to business. From this list it is evident that there are two distinct fields of risk for pure and speculative risks, while a similar difference exists between the unchanging static and the continually changing dynamic risks.

HAZARDS AND THREATS (Objects of Risk Management)	
Pure risk topics	Speculative risk topics
Occupational health and safety	Financial / credit risks
Fire	Investment
Security	Business risks
Environmental	Political risks
Quality assurance	Social/cultural risk
IT reliability	Human Resources
Business interruption	Marketing
Flood	IT Strategy
Earthquake, etc	Total Quality Management, etc

Table 1. Examples of pure and speculative risks

Pure risks are assessed on a uni-dimensional scale (e.g. related to bad outcomes only) whereas speculative risks require two separate assessments, related to potentially good (positive) and bad (negative) outcomes.

2.4 The nature of risks

The nature of the risk is determined by considering a series of questions relating to the nature and scope of risk. This must be done before any risk is assessed or before one makes any decisions on risk.

Olsson (2002) provides the following questions to be considered for assessing the dimensions (scope) of risk:

- How long will we be at risk (time)?
- How big is the risk likely to be (size of exposure)?
- What is the probability of occurrence (probability)?
- How close to the expected outcome is the risk event likely to be (volatility)?
- Is it a simple risk to understand (complexity)?
- How many types of risk are involved (inter-relationships)?
- Can I manage this risk (influence)?
- What will it cost to address these risks (cost effectiveness)?
- How will the risk change over time (life cycle)?

Germain et al (1998) refers to the need to have PPPE, namely People, Property, Processes and the Environment to be present as the 4 elements necessary for a working system in an enterprise. From a risk assessment point of view Bennett has expanded this to PEPMELF , where each of these elements of risk needs to be considered in turn.

From a simple practical point of view, risks can be identified by considering each of the PEPMELF approach elements in turn. For example:

* Who or which people, animals, plant life etc. are at risk?
* What are the environmental risks?
* Where is the environment at risk?
* Why is the environment at risk?
* When is the environment at risk?
* How many aspects of the environment are at risk? and
* How often is the environment at risk?

3 THE RISK MANAGEMENT PROCESS

3.1 The risk management process in brief

The Risk Management Process is a universal stepped process that can be applied to manage any enterprise, organisation, business or operation, etc, with the overall objective of reducing the occurrence of risk related loss incidents to acceptable risk and impact levels.

There is some variance between different authors regarding the elements of the Risk Management Process. Prichard (1997) suggests that there are 4 elements (steps) one should consider when performing risk management, namely:

* Risk planning;
* Risk assessment;
* Risk response development; and
* Risk response control.

However, this approach does not mention a monitoring or review function, which when included, enables continual improvement over a longer term. Once a risk monitoring and review elements are added, it results in a Risk Management process as illustrated in figure 1 below.

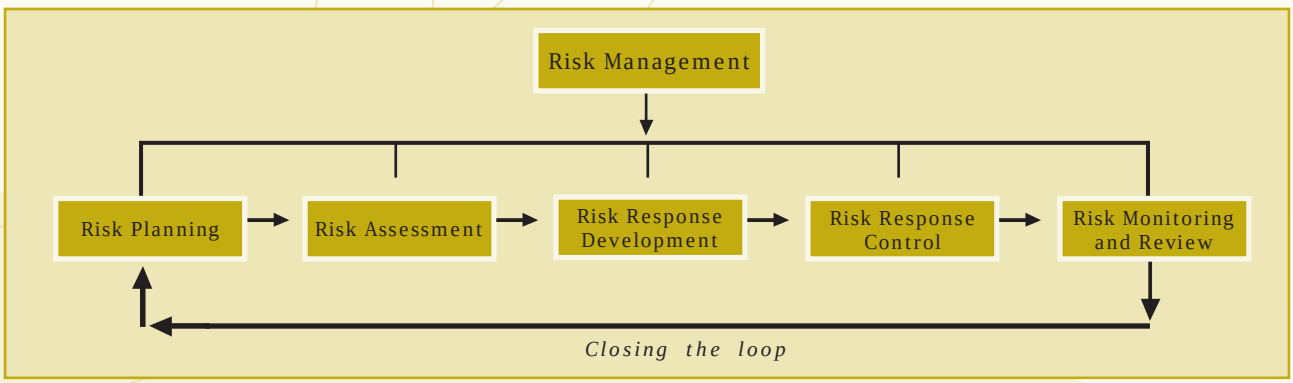

Figure 1: The basic steps structure of the risk management process

Other authors emphasize all risks can be effectively controlled by physical means only, and that remaining uncontrolled residual risk could still cause significant harm. To manage this residual risk, one can establish financial provisions in the form of a risk financing element in the risk management structure, to compensate for incidents that do occur. Most authors, therefore, agree that the Risk Management Model has a risk control and a risk financing dimension. For instance, Valsamakis et al (2005) defines risk management as "a management function aimed at protecting the organisation, its people, assets and profits against physical and financial consequences of risk. It involves planning, coordinating and directing the risk control and risk financing activities in the organisation." This definition includes a risk financing dimension.

Thus, with minor refinements to the basic structure of risk management, the largely accepted full Risk Management Process is presented in figure 2 below.

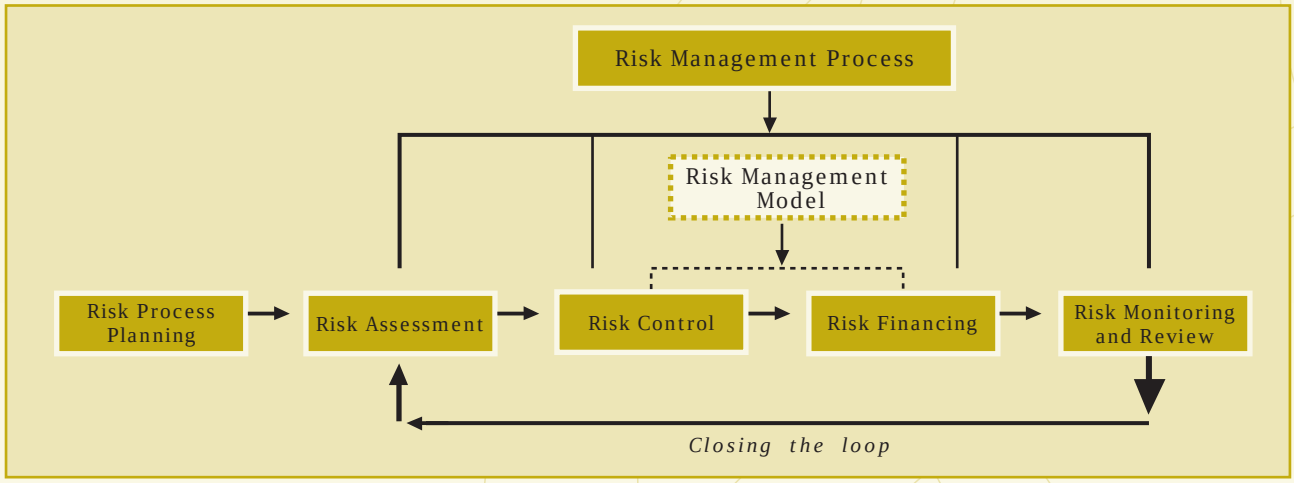

Figure 2: The full Risk Management Process

3.2 Steps in the risk management process

The four main steps in the risk management process will now be dealt with in more detail.

Step 1 Risk Management Planning: This involves planning to ensure that all the steps to follow (from risk assessment to risk review) run smoothly. It includes deciding on the level and type of risk assessment, the deliverables and ensuring that all necessary resources are available for the risk management process at the times and places where they need to be.

Step 2 Risk Assessment: This comprising a risk identification stage, where the potential hazards and/or exposures to risks are identified, a risk evaluation stage, where the magnitude of the risks identified and quantified and prioritised, while the value judgement stage, involves deciding on the acceptability of the nature and magnitude of the risks identified.

Step 3 Risk Control: The risk control strategy is firstly decided upon by applying the "4T's" to risk, followed by a practical approach of managing the risks through making procedural, process or system changes involving the "7E's" .

Step 4 Risk Financing: where applicable. It may be applicable where the magnitude of the risk scenario indicates that financial provisions need to be made to pay for the losses suffered if a risk scenario occurs. There are three main methods of establishing risk financing funding provisions through internal/retained, shared and/or external or transferred funding sources.

Step 5 Risk Review: This should be regularly performed to ensure that the risk controls implemented are working effectively and to determine if any new or changed risks need to be managed. If defective controls or new risks are detected, then control revisions or a re-assessment of the risk management process is performed to establish an ongoing improvement in risk reduction.

These four core steps of the Risk Management Process (excluding planning) are graphically presented in figure 3.

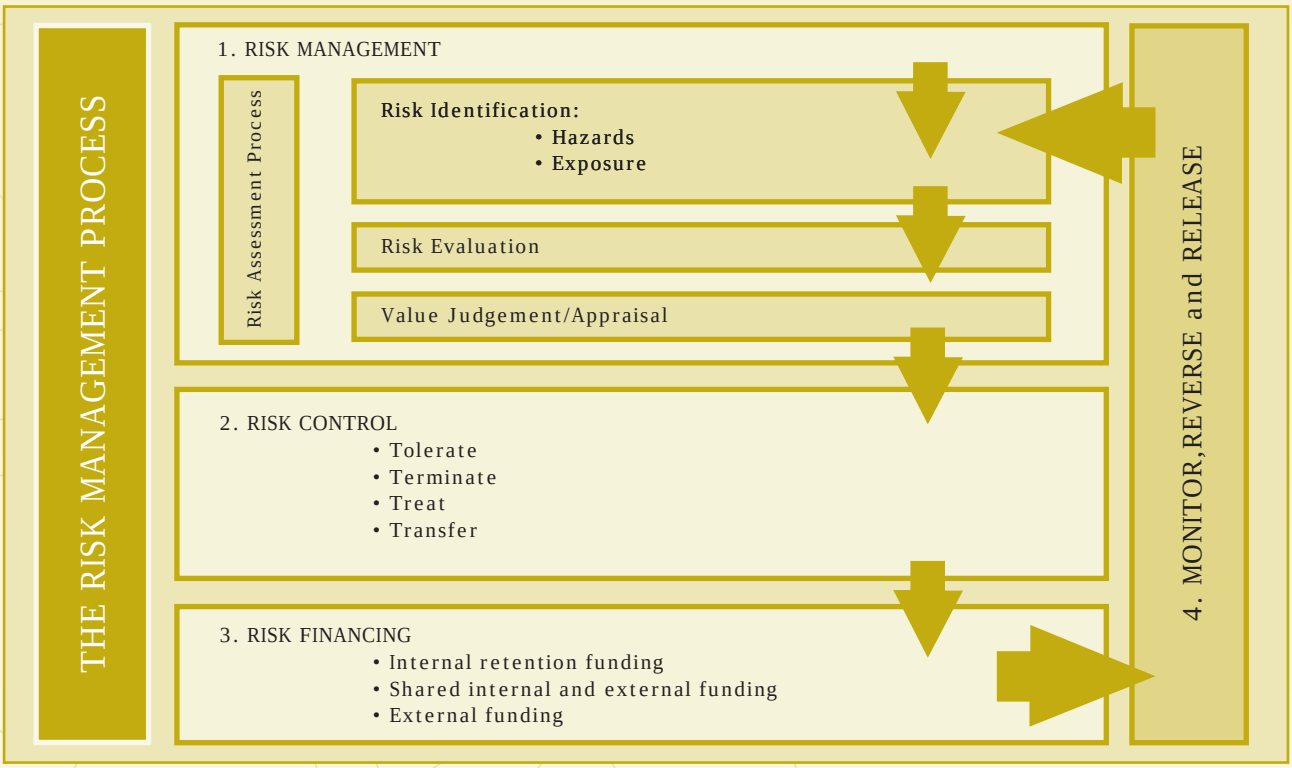

Figure 3: The Risk Management Process

3.3 Risk management planning

Prior to embarking on a risk management process, planning is necessary to ensure that the risk management runs smoothly. Therefore, in addition to the four steps mentioned above,

At the outset there has to be some project planning, because the risk assessment process must be customised to each project and this is dependant upon all sorts of factors, which van Well-Stam (2004) lists as:

* The phase or stage of the project;
* The size of the project;
* The complexity of the project;
* The people who are to work or are working on the project;
* The size of the project organisation;
* The objective of the risk analysis;
* The time, capacity and budget available for performing the analysis;
* The quality and degree of documentation required and the intended basis; and
* The results required.

The Risk management plan should include:

* An objective and the desired end result of the process;
* Requirements in terms of time, money, quality, information and organisation necessary to achieve the end results;
* Selection of knowledgeable and experienced personnel for the risk assessment team to ensure a credible outcome. One person should be identified to facilitate the risk assessment process and another to record the results of the assessment.
* A decision as to the type of risk assessment to be performed (i.e. a base line or an issue-based risk assessment);
* A suitable meeting venue;
* Availability of information related to the project or incident being risk assessed. This includes any specific procedural or operational requirements and other relevant drawings, and manuals (e.g. layout and design drawings, specifications, pipeline and instrumentation (P&ID) drawings, supplier and operational manuals, Safe Working Procedures, maintenance records, any previous risk assessments related to the issue, etc.);
* A means to record the risk assessment activities is necessary. This usually requires appropriate work sheets on a computer with a data projector as a suitable platform for the assessment team;
* Identification and value judgement of each risk during the risk assessment to identify the key risks to be afforded priority for the application of risk control measures;

* Identification of risk control measures to lower the risk levels to acceptable levels. This process is repeated until all the identified risks of a harmful magnitude are suitably controlled or the risk is low enough to be regarded as acceptable;
* Development and communication of a risk control implementation plan with formalised implementation documentation; and
* Establishment of a programme to monitor and review the risk management process and delegating authority to revise unsatisfactory aspects.

3.4 Risk Assessment

A brief overview of risk assessment is given in this section. A detailed explanation of risk assessment is provided in Section 4.

Risk assessment is a process where the hazards and exposures are identified, the risk potential of these hazards and exposures are analysed and estimated and a decision as to the acceptability of these risks to people, business or the environment is made.

Risk Assessment is often defined as the identification of undesired events, their causes and analysing their likelihood and potential consequences - considering existing control measures - in order to make a valued judgement as to the risk's acceptability. The Dictionary of Insurance (Bennett 2004) defines risk assessment as a collective reference to risk identification, risk analysis and risk evaluation.

These definitions infer that there are three steps required to perform a risk assessment:

Stage 1 A risk identification element stage (to determine what risk(s)

Stage 2 A risk analysing and/or evaluation element stage (to determine a risk's magnitude)

Stage 3 A value judgement element stage (to determine a risk's acceptability)

The Risk assessment process is a generic method of assessing any situation that could involve risk and uncertainty. It is applicable wherever there is a chance of risk occurring. Thus, risk assessment can be applied to:
- A new development (eg. a site expansion, a new plant, establishing a site, etc.);
- A development of an existing entity (eg. changes or modifications to be introduced to a site, plant, machine, process, operational method, system, etc); and
- A development closure (e.g. de-commissioning a plant, machinery dismantling and removal, etc.)

Furthermore, the risk assessment process can be focused on different disciplines, like environmental matters, health and safety, general business, structural and other engineering, machinery design, and operation, production process operations, waste handling operations, transportation methods, construction, etc.

3.4.1 Levels of Risk Assessment

Risk assessments can be performed relative to different levels of business operation, namely at:
* A corporate or strategic level, where the assessment outcome could change the direction or focus of the business;
* A group or macro operational level, where the assessment outcome could change the nature or operations of the business; and
* A business unit or operational level, where the assessment outcome could change the processes or the methods of working.

3.4.2 Types of Risk Assessment

Within each of these business levels there are three main types of risk assessment that could be performed, to obtain suitable information for decision-making.

(a) Baseline Risk Assessment:

A Baseline Risk Assessment is performed to obtain a benchmark of the types and sizes of potential risks, which could have a significant impact on the whole business. This assessment could be focused on internal and/or external influences and could vary in scope from a single site to a regional or national basis.

A baseline environmental risk assessment for a new site could cover legal aspects; landscape changes; emissions, effluent and waste discharges; risk exposures to neighbours; site access; emergency procedures, etc, which would normally be covered in an environmental scoping study.

The outcome of a baseline risk assessment is a risk profile, which identifies potential high risk items to highlight which risks need to be managed first to reduce the risk magnitude to acceptable levels. However, to obtain a more detailed insight into the nature of an important high level risk that has been identified, it may be necessary to perform an Issue Based Risk Assessment.

(b) Issue Based Risk Assessment

An Issue Based Risk Assessment is normally focused at operational activities, process and system based business functions and is a more focused and an in-depth assessment than a baseline assessment.

The issues identified are normally determined from proactive or reactive occurrence information, protection and safeguarding systems, change management and baseline assessment inputs.

Issue based risk assessments can be focused on any of the following aspects:
* Job-task or procedure (e.g. welding, manual lifting, waste collection, etc.);
* Processes (e.g. effluent discharges, blending, heating, waste treatment, engineering standards, management processes, etc.);
* Equipment (e.g. Personal Protective Equipment (PPE), tools, machinery, fire equipment, pipe work, boilers, reactors, scrubbers, etc.);
* Work Group (e.g. electricians, welders, cleaners, bricklayers, plumbers, etc.),
* On other specific fields, like using the PEPMELF element headings as the basis for the risk assessment.

(c) Continuous Risk Assessment

Continuous Risk Assessment is performed at an operational level, where the processes, systems and activities are monitored on an ongoing basis by the operational management and the front line supervision.

This continuous risk monitoring is achieved through inspections, critical job or task analysis, planned job observations, pre task or toolbox talks and/or through non-conformance or defect quality reporting means. This ongoing monitoring at an operational level permits any new, changing or poorly controlled risks to be identified.

Continuous risk assessment facilitates monitoring the effectiveness of the applied risk controls and can highlight the need to re-assess new or changing risks and non-conformances. Here the daily or regular observation and/or monitoring of the effluent, waste and emissions released from the site would be performed by site supervision, with corrective action being taken against poor risk controls or system deficiencies when detected.

(d) Comparison of risk assessment types and levels

The risk assessment types, levels and normal outcomes are summarised in Table 2, together with some typical project examples listed:

Risk Assessment type	Risk Assessment level	Risk Assessment outcomes	Risk Assessment project examples
Baseline	At corporate, company or business unit level.	> Risks of strategic importance identified and assessed. > Outcome could influence a change in business focus or direction. > Risk profiles are obtained.	> On a new plant expansion > On a green fields development project > On the impact on the public > A general health and safety analysis > On corporate compliance
Issue based	At business operation, department or section level	> To distinctly and clearly identify and quantify the risk causes associated with the activities, processes or tasks. > Outcome could influence the business operations, methods and procedures.	> On operational process changes. > On machinery safeguards. > On chemicals handling and use procedures. > On maintenance procedures. > A PPE needs assessment. > On contractor management and controls.
Continuous	At workplace conditions, process and activities level	> An ongoing line assessment and review process to monitor static and dynamic risk changes in the workplace conditions, processes or activities. > Outcomes could influence how work and work methods are performed	> On planned inspections > On critical task analysis > On planned job observations > On Toolbox talks > On manual lifting and handling > On PPE usage

Table 2: A comparison of the different risk assessment types and their associated characteristics

(e) Risk assessment techniques

Hyatt (2003) lists various technical risk assessment techniques and tools that are focused at different applications and levels of risk assessment outcomes, for example: Preliminary Hazard or Screening Level Risk Analysis; Hazard and operability analysis (HAZOP); Failure mode and effects criticality analysis (FMEA or FMECA); What-if Analysis and/or Checklist Analysis; Fault Tree Analysis (FTA), and so on. It is not the intention of this document to provide details of these methods, but only to explain the risk management process.

3.5 Risk control

Risk Control is the second stage of the risk management process. At this stage the risk is minimised through design and implementation of physical risk management programmes with the following objectives:

- Reduction of the magnitude of the exposure
- Reduction of the frequency of the loss producing events
- Dealing (physically) with loss-producing events
- Recovery (physically) from the loss–producing events

Risk control entails practical methods to reduce risk at the source of the risk. Implementation and monitoring of risk control is normally performed as a line management function, with the understanding and commitment for the process being driven by top management.

Although there are a number of formal definitions of risk control (e.g. refer to IRMSA's and Prichard (1997), all the definitions have basically the same meaning as shown in Table 3 below.

TERMS USED IN RISK CONTROL				MEANING
Finance	Safety	Risk Management	Occupational Hygiene	
Decline	Terminate	Elimination	Elimination	Some risks can be avoided by not entering into, stopping the activity or refraining from performing specific hazardous activities.
Accept	Tolerate	Acceptance	PPE and Surveillance	Where the risk return properties are acceptable, or low risk outcomes can be expected, so the risk exposure is accepted.
Mitigate	Treat	Reduction / Mitigation	Source control	Where action can be taken to reduce the impact of the risk(s) to an acceptable exposure level.
Manage	Transfer	Transfer	Minimisation	Where specific control activities are applied to minimise risk exposure through transferring or outsourcing the risky activity to another party.

Table 3: Comparison of the risk control terminology

3.6 Risk financing

Risk Financing is the third stage in the risk management process. Risk financing entails establishing financial provisions to pay for the losses that may occur as some losses could occur in spite of applying risk control measures. Risk financing is necessary to pay for any losses and for the recovery from any loss causing incident suffered when risk controls fail or where risks cannot be adequately managed.

In the selection of the most effective method of risk financing there are three main choices:

* The retention of risk financing (internal funding) under a deliberate self-funding plan
* The combination of internal and external funding, with excesses or deductibles being paid by the insured and a commercial insurer paying for losses to the policy value limits.
* The external risk financing (transferred funding) normally through to a commercial insurance company.

Commercial insurance for environmental incidents is available, but this insurance cover tends to be very costly, as the insurance industry's environmental rehabilitation payment liability losses from major environmental incidents is vast, like oil spillage pollution clean-up costs experienced for several recent oil tanker-related sea disasters.

It needs to be noted that risk financing methods are normally established to pay for possible high severity or high frequency loss incident occurrences, and are not established for every potential risk or residual risk scenario. This being the case, the risk financing step may be ignored between the risk control and risk review steps of the risk management process.

3.6.1 The costs of risk

According to Valsamakis et al (2005) Barlow introduced the concept that cost of risk which is the sum of the following:

* Insurance costs (i.e. premiums, excesses, uninsurable losses, etc)
* Un-reimbursed losses (i.e. self-insured and self-retained expenses and losses)
* Risk control and loss prevention costs (i.e. equipment provision, depreciation, risk management staff and training, consultant audits, costs, etc) and
* Administrative costs (i.e. investigation and claims handling, broker costs, etc)

Looking at these likely costs, the sums involved can range from insignificant to enormous amounts, which will need to be financed from internal or external sources or both. The application of good risk management practices may facilitate reductions in the cost of risk costs such that higher levels of shared or retained self-funding could be contemplated, thereby achieving cost savings.

3.6.2 Internal or retention financing

Practical facilities for internal retention funding range from retention funds (an accounting provision or reserve in the books of a firm) to an insurance company that underwrites the risks of its parent organisation. Such retention funds are drawn from cash flow, provisions, reserves or equity sources. A classic example of where such internal financing is hidden is when the various risk related losses are directly financed and hidden through the engineering repairs and maintenance budget.

There are certain loss situations where the loss is uninsurable and so the business or organisation will have to provide funds for such eventualities and for any situations where inadequate insurance covers are encountered.

3.6.3 Internal and external shared financing

The second main form of funding is a shared funding where internal retained funding and external funding are both employed. The common example is a commercial insurance policy where the insurance premium is reduced as the insured accepts to pay an excess or deductible amount should a loss occur.

3.6.4 External financing

External financing involves the transfer of the risk to a 3rd party commercial insurer, who accepts the liability to pay for specified losses on the insured's behalf. These payments would be intended to only place the insured in a situation similar to and not greater than that at the time the loss occurred. This external funding can be drawn from captive and commercial insurance companies, state risk financing and capital market sources.

This Risk Financing aspect is important as an incident like a fire destroys property, which can be covered under a fire insurance policy, but the contaminated product materials or contaminated fire fighting water may not be permitted to be sent to a local landfill site or to flow into the passing stream, for example. This may result in significant costs to properly dispose of these contaminated materials. Additional insurance may be purchased to provide the necessary cover for specific types of losses, which may not normally be covered under traditional insurance policies.

3.7 Risk review

Once all the various risk assessments are done, the risk controls have been implemented to mitigate the risks to acceptable levels and risk financing is provided (if necessary), the risks need to be monitored and reviewed to check that the controls that are being applied are effective in reducing the level of risk or acceptable levels.

Management must regularly monitor and review the various control measures applied. Where unsatisfactory risk controls or new risks are encountered during these audit reviews, management must ensure that new or changing risks are dealt with by existing controls or by re-assessing these risks. Re-assessing these risks and implementing revised or new risk controls will close the risk management process loop and facilitates achieving continuous improvement in an enterprise.

4 RISK ASSESSMENT IN DETAIL

4.1 Risk identification

This risk identification stage (sometimes called hazard identification) is the first stage of the risk assessment process. It involves the identification of possible risks that could constitute a hazard and/or exposure to the business, operations, people or the environment.

There are two risk identification elements, namely:

* Hazard: This is described as being a sub-standard condition, an inherent hazard, unsafe acts, at-risk behaviour or defective design. In terms of speculative risks, hazards are often called risk factors.
* Exposure: Exposure is normally related to occupational health (medicine and hygiene), environmental impairment, legal liability, financial transactions/activities, societal pressures, reputation and globalisation exposure issues, which impact on property, personnel, net income and legal liabilities. These exposures could be an unprotected vulnerability to a single contact exposure or could be exposures ranging from multiple short exposures to a continuous risk exposure situation.

Various methods are used to identify risks, for instance:

* Standardized surveys or questionnaires (e.g. insurance, safety, compliance)
* Personal inspections (e.g. fire, safety, maintenance, environmental, quality, etc)
* Records and files (e.g. minutes, incident investigation, audit and non-conformance reports)
* Financial statements (e.g. income and expenditure statements, close loop document trails, functional division of labour problems, etc)
* Flowcharts and drawings (e.g. flow bottlenecks, layout and P&ID drawings)
* Brainstorming (e.g. issues and scenarios related to planned development projects)
* Knowledgeable people (e.g. employees, experts and industry related knowledge sources)
* Hazard Analysis Techniques (i.e. using. selected techniques to establish the risks related to specific types of situations (e.g. using HAZOP, What-if, FMECA, FTA, etc).

There are two risk identification inspection approaches, namely:

* a physical “walk-about” inspection; and
* a scenario brainstorm risk inspection

The obvious risk identification method is to perform a physical “walk about” inspection of the operations in a work area or by observing the work methods and tasks being performed within a workplace. However where no physical workplace exists a Scenario Brainstorming Risk Identification method, which can be used to identify risks for any situation where people, processes or assets are at risk. This method involves a scenario being visualised and by using a group of knowledgeable people to brainstorm a business, operation or site scenario, a series of potential risks and other related hazards and exposures can be identified. This is a useful technique for performing new or green-fields construction work site assessments or for initial environmental risk assessments.

4.2 Risk evaluation

Risk evaluation or risk analysis is the second stage of the Risk Assessment Process and includes the analysis and quantification of risk element stages. Risk evaluation is generally defined as the process of evaluating the frequencies and consequences (and possible exposures) of risk occurrences of a hazardous nature, activity or exposure.

It is important to focus not only on the consequences of a risk, but also on the frequency. Deshotels (1995) states that the understanding of risk is ... complicated because society, in general, seems to focus on the consequence of an event without considering its probability or likelihood. This tends to occur because risk is associated with events with extremely low probabilities and high consequences. The average person has difficulty appreciating low-probability events and therefore pays more attention to the consequences.

There are three broad approaches to risk assessment evaluation, namely a heuristic, a scientific and a hybrid approach.

* The heuristic approach: this approach may include some basic form of quantification. Generally it is qualitative and subjective, relying on individual’s collective judgement in assessing the magnitude aspects of the risks considered, which often use risk identification terms with low, medium or high risk characteristics.
* The scientific approach: this approach employs quantitative modelling and generally requires some formal training to deal with the complex mathematics or mathematical equations to describe the risk characteristics. Examples of this include the mathematical formulae to determine explosion and fireball hazards, total risk calculations and incident, dispersion and explosion modeling

calculations. (Note: This form of assessment is normally used for assessing Major Hazardous Installation risks under the Occupational Health and Safety Act,1993 (Act No. 85 of 1993).

* The hybrid approach: This approach is semi-quantitative, where a combination of low, medium and high are blended with basic numbering or mathematical formulae, like when using a matrix format to rank characteristics of the risk on two axes (See Table 4 below).

Risk evaluation is the product of the probability of occurrence and the consequence or net effect of that event. As both probability and consequence are being described in other terms by various authors, the following terms are often interchanged depending on the form of information that is available for risk evaluation purposes, as Bennett (2005) illustrates in table 4.

Occurrence description	Term used	Value example
How often function	Likelihood	Regularly, yearly
	Frequency	3 x per year
	Probability	1 in 50 chance
How severe function	Consequence	In R, $ £, injury
	Severity	In R, $ £, injury
	Impact	In R, $, £, injury
How long or condition function	Exposure	Hours, days, years or an unprotected vulnerability

Table 4: The interchangeability of various terms

With this term interchangeability being accepted, risk at the evaluation assessment stage can be described as:

Risk = Likelihood x Consequence OR Risk = Likelihood x Severit
Risk = Frequency x Consequence Risk = Frequency x Severity
Risk = Probability x Consequence Risk = Probability x Severity

Likelihood can be considered not only as a probability of occurrence or frequency function. It can also be considered as a conditional function where the possibility or frequency of occurrence is conditional on another factor, namely an exposure dimension in time or a particular condition (for example: the risk of a serious acid burn is possible only if a person is likely to come into contact with acid under a condition of not being safeguarded by personal protective equipment). Adding this exposure element into the risk formula changes the risk formula functions to:

Risk = Likelihood x Exposure x Consequence

OR

Risk = Likelihood x Exposure x Severity

In its simplest form a basic risk evaluation comprises listing all the identified hazards and exposures, determining the possible consequences of each risk identified and assigning a value to the level of risk. The values signed are normally numeric values, such as 1 = very low, 2 = low, 3 = medium, 4 = high and 5 = very high for likelihood, for example.

Between three and five levels of numeric value can be assigned to each of the risk formula functions. Once numeric values are incorporated into the risk formulae then the calculated scores become a risk rating value. Provided that the same rating system is used for different risks, the risk scores for each risk identified can be compared and ranked. For a two-element risk formula situation using consequence and likelihood as risk functions, the risk rating can be represented in a risk matrix format, as in Table 5.

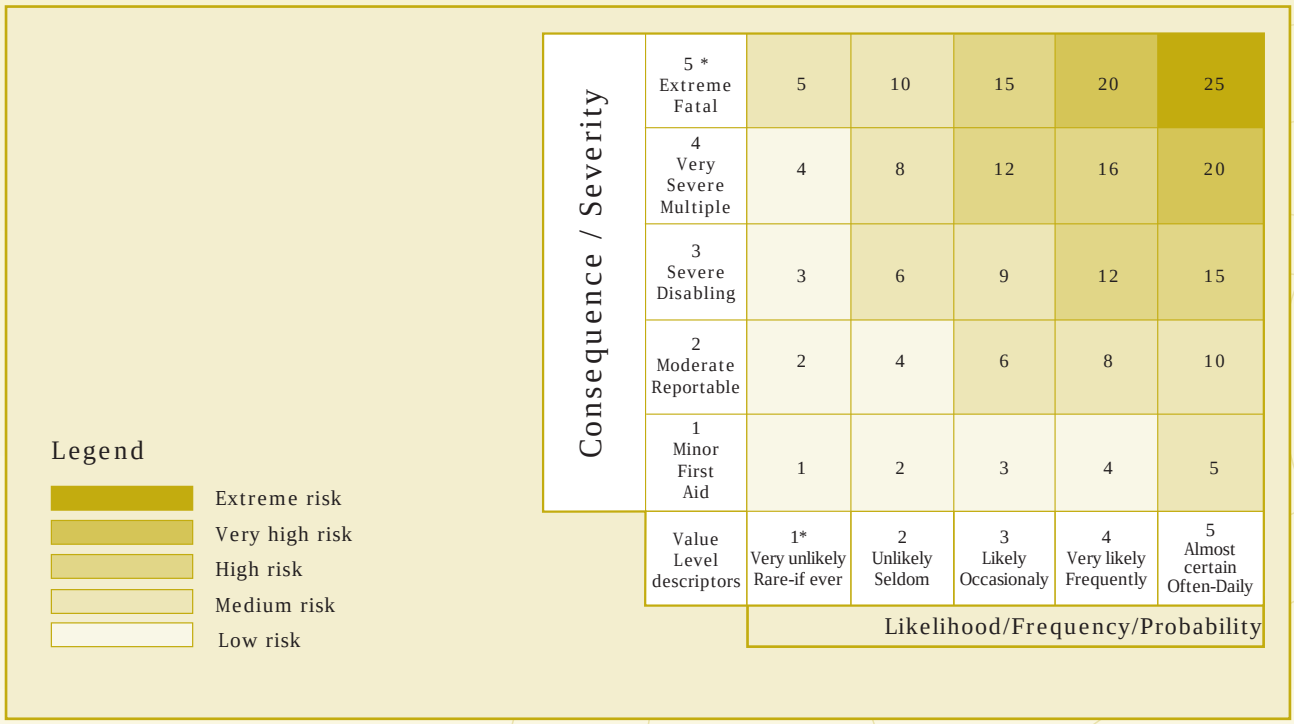

Table 5: A risk evaluation matrix table scoring 2 functions

A risk evaluation value can easily be determined using the above tabulation. Examples of how these formulas can be applied are provided in the text box below.

Example of a 2 function risk formula

As a worked example for the 2 function risk formula, assume a situation where the condition of an operating steam boiler is poor, such that the likelihood of a boiler failure is high (4), while the consequence of a boiler failure involves an explosion and no steam supply until a replacement boiler is commissioned in about 12 months time, giving a very high (5) consequential loss risk.

By calculation: the boiler failure risk rating = Likelihood x Consequence = 4 x 5 = 20 (out of a 25 max score)

By using the risk matrix shown in Table 5: the risk rating score is represented by the value located at the intersection of the high likelihood column and the very high consequences row, giving a risk rating of 20, a very high overall risk scenario.

Example of a 3 function risk formula

For calculating a 3 function risk formula, assuming the above worked example information again, where the condition of an operating steam boiler is poor, such that the likelihood of a boiler failure is high (4), but the boiler is in daily use giving a very high (5) exposure and the consequence of a boiler failure involves an explosion and no steam supply until a replacement boiler is commissioned in about 12 months time, a very high (5) loss consequence risk.

This boiler failure risk rating score is calculated as:
Risk = Likelihood x Exposure x Consequence = 4 x 5 x 5 = 100 out of a possible maximum of 125, (i.e. 5x 5x 5), which represents a high to extreme overall risk rating for a boiler failure.

Germain et al (1998) presents the work of WT Fine and others in Table 6, who offer the categorisation of criteria and values to establish risk scores for personal safety type risks. This example is a 3 function format of likelihood x exposure x consequence.

RISK SCORE – LIKELIHOOD X EXPOSURE X CONSEQUENCE	
LIKELIHOOD * : (L)	Value
Might well be expected (Happens often)	10.0
Quite possible	6.0
Unusual but possible	3.0
Only remotely possible (has happened somewhere)	1.0
Conceivable but very unlikely (hasn't happened yet)	0.5
Practically impossible (one in a million)	0.2
Virtually impossible (Approaches the impossible)	0.1
* The probability of a loss when the hazardous event does occur	
EXPOSURE * (E):	Value
Continuous	10.0
Frequently (daily)	6.0
Occasionally (weekly)	3.0
Unusual (monthly)	2.0
Rare (a few per year)	1.0
Very Rare (yearly)	0.5
No exposure	0.0
* How frequently the hazard event occurs	
CONSEQUENCES (C):	Value
Catastrophic (Many fatalities, or damage over $10 000 000)	100
Disaster (A few fatalities or damage over $1 000 000)	40
Very serious (One fatality or damage over $100 000)	15
Serious (Serious injury or damage over $10 000)	7
Important (Temporary disablement or damage over $1 000)	3
Noticeable (Minor first aid or damage over $100)	1
R = L x E x C: The risk score (magnitude of the risk) is derived by multiplying the likelihood value times the exposure value times the consequence value	
RISK CLASSIFICATION	RISK SCORE
Very high risk: consider discontinuing the operation	Over 400
High risk: Immediate correction required	200 – 400
Substantial risk: Correction needed	70- 200
Possible risk: Attention is indicated	20 – 70
Low risk: Risk perhaps acceptable as is	Under 20

Table 6: A Risk Evaluation Scoring Categorisation Example (after W T Fine)

Once all the risks are risk scored, then the risks can be ranked in order of priority and these ranked scores can be represented in a histogram format to establish a Risk Profile for the risk situation(s) assessed.

4.3 Risk judgement

Once the risk identification and risk evaluation are complete, the acceptability of a risk to an organisation is assessed. This is known as risk judgement (also called risk appraisal) and is the third and last task in risk assessment process. The decision about the acceptability of a risk is achieved through a value judgement, and is an assessment of the significance of the risk to the organisation.

This judgement can be made in terms of several factors:

* The Operation's Risk or Loss Bearing Capacity (i.e. how much can be lost before it affects the business operations)
* Liability, (legal in terms of statutory, common and contract law, etc)
* Social, (e.g. social responsibility to society and the community)
* Moral, (e.g. moral responsibility to provide a healthy & safe workplace)
* Reputation (e.g. especially companies listed on stock exchanges) or
* Financial criteria, etc.

Table 7 outlines the relationships between the various criteria being considered during value judging and their potential impact.

Risk Control Measure	Nature of the Risk	Risk significance
Terminating	Used when the high frequency and high severity risk occurrences need to be eliminated.	Intolerable risk, as the level of risk is unacceptably high, so the risk is stopped or ended
Treating	Risk control methods can be applied to reduce the low to medium frequency and severity risks to acceptable levels.	Tolerable risk, if the level of risk is reduced and managed to an acceptable level of risk
Tolerating	Used when the low frequency and low severity risks are deemed acceptable, but should be monitored	Acceptable risk, because of no risk to an acceptable level of potential risk impact
Transferring	Used when the frequency and severity levels are significantly high enough to lead to a potential high loss that needs to be avoided.	Intolerable or unacceptable risk that is transferred to a third party to avoid or to eliminate the risk liability impact, by transferring the risk in an outsourcing way.

Table 7:
A description of the impact of risk control measures on risk significance

Once risk evaluation has been applied to a baseline risk assessment, there are usually several risks that could impact at a business strategic level of operation. Issue based and continuous risk assessments on the other hand are important because of their loss causing potential, but usually not at a business strategic level. Whether the risk affects the organisation at strategic or operational level is based on questions like:

* Is the risk magnitude of a strategic level impact importance to the business?
* In what areas or risk fields would the evaluated risk and its magnitude impact e.g. business operations, liability, societal, moral, reputation or financial?
* Is there a possibility of several potential risks impacting simultaneously?
* What mitigation measures are currently in place and are they adequate?

Based on the answers to these questions one should be able to determine if the risks are acceptable or not. Acceptability can be rated on the following scale:

* The risk impact is negligible and therefore is acceptable.
* The risk is tolerable at current control levels & is controlled to an As Low As Reasonably Practicable (ALARP) level.
* Not exceeding the company's desired loss bearing capacity
* Not exceeding the management's risk aversion, or
* The risk is unacceptably high and/or is poorly managed and is unacceptable.

However if the risks are not considered acceptable, then risk control techniques to mitigate the risk to an acceptable level need to be applied.

5 RISK ASSESSMENT IN INTEGRATED ENVIRONMENTAL MANAGEMENT

There is a clear relationship between risk assessment, the risk management process and the assessment processes used in the Integrated Environmental Management field.

The generic type of risk assessment and the risk management process has been modified and customised to deal with the specific requirements for Integrated Environmental Management.

There is an ongoing interplay between business operations and the environment, as on a daily basis business operations use inputs of various environmental resources, which are processed to produce various outputs, with some outputs being reworked, recycled or released back into the environment as waste.

This basic business production and environmental relationship is shown in Figure 4 below.

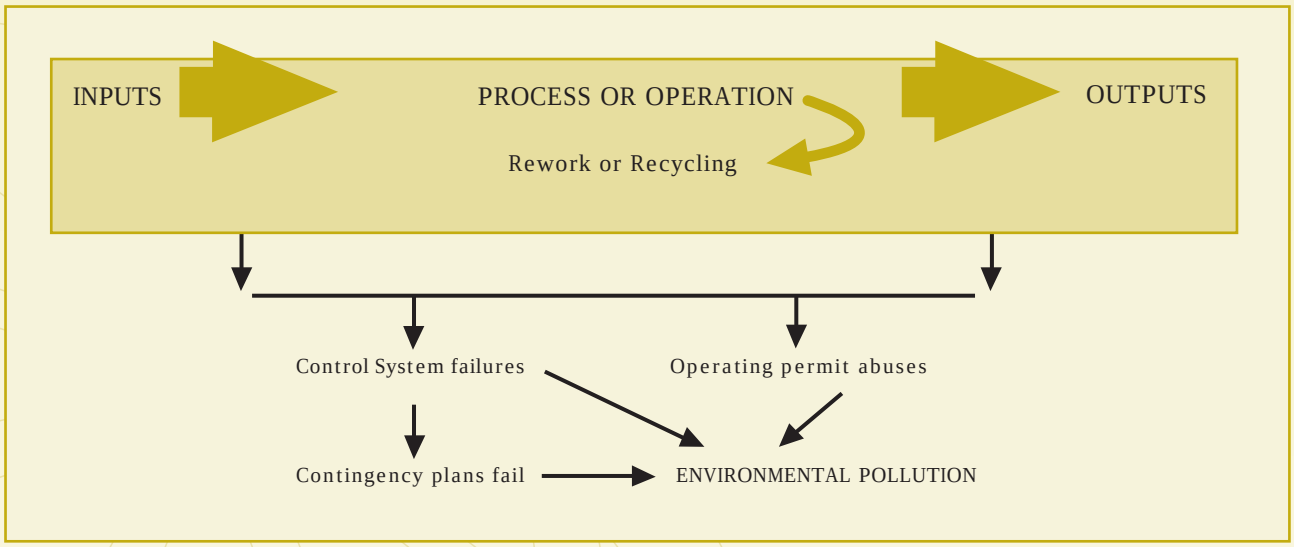

Figure 4: A normal production operation and the issues that can result in environmental pollution incidents

During this production process many operational or system failures or abuses could occur. These could cause harm in the form of injury or occupational illnesses, the release of potentially hazardous materials (gasses or substances and materials) into the atmosphere, surface water or ground water.

Business operations produce various products, by-products and waste materials, where some wastes are toxic, flammable or corrosive, etc and when an operation produces more wastes than usual this constitutes a risk with a higher potential for causing harm to the business operations and/or to the environment.

To avoid such occurrences, it may be necessary to perform risk assessments on these business operations, because without understanding what can go wrong and how badly, no effective control can be exercised over such risks.

5.1 Using risk assessment as a supplement or alternative to Environmental Impact Assessment

Although Environmental Impact Assessments (EIAs) are required for activities that are deemed likely to cause significant environmental impacts, it is only one of the tools of IEM and is not necessarily effective at addressing all environmental impacts. There are certain risks that need to have more generic assessments performed or other types of risk assessments performed to determine the potential threat of other risks, as part of an overall EIA study or as an alternative tool to EIAs. This is especially the case for activities about which there is a great deal of uncertainty.

An example of such activities is the development of release of Genetically Modified Organisms (GMO) or the release of biological control agents for the control of invasive alien species. A normal EIA study may not determine all the potential risks a GMO could cause to non-environmental systems. A GMO may have a considerable risk threat to business operation systems like machinery corrosion in cooling water systems, water treatment plant effectiveness, scale built-up affecting boiler operation efficiency and to reduce food production yields from genetically modified seed. In such situations, HAZOP, FMECA and other sophisticated risk assessment techniques may have to be used to assess the potential risks involved. In the case of the release of biological control agents, the impacts of the activity are highly uncertain and speculative, and normal impact assessment techniques may not be sufficient to predict the impacts of the activity.

A further difference between EIA and risk assessment is that risk assessment can be very successfully applied to existing operations and impacts, whilst EIA is essentially a predictive tool that is applied to the potential environmental consequences of a proposed future course of action. EIA as a tool is designed to provide information for decision making about whether and under what conditions a proposed activity should be implemented, and provides decision-makers with a number of alternatives so that they can choose the option with the least environmental impacts or the greatest net benefit to society. However, in the case of an existing operation, an EIA may not be well equipped to provide detailed answers for decision-makers (including authorities and the activity owners themselves) to determine how best to deal with an existing impact. For existing impacts (whether ongoing or once-off “disasters”, risk management provides a better option to analyse the impact and develop adequate controls to minimise the risk.

Thus, risk management and risk assessment may be used as alternatives to EIA (especially in the case of existing operations) or as part of an EIA, where risk assessment can be used to analyse particular impacts about which there is a higher degree of uncertainty than other more easily predicted impacts.

5.2 Similarities between risk assessment, ecological risk assessment and EIA

If one compares the Ecological Risk Assessment (ERA) process and the generic Environmental Impact Assessment (EIA) process, as extracted from the Integrated Environmental Management Information Series document number 6 on Ecological Risk Assessment (DEAT 2002), and the generic Risk Management Process, there are clearly similar processes and assessment parameters being used, as illustrated in figure 5 below. Figure 5 shows that the assessment processes used in the ERA and Risk Management Process are far more alike in structure and parameter terminology than that between the Risk Management Process and the EIA process.

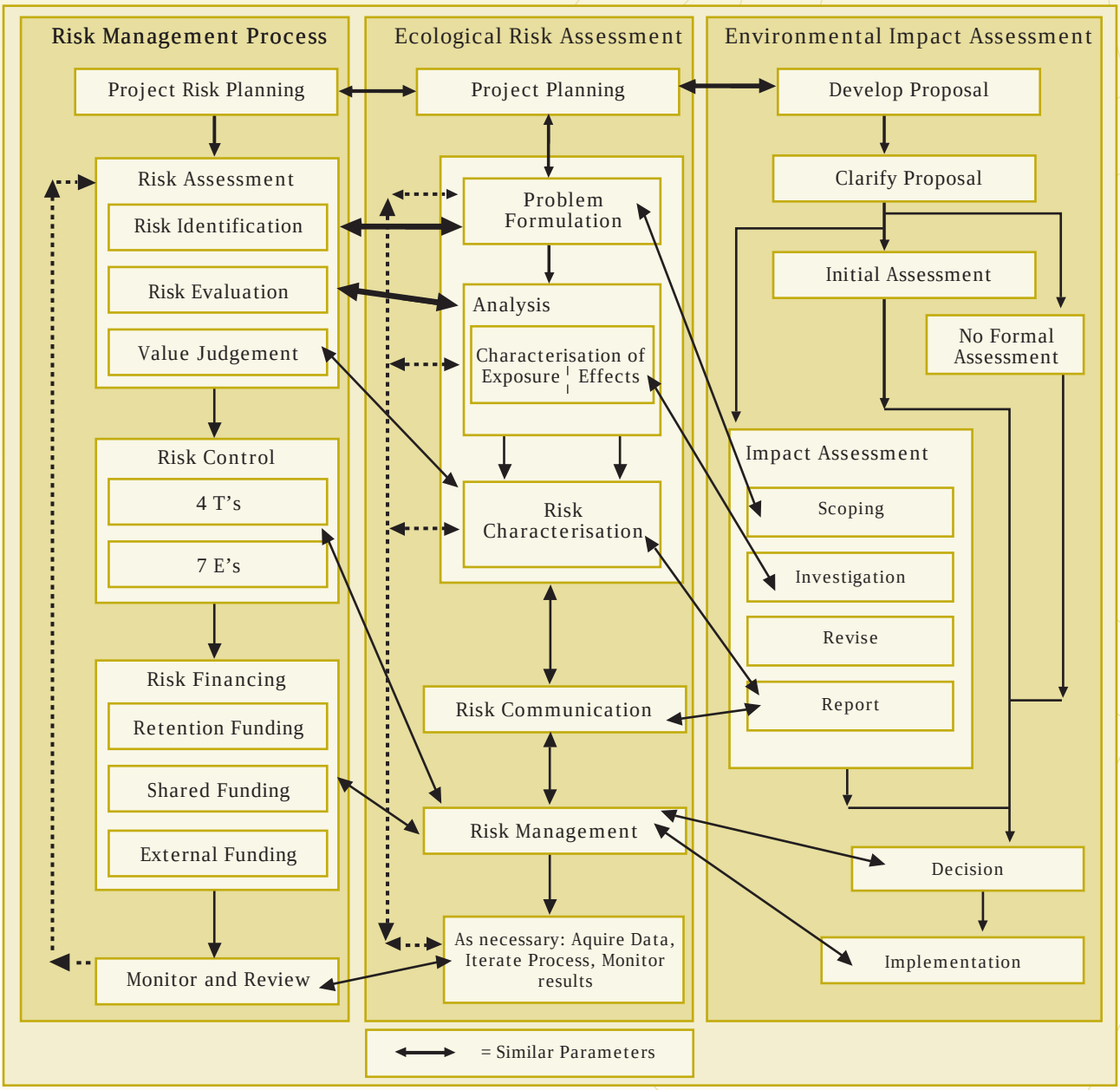

Figure 5: A comparison of the Risk Management Process steps with that of an Ecological Risk Assessment (ERA) and a generic Environmental Impact Assessment (EIA), which highlights the similarities of the various processes steps and the assessment parameters used.

Many businesses are striving to achieve an ISO 9000, ISO 14000 and OHSAS 18000 certification. All of these as part of an integrated Safety, Health, Environment and Quality (SHEQ) management programme. These are three programmes used to achieve some discipline integration, but what about the integration of all the other functional areas e.g. production, maintenance, marketing and procurement?

6 WHEN TO USE THE RISK ASSESSMENT AND THE RISK MANAGEMENT PROCESSES

Whenever there are situations where the nature of risks, their causes and their magnitude are unknown or poorly defined, formalised risk assessments should be performed, followed by the other risk management process steps. For example:

* At the start of new projects related to development projects, like new site or plant designs, etc. The HAZOP and What-if risk assessment technique tools are often used for these risk assessments.
* When plans are being made to perform machinery or production process modifications, facility extensions or expansions, etc where the potential risks are unknown or poorly defined. Here again HAZOP is often used in both the parameter and procedural forms to achieve the desired outcomes. Change Management assessments can also be used for assessing some operational modifications.
* After an accident or incident where harm, damage, machinery or process failure incidents have occurred and the actual causes of the incident are unknown or unclear, a FMEA or Fault Tree Analysis risk assessment technique can be used.
* Before planning for an operation to be relocated, discontinued, closed or demolished, there is a need to assess the various risks that could arise. The effective loss of an operation or losses arising from actions and activities performed while relocating, demolishing or removing plant, services or structures are risks that can be avoided or mitigated if proper risk assessments are performed during early planning stages. For example, an early assessment of the closure requirements and the potential risks is an important element in terms of achieving mine or other environmental closures. A change management related risk assessment can enable the likely problems (ie. both the environmental and other issues) to be identified up front and this allows time to deal with and resolve the issues.

7 BENEFITS OF RISK ASSESSMENT AND THE RISK MANAGEMENT PROCESSES

There are a number of benefits from performing risk assessments and using the risk management process, as presented below:

* The basic steps of the risk assessment process are flexible enough to facilitate the process being used to identify, evaluate and value judge a wide range of risks.
* In some cases once a risk assessment has been performed, the process may not have to be repeated unless some change has given rise to a new risk occurring or the previously assessed risks have undergone some dynamic change, necessitating a re-assessment.
* Performing risk assessments facilitates compliance with legislation of various sectors such as occupational health and safety, mining, environment, etc.
* Risk assessments at the early stages of a project will permit certain design measures, controls and procedures to be developed and incorporated into the project's design to eliminate the causes of potential risks. This can avoid the need to provide for certain additional resources for re-active cleanup and can save on retrofit upgrade design changes or alteration costs at a later stage.
* With the nature and causes of risks established, it is possible to develop suitable risk control standards, systems, compliance and management systems to effectively control the risks, particularly in relation to worker accident or incident prevention.
* Risk assessments followed by applying risk controls is a proactive means to avoid incidents, with an accident or incident investigation being the reactive means of addressing incidents.
* The risk assessment and risk management process is an accepted and systematic method of identifying, assessing and managing the risk, such that most risks will be identified and can be suitably eliminated or managed in the long-term.
* The risk management process provides a generic framework approach to identify and manage all forms of risk and it can be easily and systematically applied to all the different business management function fields of any sized enterprise.
* The risk management process approach permits a cyclic process review leading to a continual improvement in ability to control risk.

8 CONCLUSION

The intention of this document was to provide an overview of the Risk Assessment and Risk Management Process as it pertains to Safety, Health and Environmental management and to general business and production operations.

The Risk Assessment and Risk Management Process is a generic systematic method for identifying, evaluating, appraising risks and permitting these to be identified and to be risk controlled through a process of applying risk mitigation actions to reduce the risks to acceptable levels,

The remaining and residual risks can present a financial risk should an incident occur, necessitating Risk Financing to be provided to pay for such losses and to facilitate a recovery to normal operations.

As risks are often dynamic there needs to be a monitoring and review process in place to monitor that the risk management processes are implemented and are maintained to effectively cater with the existing and newly identified risks. This closing of the loop facilitates the process being of a cyclic nature with the objective of achieving continual risk improvement in the longer term.

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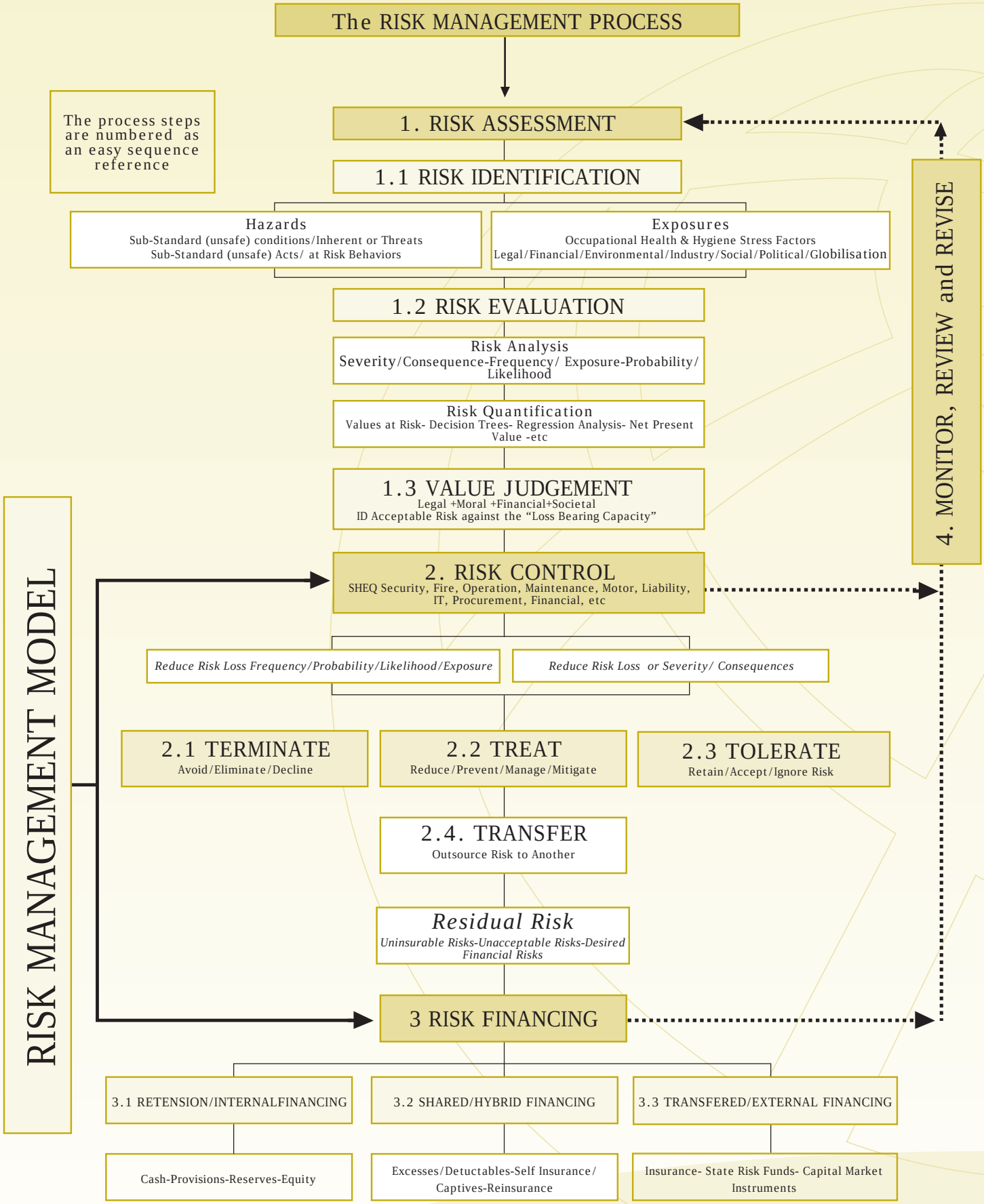
10 GLOSSARY

Definitions *: (* Note: the definitions listed here are the generic set published in the Integrated Environmental Management Information series of documents, with some additional definitions or explanations provided).
ALARP (As Low as Reasonably Possible) - A methodology for justifying if risk control measures reduce risks to reasonable and practical levels.
Assessment endpoint - An explicit expression of the environmental values that is to be protected - identified during initial discussions between risk assessor and risk manager, and ecologically relevant receptor/s at risk. For example: fish is a valued ecological entity, reproduction of fish is a specific attribute. Together they form an assessment endpoint.
Comparative risk assessment - compares risks across different contaminants based on exposure scenarios.
Conceptual model - identifies how risks may form, based on information on stressors/contaminants, receptors, potential exposure pathways, and predicted effects on the assessment endpoints.
Ecological risk assessment - The application of risk assessment techniques to assessing risks to plants, animals and ecosystems. Evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors. The assessment may describe the type, magnitude and probability of the effect and relate to a specific spatial and temporal context.
Exposure assessment - The process of measuring or estimating the intensity, frequency, and duration of exposures to an agent currently present in the environment, or of estimating hypothetical exposures that might arise from the release of new chemicals into the environment.
Hazard - A state or set of conditions that may result in an undesired event; the cause of risk. In environmental toxicology, the potential for exposure of organisms to chemicals at potentially toxic concentrations constitutes the hazard. In general terms, hazard is a condition or practice with the potential to cause harm.
Hypothesis - A statement of condition that can be tested in the assessment. The conventional approach is to falsify the hypothesis, thus rejecting it. The hypothesis can also be accepted.
Likelihood - An expectation of a specific outcome. It could be based on quantitative analyses, qualitative assessments, expert opinion or perception. There is also a conditional likelihood case where the likelihood of a certain outcome would only occur if the conditional requirement is initially satisfied.
Lines of evidence - Information derived from different sources or by different techniques that can be used to evaluate risk hypothesis(/es).
PEPMELF - People, Equipment, Processes, Materials, Environment, Legal (liability) and Financial.
Prospective risk assessment - assesses the likelihood of an undesirable effect on an ecological system, given the specific exposure to a stressor.
Qualitative risk assessment - The likelihood or the magnitude of the consequences are expressed in qualitative terms (i.e. not quantified).
Quantitative risk assessment - The probability or frequency of the outcomes can be estimated and the magnitude of consequences is quantified so that risk is calculated in terms of probable extent of harm or damage over a given period.
Receptor - The ecological entity (e.g. plant, animal or ecosystem) exposed to the stressor. Generally asks the question, "What might be affected by contamination and in what way?"
Retrospective risk assessment - assessment that recognizes that an undesirable effect on an ecological system has occurred.
Risk - The chance of something happening that will have an undesired impact. It may be an event, action, or lack of action. It is measured in terms of consequences and likelihood or probability and severity. Risk does have different meanings within certain contexts, for example: Risk (safety) = a chance of loss; Risk (identification) = hazards and/or exposure; risk (evaluation) = frequency and consequence; Risk (insurance) = the insured)
Risk Analysis or Risk Evaluation - the process of evaluating the frequencies and consequences (and possible exposures) of risk occurrences of a hazardous nature, activity or exposure.
Risk Assessment - the identification of undesired events, their causes and analysing their likelihood and potential consequences - considering existing control measures - in order to make a valued judgement as to the risk's acceptability
Risk characterization - A synthesis and summary of information about a hazard and associated effects, so that it addresses the needs and interests of decision-makers and interested and affected parties. Generally answers questions such as "What contaminant? What pathway? What receptor? What exposure? and What effect?"
Risk Financing - managing the sources and uses of funds that an organization relies on to finance its recovery from accidental property, net income, liability and personnel losses
Risk management - The systematic application of management policies, procedures and practices to the tasks of analysing, evaluating, controlling and communicating risk.
Risk perception - the overall view of risk held by a person or group; includes both feeling and judgement.
Stressor - A physical, chemical or biological entity that can induce an adverse response.
Sustainable development - the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Toxicity assessment - The overall process of evaluating the type and magnitude of toxicity caused by a hazardous substance. It involves determining the toxicity of the contaminants, and establishes the sensitivity of the ecological receptor(s). Asks for example "What potential effects might the contaminants cause and at what concentration?"
Value Judgement or Risk Appraisal - is the process of making a decision that judges how significant the impact of the risk could be to an enterprise and as to its level of acceptability or unacceptability to the enterprise, the people or to any operations, processes, etc.



ANNEXURE:

The Risk Management Process and Risk Management Model flow chart
This chart presents a flow chart summary of the risk management model and process, listing the various terms that some of the different disciplines use and provides some idea of the scope of the various steps and methods employed within the process.

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