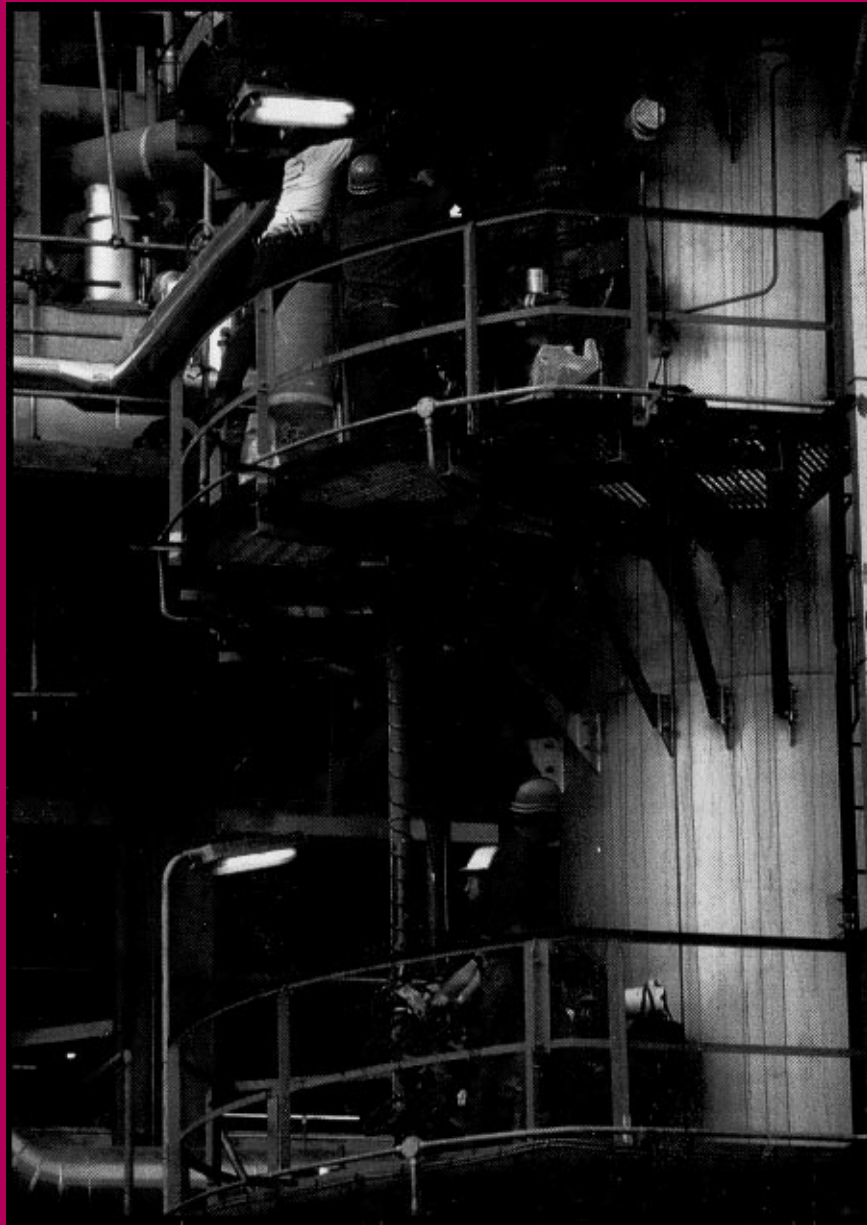


HEALTH AND SAFETY IN EMPLOYMENT ACT 1992

**APPROVED CODE OF PRACTICE FOR
MANAGING HAZARDS
TO PREVENT MAJOR
INDUSTRIAL ACCIDENTS**



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New Zealand Council of Trade Unions, as represented by the New Zealand Fire Fighters Union;

Petrochem, Hawera;

Petrocorp Exploration, New Plymouth;

Safety Solutions, Inglewood;

Shell Todd Oil Services, New Plymouth.

NOTICE OF ISSUE

I have issued this *Approved Code of Practice for Safety and Health in Managing Hazards to Prevent Major Industrial Accidents*, being a statement of preferred work practices or arrangements for the purpose of ensuring the health and safety of persons to which this code applies and persons who may be affected by the activities covered by this code.

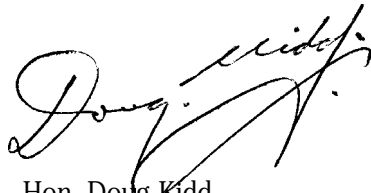


R. Stockdill
Acting Secretary of Labour
July 1994

FOREWORD

I have approved this statement of preferred work practices, which is an approved code of practice for safety and health in managing hazards to prevent major industrial accidents, under section 20 of the Health and Safety in Employment Act 1992.

When a code is approved, a court may have regard to it in relation to compliance with the relevant sections of the Health and Safety in Employment Act. This means that if an employer in an industry, or using a process to which the code applies, can show compliance with that code in all matters it covers, a court may consider this to be compliance with the provisions of the Act to which the code relates.

A handwritten signature in black ink, appearing to read 'Doug Kidd', written in a cursive style.

Hon. Doug Kidd
Minister of Labour
July 1994

A SUMMARY OF THE HEALTH AND SAFETY IN EMPLOYMENT ACT 1992

The principal object of the Health and Safety in Employment Act 1992 (HSE Act) is to prevent harm to employees at work. To do this, it imposes duties on employers, employees, principals and others, and promotes excellent health and safety management by employers. It also provides for the making of regulations and codes of practice.

REGULATIONS

Regulations are promulgated from time to time under the HSE Act. Regulations may, among other things, impose duties on employers, employees, designers, manufacturers, and others relating to health and safety. These regulations may apply with respect to places of work, plant, processes or substances and may deal with particular problems that have arisen.

APPROVED CODES OF PRACTICE

“Approved Codes of Practice” are provided for in the HSE Act. They are statements of preferred work practice or arrangements, and may include procedures which could be taken into account when deciding on the practicable steps to be taken. Compliance with codes of practice is not mandatory. However, they may be used as evidence of good practice in court.

EMPLOYERS' DUTIES

Employers have the most duties to perform to ensure the health and safety of employees.

Employers have a general duty to take all practicable steps to ensure the safety of employees while at work. In particular, they are required to take all practicable steps to:

- Provide and maintain a safe working environment;
- Provide and maintain facilities for the safety and health of employees at work;
- Ensure that machinery and equipment is safe for employees;
- Ensure that working arrangements are not hazardous to employees; and
- Provide procedures to deal with emergencies that may arise while employees are at work.

Taking “*all practicable steps*” means doing what is reasonably able to be done in the circumstances, taking into account:

- The severity of any injury or harm to health that may occur;
- The degree of risk or probability of that injury or harm occurring;
- How much is known about the hazard and the ways of eliminating, reducing or controlling it; and
- The availability, effectiveness and cost of the possible safeguards.

HAZARD MANAGEMENT

Employers must identify and regularly review hazards in the place of work (existing, new and potential), to determine whether they are significant hazards and require further action. If an accident or harm occurs that requires particulars to be recorded, employers are required to investigate it to determine if it was caused by or arose from a significant hazard.

“*Significant hazard*” means a hazard that is an actual or potential cause or source of:

- Serious harm; or
- Harm (being more than trivial) where the severity of effects on any person depend (entirely or among other things) on the extent or frequency of the person’s exposure to the hazard; or
- Harm that does not usually occur, or usually is not easily detectable, until a significant time after exposure to the hazard.

Where the hazard is significant, the HSE Act sets out the steps employers must take:

- Where practicable, the hazard must be eliminated.
- If elimination is not practicable, the hazard must be isolated.
- If it is impracticable to eliminate or isolate the hazard completely, then employers must minimise the likelihood that employees will be harmed by the hazard.

Where the hazard has not been eliminated or isolated, employers must, where appropriate:

- Ensure that protective clothing and equipment is provided, accessible and used;
- Monitor employees’ exposure to the hazard;
- Seek the consent of employees to monitor their health; and
- With informed consent, monitor employees’ health.

INFORMATION FOR EMPLOYEES

Before employees begin work, they must be informed by their employer of:

- Hazards employees may be exposed to while at work;
- Hazards employees may create which could harm other people;
- How to minimise the likelihood of these hazards becoming a source of harm to themselves and others;

- The location of safety equipment; and
- Emergency procedures.

Employers are also required to inform employees of the results of any health and safety monitoring. In doing so, the privacy of individual employees must be protected.

EMPLOYERS TO INVOLVE EMPLOYEES IN THE DEVELOPMENT OF HEALTH AND SAFETY PROCEDURES

Employers need to ensure that all employees have the opportunity to be fully involved in the development of procedures for the purpose of identifying hazards and dealing with significant hazards, or dealing with or reacting to emergencies and imminent dangers.

TRAINING OF EMPLOYEES

Employers must ensure employees are either sufficiently experienced to do their work safely or are supervised by an experienced person. In addition, employees must be adequately trained in the safe use of equipment in the place of work, including protective clothing and equipment.

SAFETY OF PEOPLE WHO ARE NOT EMPLOYEES

Employers are also responsible for the health and safety of people who are not employees. Employers must take all practicable steps to ensure that employees do not harm any other person while at work, including members of the public or visitors to the place of work.

EMPLOYEES' AND SELF-EMPLOYED PERSONS' DUTIES

Employees and self-employed persons are responsible for their own safety and health while at work. They must also ensure that their own actions do not harm anyone else. However, these responsibilities do not detract from the employers' or principals' responsibilities.

ACCIDENTS AND SERIOUS HARM (RECORDS AND NOTIFICATION)

The HSE Act requires employers to keep a register of work-related accidents and serious harm. This includes every accident that harmed (or might have harmed):

- Any employee at work;
- Any person in a place of work under the employer's control.

Employers are also required to investigate all accidents, harm and near-misses to determine whether they were caused by a significant hazard.

Employers are required to notify serious harm that occurs to employees while at work to the Secretary (in practice, the nearest OSH office), as soon as possible. In addition, the accident must also be reported on the prescribed form within 7 days. (Forms are included in the *Workplace Accident Register* available from OSH offices and selected stationers).

If a person suffers serious harm, the scene of the accident must not be disturbed unless to:

- Save life or prevent suffering;
- Maintain public access for essential services, e.g. electricity, gas;
- Prevent serious damage or loss of property.

The OSH office will advise whether it wishes to investigate the accident and what action may be taken in the meantime.

1. INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

In common with the worldwide trend, New Zealand has experienced a significant increase over the last 30 years in the rate and scale of its industrial development. Associated with these developments has been the necessary rise in the storage, processing and use of a variety of substances on a relatively large scale. Some of these substances and activities have the potential to cause injury or damage beyond the place of work.

In order to enjoy the benefits of industrial development, society requires that associated hazards are managed. It is therefore necessary that employers demonstrate that their installations are properly designed, well constructed and safely operated. Employers have a responsibility for managing their own hazards. They “own” the hazard and are best placed to understand the risks.

1.2 OBJECTIVES

This code of practice describes a management system for the control of hazards in order to prevent major industrial accidents. This system is based on self-regulation and self-audit and will provide a means to:

- (a) Prevent major industrial accidents from occurring;
- (b) Minimise the consequences of a major industrial accident; and
- (c) Ensure appropriate emergency planning procedures are in place.

This code of practice is made pursuant to section 20 of the HSE Act and establishes a format for the control of hazards at installations having the potential for a major industrial accident. It is intended primarily as a means of compliance with sections 6 to 19 of the HSE Act and is not a substitute or replacement for any existing Act or statutory regulation, nor is it intended in any way to inhibit the use of other practices or methods.

Accidents may be classified as either LOW-FREQUENCY, HIGH-SEVERITY (i.e. the rare event) or HIGH-FREQUENCY, LOW-SEVERITY. This code deals with both the technical aspects of “process safety” (low-frequency, high-severity) accidents, and also the wider issue of “occupational safety” (high-frequency, low-severity) accidents. The reason is that the latter type is often the forerunner of a major industrial accident. Several well-documented accident reports support this, suggesting that the complete picture is required to properly manage hazards. See figure 1.

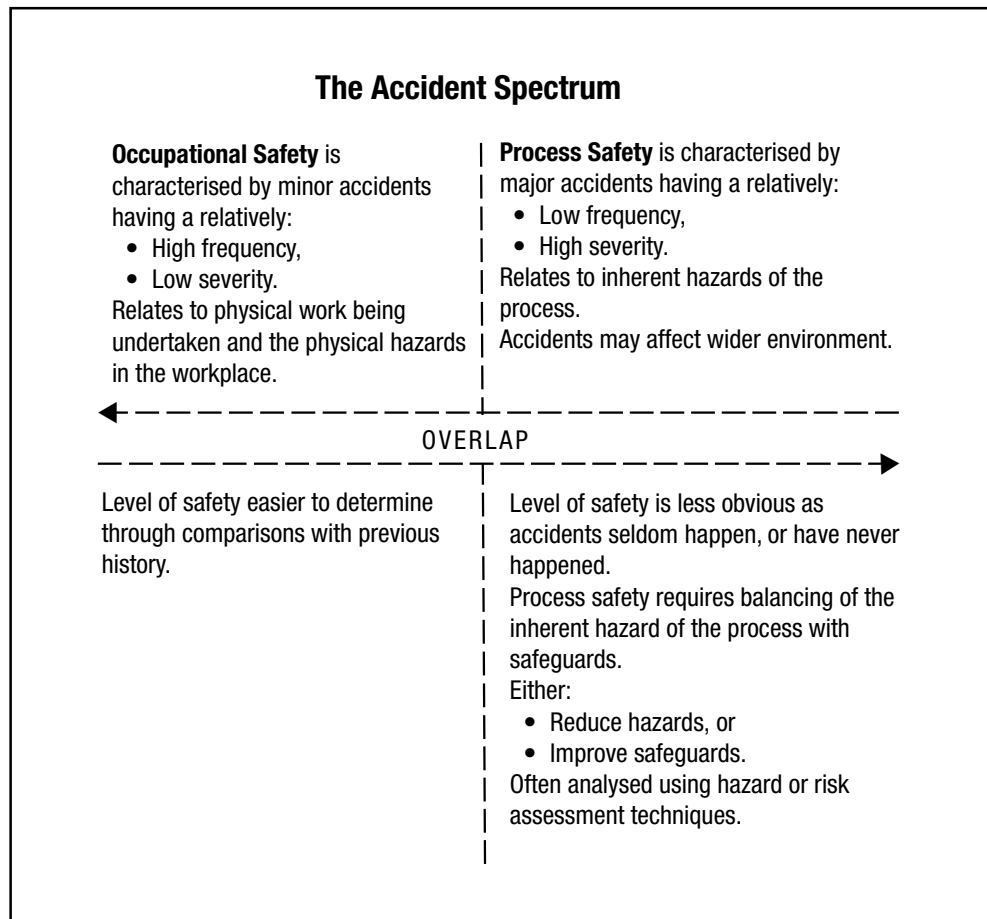


Figure 1: The accident spectrum.

Nevertheless, the main purpose of this code is the prevention of low-frequency, high-severity accidents.

This code of practice also covers major industrial accidents that could affect the environment. The causes of a major industrial accident that damages the environment are usually the same as the causes of a major industrial accident that affects the health and safety of employees. For completeness, it was considered necessary to include both types of accidents.

2. SCOPE

This code has been written for installations with the potential for a major industrial accident. Other organisations should consider its use based upon a preliminary assessment of hazards.

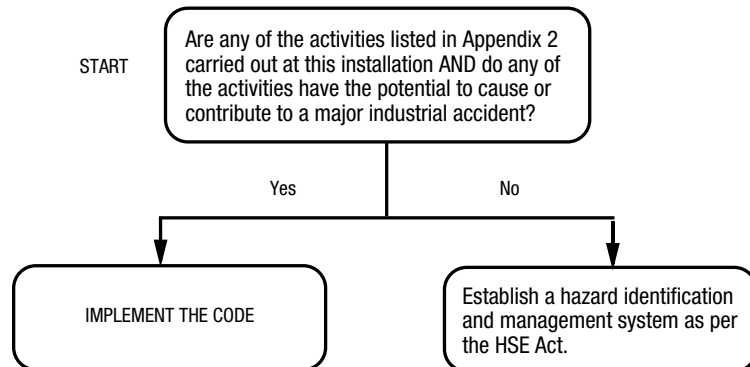


Figure 2: Flow chart to decide if this code should be used.

Figure 2 provides guidance as to which organisations should implement the code. Even if the answer is “no” using figure 2, there may nevertheless be some activities for which this code may provide useful guidelines in establishing hazard identification and management systems.

The appropriateness of the code in relation to the scale of operations (for example service stations or other installations which have the potential for a major industrial accident) will depend on the alternative systems which are in place. As an example, generic checklists for pipes, valves, tanks, cleanliness, operator training and so on, together with codes and regulations for separation distances, layout, etc. and whether the installation managers feel their obligations under the HSE Act have been satisfied.

Professional safety advice may be needed.

3. IMPLEMENTATION

It is the responsibility of the installation management to determine whether the hazards in their installation could cause a major industrial accident and whether this code of practice applies. They should ensure that their “Hazard Management System”, in line with the recommendations of this code, is prepared, implemented and maintained.

OSH may be able to provide technical and administrative assistance on issues related to installations that need to comply with this code of practice. Systems for managing safety may be audited by OSH to ensure compliance with the relevant sections of the HSE Act.

OSH has a responsibility to promote awareness of, and enforce compliance with, the HSE Act. Refer to section 30 (functions of inspectors) of the HSE Act which clarifies the advisory and enforcement roles of inspectors.

4. HAZARD MANAGEMENT SYSTEM

4.1 INTRODUCTION

A hazard management system is the basis for ensuring that installations are safely designed, built, maintained, modified and operated.

The implementation of a hazard management system, as outlined in this code, is an effective way to identify weaknesses and prevent accidents.

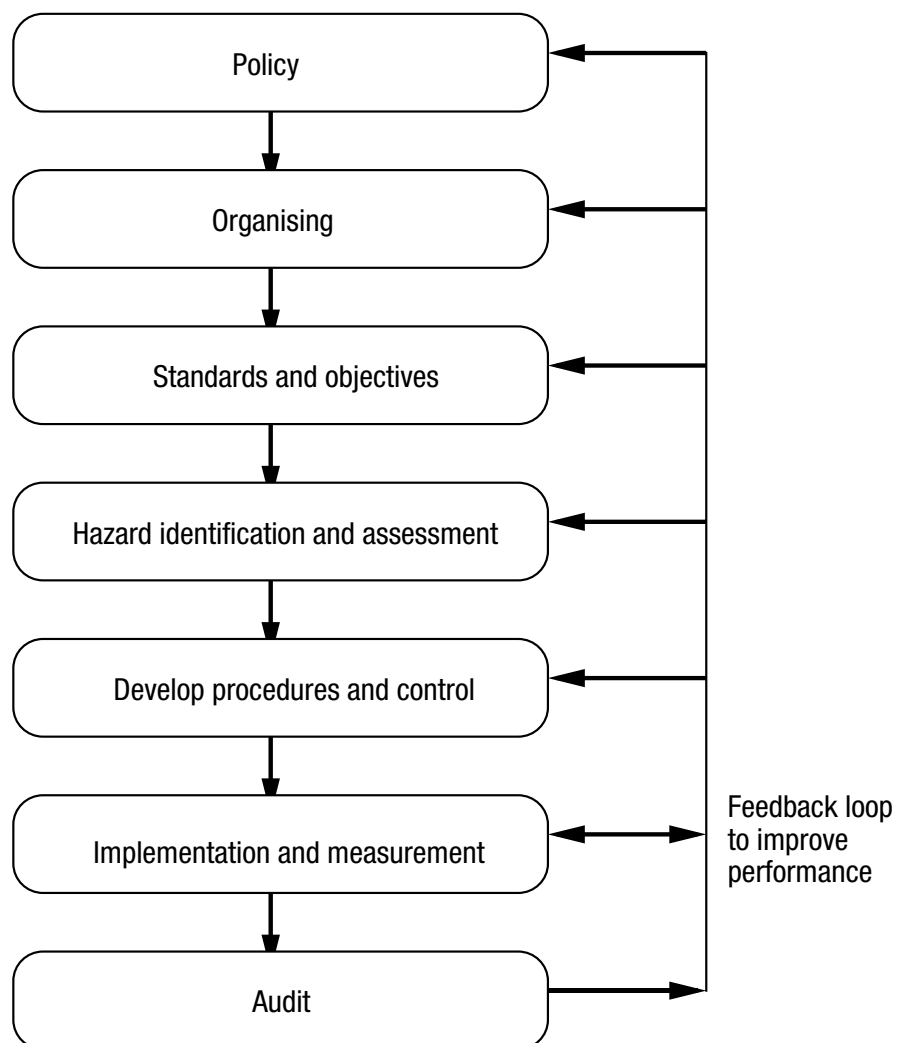


Figure 3: Hazard management system structure.

4.2 POLICY

Installation management should have written policies designed to maximise the contribution of individuals and groups through participation at all levels and unite health, safety and environmental objectives with business goals. Safety, health and environmental policies should be written and be available to all people at the installation. See appendix 4.

Health Safety and Environmental Policies

- Set the direction for the organisation by communicating management's commitment to health, safety and the environment.
- Explain the basis of the policies and how they contribute to business performance by preventing injuries and ill health, protecting the public and the environment, and by preventing unnecessary losses and liability.
- Establish the importance of health, safety and environmental objectives in relation to other business objectives.
- Commit the organisation to pursuing progressive improvements in health, safety and environmental performance. Legal requirements define the minimum level of achievement.
- Explain the responsibilities of managers and the contribution that employees can make to policy implementation by outlining the participation procedures.
- Commit the organisation to maintaining effective systems of communication on health, safety and environmental matters.
- Commit the Chief Executive Officer of the organisation to implement the policy by providing adequate resources and by ensuring the competence of all employees.
- Are signed and dated by the Chief Executive Officer of the organisation.

4.3 ORGANISING

In order for the company's health, safety and environmental policies and the hazard management system to be properly implemented, it is necessary to have an effective management structure. The specific management organisation will vary from company to company but a number of principles are common:

- Health, safety and environmental management are line management functions and as such are part of the accountability and responsibility at all levels of management.
- As with all management functions, the process starts with the chief executive, who needs to demonstrate visible commitment to the issue.
- Health, safety and environmental responsibilities should be included in all managers' job descriptions.
- Managers should be assessed on their health, safety and environmental

performance as well as other matters.

- A clear distinction must be made between line management and advisory (e.g. health, safety and environmental adviser/officer) roles.

4.4 STANDARDS AND OBJECTIVES

The establishment of standards sets the targets required to meet the installation's policy requirements in health, safety and the environment. Adequate standards are essential for adequate control. Standards that are specific and clear let people know what is expected of them. They permit meaningful measurements of how the system is performing.

4.5 HAZARD IDENTIFICATION AND ASSESSMENT

Hazard management systems are based upon the principle that all the hazards within every installation are identified, understood and controlled.

The four essential steps in the successful management of hazards are:

- Systematic identification;
- Assessment of significance;
- Implementation of controls to "eliminate, isolate or minimise";
- Planning for recovery in the event of loss of control.

A regular check that each step has been carried out ensures the hazard management system is working.

Some methods for systematic identification and assessment are covered in part 5 and appendix 3 of this code.

4.6 PROCEDURES AND CONTROL

Procedures are the method by which standards are implemented. They are an essential feature for safe design, construction, operation, maintenance and modification. Good procedures are essential for good control.

4.7 IMPLEMENTATION AND MEASUREMENT

Following implementation, performance may be measured against predetermined plans and standards, and form the basis for appropriate remedial action. See part 8 of this code.

4.8 AUDITING AND REVIEW

Auditing is an essential feature of managing safety which ensures that the whole system is functioning and provides a vehicle for improvements. See part 11 of this code.

4.9 SAFETY REPORT

A “safety report”, sometimes referred to as a “safety case”, collates all the safety information into one document so that all persons on the installation are aware of the hazards and safety of the installation. It can also be made available to regulatory authorities as evidence of the safe operation of the installation. The report should be continually reviewed and updated.

The safety report should describe:

- The installation, processes and hazardous substances used;
- The hazards and their control;
- The consequences to people and the environment of potential major industrial accidents by means of systematic hazard analysis;
- The organisation of the installation and management of its safety;
- Emergency systems provided to mitigate the consequences of major industrial accidents.

4.10 EXAMPLES OF HAZARD MANAGEMENT SYSTEMS

Some examples of existing hazard management systems are included in appendix 5. These show how several companies have developed systems for managing safety in their installations.

5. HAZARD IDENTIFICATION AND ASSESSMENT

5.1 INTRODUCTION

Section 7 of the HSE Act requires employers to systematically identify, assess and control hazards. It is the employer's responsibility to satisfy themselves that this has been carried out. Hazard identification will be required for:

- New plant;
- Existing plant;
- Modifications to plant; or
- After an accident.

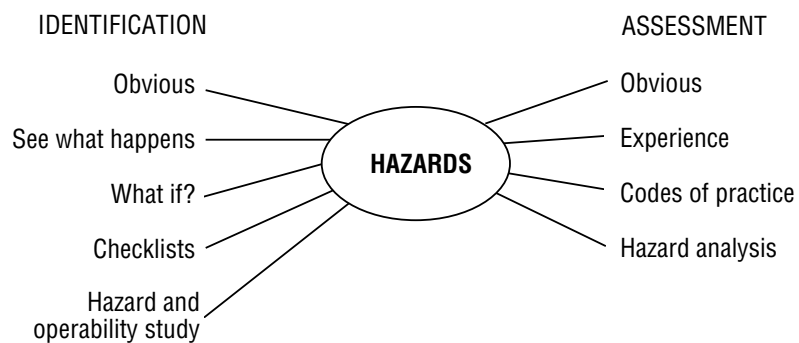


Figure 4: Hazards.

Figure 4 shows the relationship between identifying and assessing hazards. Appendix 7 provides guidelines on risk assessment.

Many tools are available for hazard identification and hazard assessment; these are constantly evolving and current methods should always be sought out and used.

Some common methods are summarised below; however, it is beyond the scope of this code to provide full details (see also appendix 9).

5.2 PLANNED INSPECTIONS

Typically these comprise a comprehensive walk-through site inspection with investigations, carried out on preplanned lines, of process hardware and techniques, interviews with key staff and inspection of records and procedures.

5.3 CHECKLISTS

Process or system checklists can be used to evaluate equipment, materials or procedures during any of the significant phases of an installation's life, i.e. design, construction, start-up, operation and shutdown. Checklists consist of key words or matters considered significant for the meaningful evaluation of procedures, equipment or materials used at the installation. Checklists should be subjected to regular auditing and updating and are generally limited to the experience of the checklist author.

5.4 TASK ANALYSIS

Task analysis enables the systematic examination of all occupations and tasks to establish the effectiveness of work procedures and practices and to identify hazards associated with any of the sequential steps. The process involves:

- Inventory of the tasks.
- Identify the critical tasks and concentrate on these. Consider such factors as:
 - the severity of the potential losses;
 - the frequency with which the task is performed;
 - the probability of loss when the task is performed.
- Break down the work into significant steps or critical activities.
- Identify what could go wrong. Consider people, equipment, materials, environment.
- Is it being done the best way? Consider cost, production, quality and safety.
- Develop controls: specific actions and precautions to prevent loss from occurring.
- Write down the procedure: a step-by-step description of how to proceed, what to do, why, in a simple, easy-to-follow format or practice.
- Put to work task instruction, skill training, etc. Documentation and follow-up of progress is important. Two basic approaches are:
 - analysis by observation and discussion;
 - analysis by discussion alone.

5.5 EXPERIENCE

The current and past experience of key personnel can be useful in identifying hazards, particularly in areas likely to be overlooked by other methods.

5.6 HAZARD AND OPERABILITY STUDY (HAZOP)

HAZOP is a rigorous and widely accepted technique for hazard identification. A system or process is studied by a team who systematically look for the cause

and effect of deviations from the norm. The team will, in general, be considering the following questions:

- What is the design intention of the plant?
- What deviations from the design could occur?
- What might cause such deviations from the design intention?
- What would be the consequences of such deviations from the design intention (such as fire, toxic release, etc.)?

See appendix 6 for further information on HAZOP studies.

5.7 FAILURE MODE AND EFFECT ANALYSIS (FMEA)

Failure Mode and Effect Analysis (FMEA) is a tabulation of each item of equipment, its failure modes, and the effects on a system of any such failure. The FMEA technique concentrates on the cause and effect of failure of individual components or systems.

5.8 ACCIDENT REPORTING AND INVESTIGATION

Efficiency in reporting and thoroughness in the investigation of accidents can be of considerable significance in hazard identification and assessment.

5.9 “WHAT IF?” ANALYSES

These consist of a structured series of considered questions dealing with aspects of the design, construction and operation of an installation and determine the general consequences of any deviation from the norm.

5.10 BRAINSTORMING

Brainstorming consists of a meeting of personnel to consider intensively all aspects of design and operation to determine how deviations from the intentions could occur which may give rise to hazards or operational problems.

5.11 HAZARD ANALYSIS (HAZAN)

Hazard Analysis (HAZAN) tries to quantify safety problems. Examples of hazard analysis include, fault tree, event tree, rapid ranking, risk estimation, and consequence models. Some sophisticated modelling techniques (e.g. dense gas dispersion) require expertise.

5.11.1 FAULT TREE

In a fault tree the conditions necessary for a failure are presented in a reverse order starting with the unwanted or “top” event. Circumstances leading to this

event are then developed. This activity, in itself, is useful in that it logically presents cause combinations. The fault tree is then “resolved” to eliminate duplication (this requires a little expertise in the application of Boolean algebra) and by applying failure estimates at the base of the tree and working up, the likelihood of the “top” event occurring may be estimated as either a probability or a frequency.

5.11.2 EVENT TREE

An event tree starts with an initiating event then works forward to develop a number of possible outcomes. At each branch the system (or person) is considered to have “failed” or “not failed” and probabilities are assigned that provide a quantitative estimate of the likelihood of each outcome.

5.12 CODES, STANDARDS, ACTS AND REGULATIONS

The use of codes, standards, or other Acts and regulations against which the acceptability of a design is evaluated can provide protection against the incorporation of previous known faults and mistakes. Frequently encountered codes are promulgated by such organisations as:

- American Petroleum Institute (API)
- National Fire Protection Association (NFPA)
- American Society of Mechanical Engineers (ASME)
- Standards New Zealand (SNZ)
- British Standards Institute (BSI)
- Occupational Safety and Health Service
- NZ Chemical Industry Council
- Standards Australia
- International Organization for Standardization (ISO)

6. PROJECT HAZARD IDENTIFICATION

6.1 INTRODUCTION

It is important to incorporate engineering controls for health, safety and the environment at the conceptual or design stage of a project rather than attempt to add them later. Usually cost savings will result.

A satisfactory approach comprises a number of safety studies conducted at appropriate stages in design and construction. See figure 5.

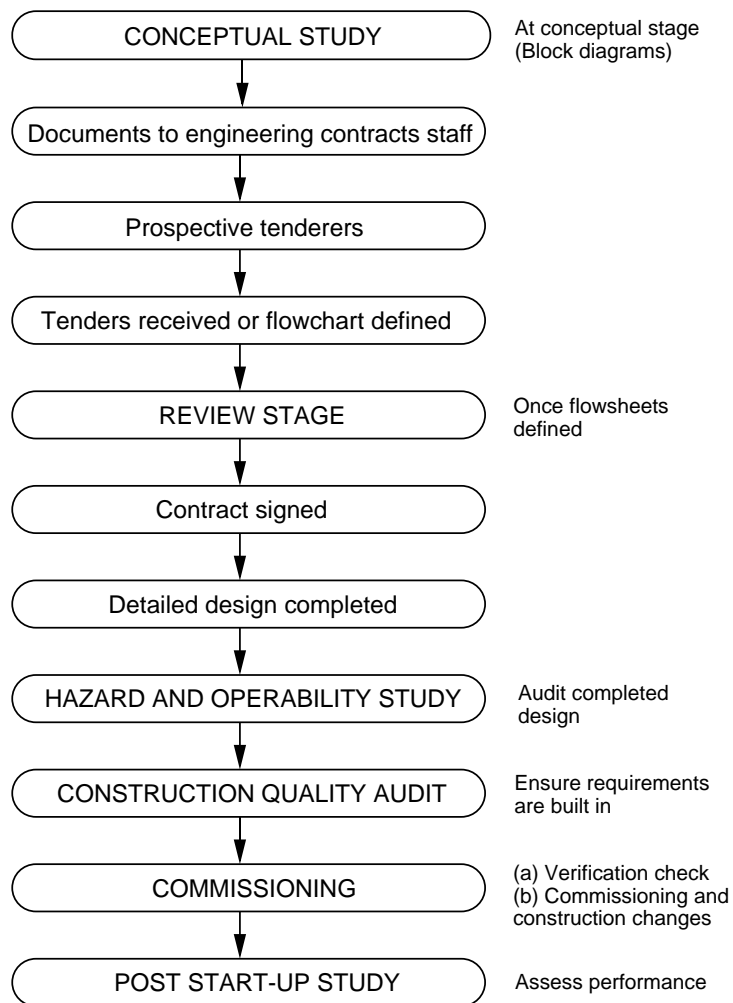


Figure 5: Stages for safety studies.

6.2 CONCEPTUAL STUDY

This is undertaken early in a project.

The objectives are:

- To identify the hazards of the raw materials, in-process materials, products, wastes and processes which are proposed to be used.
- To define legal, safety, health and environmental criteria.
- To define design guidelines, codes and standards for incorporation in the technical specification sent to tenderers, which will result in a design meeting the safety, health and environmental criteria.

6.3 REVIEW

When tenders are received (or, in a non-tendering situation such as an in-house design, when the flowsheet is generally defined), the broad design as developed is reviewed, with the following objectives:

- To check that the design guidelines specified as a result of the “conceptual study” have all been included.
- To assess, as far as practicable, whether the design will meet the safety, health and environmental criteria.
- To identify design features, or sections, which will require special attention during the following detailed design.

6.4 HAZARD AND OPERABILITY STUDY

(See part 5 and appendix 6)

When the detailed design is completed to the “Piping and Instrumentation Diagram” stage (equivalent to the final flowsheet showing schematically every piece of equipment, every pipeline, valve, instrument and control system), it is possible and very valuable to conduct a HAZOP study.

The design is subjected to a systematic and detailed study by a team of people with a range of backgrounds and expertise, systematically looking for ways in which upsets could occur with serious safety and operational results.

The intention is to identify hazards and problems that prevent efficient operation and then decide what to do about them.

6.5 CONSTRUCTION QUALITY AUDIT

In addition to the quality assurance procedures during construction and commissioning, it is helpful to check the physical plant as it is completed, specifically to ensure that the requirements identified during earlier studies have actually been incorporated in the plant.

This inspection can be part of the training and familiarisation programme for new employees and the commissioning team, by involvement in formal check listing of the construction work. Exceptions and deficiencies are listed, classified and remedied.

6.6 PRE-COMMISSIONING AND COMMISSIONING

Before the project is commissioned, or started up, it is valuable to have the area inspected by a senior manager who is not closely associated with the project.

The manager should also ask to see:

- The minutes of the HAZOP studies;
- The pressure vessel register;
- The list of “reservations” or the list of jobs yet to be completed;
- Approvals from the various statutory bodies, and so on.

While it is not expected that significant faults will be found at this stage, the knowledge that the document review and inspection will take place encourages the project team to undertake the work.

Construction or commissioning field changes should be subjected to a modification control system (see section 7).

6.7 POST START-UP STUDY

After the project is complete and successfully commissioned, it is worthwhile to review the initial objectives and determine if these have been achieved. Such a review may help prevent errors or omissions causing a major industrial accident, or prevent recurrence on future projects.

A series of review questions could be developed. These could include:

- Have all the hazards of the raw materials, in-process materials and end-products been identified, and are these hazards being properly managed?
- Have all the hazards of the processes been identified and were engineering controls incorporated in the design?
- Did the design meet the health, safety and environmental criteria?
- Have all the appropriate regulatory authorities been advised as necessary? Is any paperwork associated with approvals, permits, licences etc., outstanding?
- Have the “as-built” drawings been completed?
- Are the operating and training manuals complete?
- Have all staff been fully trained in the operations of the new plant?
- Have all sections of the plant been HAZOPed or safety reviewed as required?

7. CONTROL OF MODIFICATIONS

A modification is any action which results in change. The action may be made by engineering, maintenance, or production personnel. Changes to procedures should also be considered as modifications.

The elements of a system for the control of plant modifications are:

- (1) procedures,
- (2) assessment,
- (3) inspection,
- (4) documentation, and
- (5) training.

There should be formal procedures that require:

- All modifications be authorised by competent persons;
- A standard method of making the safety assessment;
- A system of inspection by a competent person to make sure the work has been done as intended and is complete;
- A system for documentation to record the change; and
- Adequate training so that all personnel concerned understand the system of control.

There is often a conflict between the wish to submit all modifications to the checking procedure (resulting in a time commitment, delays in implementation, and a tendency to be superficial) and the wish to streamline the procedure by only putting selected modifications through the procedure (resulting in those modifications which bypass the procedure possibly introducing hazards).

One way to balance thoroughness and efficiency is a two-stage approval procedure as follows:

All modifications are described on a modifications request form (Refer appendix 9.b.2). A checklist of questions is answered which covers a wide range of possible effects, and prompts the consideration of unwanted consequences. The form is then circulated to several designated staff with responsibility for the plant, for approval. If any reviewer is unsure about the potential for unforeseen problems, the modification is submitted for a more detailed study by a suitably selected team. See parts 5 and 6 of this code.

It is important that the procedure be audited periodically to ensure that it is being used. For example, any job request to implement change could have stapled to it a copy of a modification request form so that these job requests are checked each month by appropriate managerial staff.

8. MONITORING SAFETY, HEALTH AND ENVIRONMENTAL SYSTEMS

8.1 INTRODUCTION

Routine monitoring of the components of safety, health and environmental systems is an integral part of the activities undertaken when managing an installation. This gives management an indication as to whether the programmes are identifying weaknesses and encouraging corrective actions.

8.2 SYSTEMS

Active monitoring systems:

- Measure the achievement of objectives and specified standards;
- Concentrate on high-risk activities by monitoring in more depth and more frequently.

Reactive monitoring systems collect and analyse information suggesting failures in health, safety and environmental performances. These require systems for reporting:

- Injuries and cases of ill health;
- Events, e.g. damage to property or the environment;
- Events that have the potential to cause injury, illness or damage to property or the environment;
- Hazards;
- Weaknesses or omissions in performance standards.

Reporting and response systems enable information to be collected and evaluated to ensure that appropriate remedial actions are taken to maintain control.

Investigation and analysis systems provide a means to:

- Give priority to those circumstances which present the greatest risk;
- Identify both the immediate and the underlying causes of events;
- Refer information to the management level with the authority to initiate necessary remedial action, including organisational and policy changes; analyse all collected data to identify common features or trends and initiate improvements.

8.3 DESIGN OF PROGRAMMES

To monitor safety, health and the environment, there are a number of principles to be applied:

- The programme, including monitoring and reporting, should be systematically designed and thoroughly implemented.
- Performance indicators should be set, reported and reviewed in the same way as other business objectives, e.g. production targets.
- Monitoring should be done by those responsible for the safety of the installation, i.e. operators, technicians, supervisors and professional staff.
- The nature of the programme for monitoring should be designed to focus on the particular hazards of that installation, and on the relevant safeguards.
- Emphasis will change with time, giving more attention to those areas which are recognised as needing improvement.
- Managers of installations should have a monitoring programme, so they are not relying solely on audits by people external to their organisation. (An audit should be a second check on an activity which is already being managed; it should not be the main means of managing that activity).
- Physical equipment, plant, everything tangible and a range of intangible components such as the “human factor” need to be monitored.

See appendix 8 for an example.

9. PERMIT TO WORK PROCEDURE

Any work has the potential for an accident. If strict safety measures and precautions are enforced then hazards can be eliminated, isolated or minimised.

The full extent of hazards can only be recognised by a thorough examination of the worksite by those responsible for the work. This responsibility can be referred to as “ownership”.

A relatively safe job can be rendered unsafe by adjacent work.

The permit to work procedure is a well-proven method which predetermines the work to be done, exposes the hazards of the operation and states the method of control.

The permit to work procedure forces those doing the work and those authorising the work to communicate and discuss their work intentions, hazards and precautions and to be accountable.

Most permit to work systems are in the form of a contract between the person who controls the work and those executing the task.

The permit to work may include a checklist of safety equipment required to perform the job, for example, personal protective equipment, fire extinguisher to be present for duration of job, safety observer to be present, and so on.

Permit to work procedures are installation-specific and their development requires the input of all those involved.

An essential feature is for parties to visit the work site, inspect it, and agree that the work will be done as described, without deviation, and that all practicable steps have been carried out in order to make the site safe for the work to proceed.

10. MANAGING CONTRACTORS

From time to time, installation management will need to employ contractors to undertake work within the installation. Installation management become “principals” when contractors are employed. Similarly when contractors employ subcontractors, contractors themselves become “principals”. The legal relationships may become complex, but to maintain safety and the integrity of the installation, it is important that the areas of control be clarified. Under the HSE Act, principals can not hand over their responsibilities for safety and health to contractors, agents, or other persons.

As a set of guiding principles, the principal should:

- When selecting contractors, obtain and evaluate information regarding safety performances and programmes.
- Inform contractors of the known hazards related to the installation that could affect the contractors’ work, and the required procedures and safety requirements.
- Ensure contractors convey this information to those under their control.
- Ensure that contractors inform the principal of any hazards which are introduced or arise during the course of the work.
- Ensure that contractors maintain an injury and illness record.
- Explain to contractors the applicable provisions of the emergency plan.
- Have developed and implemented safe work practices to control the entrance, presence and exit of contractors in process or work areas.
- Periodically evaluate the performance of contractors in fulfilling their obligations.

11. SYSTEMS AUDIT

11.1 INTRODUCTION

As indicated in the introduction, this code is based on self-regulation and audit.

There are three types of audit:

Internal Audit — Uses the installation's own resources.

External Audit — Uses experts in the relevant areas as consultant auditors.

Extrinsic Audit — Imposed by an outside agency.

The internal and the external audit are different means of achieving a self-audit and which one is used will be dependent on the level of expertise available within the company. The intent of the self-audit would be a regular review of the installation's hazard management system.

The extrinsic audit would be an audit for compliance with the relevant sections of the HSE Act and other enactments. Regulatory and advisory authorities can provide information and assistance with the self-audits where required.

11.2 AUDIT OBJECTIVES

The primary objectives of an audit are to:

- Establish what is the current situation;
- Determine what the situation should be;
- Identify the differences, if any;
- Identify the reasons/causes of any differences;
- Recommend possible solutions and improvements;
- Follow up with an action plan agreed to by persons having the authority to implement the plan.

Audits should be carried out by competent people who are independent of the area or section being audited. This may involve one person, a team of managers, specialists and non-management employees or external consultants. Those with auditing responsibilities will generally require specific training in this task to secure competence.

11.3 KEY ELEMENTS

Audit systems are designed to assess the following key elements of health, safety and environmental management:

- The policy, including its intent, scope and adequacy.
- The organisation, including:
 - the acceptance of health, safety and environmental responsibilities by all staff including the managers and the adequacy of arrangements to secure control;
 - the adequacy of the arrangements to secure the involvement of all employees in the health, safety and environmental effort;
 - the adequacy of arrangements to secure the communication of policy and relevant information;
 - the adequacy of arrangements to secure the competence of all employees.
- The planning and policy implementation including:
 - overall control and direction of the health, safety and environmental programme;
 - standard-setting: its adequacy and relevance;
 - the allocation of resources to implement standards;
 - the extent of compliance with standards and their effectiveness in risk control;
 - the long-term improvement in the accident and incident performance.
- The measuring systems indicating their adequacy and relevance.
- The reviewing systems demonstrating the ability of the organisation to learn from experience and improve performance.

11.4 AUDIT COMPOSITION

In order to comply with this code, the installation audit should include:

- Documentation showing, but not necessarily limited to:
 - the identification of each hazard;
 - the assessment of each hazard;
 - the engineering control of each hazard;
 - the training in the operation of each hazard;
 - the control measures in place;
 - the emergency response plan;
 - the management systems;
 - the records of the operation of the installation which are required to comply with the Act;
 - the recommendations from previous audits.
- An inspection of the hardware associated with each hazard.

- Interviews with the installation staff at all levels to determine the extent of understanding and implementation of the safety management systems.

Audits and follow-up actions should be carried out in accordance with documented procedures.

Results should be documented and brought to the attention of the personnel responsible for the areas audited.

12. TRAINING

12.1 INTRODUCTION

Since employees play an important role in the prevention of major industrial accidents, installation management should ensure that employees understand the processes and hazards at the installation.

Employees must also be adequately trained in the safe use of equipment at the installation, including protective clothing and equipment. Employees need to know how to raise the alarm in the event of an emergency. Where a situation may arise that could result in an accident, employees should have a means to report the situation immediately to a supervisor.

Every employee must take all practicable steps to ensure their own safety, and that their own actions or inactions while at work do not cause harm to others. Refer to sections 12, 13 and 19 of the HSE Act for legal requirements.

12.2 INDUCTION

The installation management should ensure that all employees receive an adequate induction to advise them of the particular hazards at the installation and of the emergency procedures.

12.3 ONGOING TRAINING

Employees should also receive ongoing training relevant to the hazards identified at the installation.

Further training must be provided before the use of any modification to plant or procedures, and also before the introduction of new plant or procedures.

Training provided to employees should be in accordance with predetermined standards and where necessary meet competency standards endorsed by regulatory authorities. Such training should be monitored, reviewed, verified and recorded.

Competency should be regularly assessed.

13. ACCIDENT INVESTIGATION AND NOTIFICATION

13.1 ACCIDENT INVESTIGATION

Although “accident investigation” is an integral part of the hazard management system, the detailed techniques have not been included in this code. The references in appendix 9 contain further information.

13.2 ACCIDENT INVESTIGATION PRINCIPLES

Installation management should establish procedures to ensure that all accidents are investigated, to identify the obvious as well as the underlying causes.

A thorough accident investigation will yield a number of lessons and corrective actions leading to specific measures to eliminate or reduce the probability of recurrence.

Reports should be prepared at the conclusion of the investigation which will include:

- Date of the accident;
- Date when the investigation began;
- A description of the accident and all relevant details;
- The obvious and underlying factors which contributed to the accident;
- Immediate actions taken;
- All measures or recommendations to prevent a repetition.

Accident investigations should be initiated as soon as practicable and the results communicated to all those who could be affected by similar circumstances. This could extend beyond the organisation.

13.3 SERIOUS HARM ACCIDENT NOTIFICATION

All accidents that cause serious harm must be notified to OSH.

Note: Section 25 of the HSE Act states the requirements for recording and notification of accidents and section 26 covers the circumstances surrounding the interference or non-interference at the scene of an accident.

14. EMERGENCY PLANNING

14.1 INTRODUCTION

An emergency plan means a written plan which, on the basis of identified potential accidents at the installation together with their consequences, describes how such accidents and their consequences should be handled, both on site and off site.

The installation management must prepare an emergency plan giving all affected employees the opportunity to participate in its development. (See sections 6(e) and 14(b) of the HSE Act).

The detail and scope will be installation-specific and will consider all reasonably foreseeable major industrial accidents.

14.2 CONTENTS OF EMERGENCY PLANS

The following matters should be covered in the emergency plan:

- A consideration of the size and nature of possible emergency events;
- Liaison with emergency services, other regulatory authorities and neighbours;
- Detailed emergency procedures, including alarms and methods of communication and personnel accounting;
- Appointment of personnel to co-ordinate emergency responses and a definition of their duties;
- Designation and equipping of an emergency control centre;
- On-scene co-ordination of fire-fighting, rescue systems, evacuation arrangements, and first aid provisions.
- Emergency shutdown procedures;
- The chemical and physical characteristics and hazards associated with products and processes;
- A site plan showing the location of essential services, process and storage areas and control rooms;
- Procedures to minimise the impact on the environment;
- Any other matters of significance at the installation which might be relevant to the content of the on-site emergency plan, including dealing with media interests, minimum staffing, holidays, shutdowns and so on; and
- Declaration and communication of the emergency status.

14.3 TESTING EMERGENCY PROCEDURES

Management should ensure that all personnel are aware of their required responses in the event of an emergency. The effectiveness of the plan and the training must be tested by holding regular emergency exercises at least every twelve months.

14.4 EMERGENCY PLAN REVIEW

After each exercise, the emergency plan should be reviewed in consultation with employees and emergency services to consider any omissions or problems highlighted.

The plan must be reviewed when any changes have been made to the installation or to the hazardous substances on site.

For additional information, refer to appendix 9.

APPENDIX 1: DEFINITIONS

For the purposes of this code of practice, the following definitions apply:

Accident: an event that causes any person to be harmed, or in different circumstances might have caused any person to be harmed.

Competent person: a person possessing adequate qualifications such as suitable training and sufficient knowledge, experience and skill for the safe performance of the specific work to a specific standard.

Contractor: a person engaged by any person (otherwise than as an employee) to do any work for gain or reward.*

Hazard: an activity, arrangement, circumstance, event, occurrence, phenomenon, process, situation, or substance (whether arising or caused within or outside a place of work) that is an actual or potential cause or source of harm.*

Hazardous substance: a substance which by virtue of its chemical, physical, biological or toxicological properties constitutes a hazard.

Installation: a place of work including but not limited to a factory, site, facility, or undertaking, that stores, processes or produces, either temporarily or permanently, hazardous substances in such a form or in such a quantity that they possess the potential to cause or contribute to a major industrial accident.

Major industrial accident: an unexpected, usually sudden occurrence including, in particular, a major emission, fire or explosion, resulting from abnormal developments in the course of an industrial activity, leading to a serious danger to workers, the public or the environment, whether immediate or delayed, inside or outside the installation and involving one or more hazardous substances.

Principal: a person who or that engages any person (otherwise than as an employee) to do any work for gain or reward.*

Risk: the likelihood of an undesired event with specified consequences occurring within a specific period or in specified circumstances. It is numerically expressed as a frequency or as a probability.

Secretary: the chief executive of the Department of Labour.*

Shall: indicates a mandatory requirement to comply with the HSE Act or regulations made under the HSE Act.

Should: indicates a preferred course of action or recommended practice to be adopted.

* Indicates that the definition has been extracted from the HSE Act.

APPENDIX 2: GUIDELINES ON COVERAGE

This code may apply, but is not limited, to installations where the following activities are carried out:

- (1) Installations that use or have on site sufficient quantities of the following hazardous substances to cause, generate, promote or contribute to “a major industrial accident”.
 - (a) Explosive substances (solid, liquid or gaseous)
 - (b) Flammable substances (solid, liquid or gaseous)
 - (c) Toxic, poisonous or infectious substances
 - (d) Radioactive substances
 - (e) Corrosives
 - (f) Oxidising substances
 - (g) Ecotoxic substances.
- (2) Installations for storage, distillation, refining or other processing of petroleum or petroleum products.
- (3) Installations for the total or partial disposal of solid or liquid substances by incineration or chemical decomposition.
- (4) Installations for the dry distillation of coal or lignite.
- (5) Installations for the production of metals or nonmetals by a wet process or by means of electrical or mechanical energy.
- (6) Installations for the production of pulp and paper, and similar processing plants.
- (7) Installations for the production, processing or treatment of organic or inorganic chemicals using for this purpose, among others:
 - alkylation
 - amination by ammonolysis
 - carbonylation
 - condensation
 - dehydrogenation
 - esterification
 - isomerisation
 - halogenation and manufacture of halogens
 - hydrogenation
 - hydrolysis
 - oxidation
 - polymerisation
 - sulphonation

- desulphurisation, manufacture and transformation of sulphur-containing compounds
 - nitration and manufacture of nitrogen-containing compounds
 - manufacture of phosphorus-containing compounds
 - manufacture of pesticides and pharmaceutical products.
- (8) Installations for the processing of organic and inorganic chemical substances, using for this purpose, in particular, but not limited to:
- absorption
 - distillation
 - extraction
 - solvation
 - mixing.
- (9) Installations where:
- chemical reactions occur at elevated temperatures, pressures or are under vacuum
 - cryogenic processes take place
 - other activities are carried out at extreme temperatures or pressures, e.g. steam generation.

APPENDIX 3: GUIDELINES ON COMPLIANCE WITH THE HSE ACT

The management of hazards, as required by the Act, can be achieved through the implementation of techniques designed to identify and control hazards. The techniques detailed below can assist installation management in this duty.

IDENTIFICATION AND REGULAR ASSESSMENT OF EACH HAZARD

Identification may be accomplished through:

- Safety audits;
- Safety reviews;
- HAZOP studies appropriate to each stage of a project or retrospectively on an existing installation;
- Safety inspections, e.g. by health and safety committee and/or installation management;
- Accident investigation.

Many tools have been and continue to be developed in the field of Hazard Analysis (HAZAN). Examples include:

- Fault tree analysis;
- Event tree analysis;
- Rapid ranking;
- Risk quantification techniques;
- Risk contours, etc.

Most of these techniques provide an insight into design and enable hazards to be prioritised.

ELIMINATION OF SIGNIFICANT HAZARDS

Significant hazards may be eliminated by:

- Removing the hazard;
- Modifying the arrangement or process.

ISOLATION OF REMAINING SIGNIFICANT HAZARDS

Remaining significant hazards can be isolated by:

- Designing to approved or generally accepted standards and codes;
- Construction to generally accepted quality standards;
- Inspection and maintenance to generally accepted quality standards;
- Operation by competent personnel;
- Appropriate modification by competent personnel.

MINIMISATION OF THE LIKELIHOOD TO CAUSE HARM

The likelihood of causing harm can be minimised by:

- The wearing of personal protective equipment;
- The provision of emergency systems, fire hydrants, gas detection, warning signs, etc.;
- Procedures and training covering the operation and maintenance of plant and action to be taken in the event of an emergency.

APPENDIX 4: GUIDELINES ON POLICY STATEMENTS

A positive health, safety and environmental culture needs to be developed in which health, safety and environmental objectives are regarded by all as aligned to other business goals. This can only happen through the active and continued commitment of senior managers and directors who, in their individual behaviour and management practice, effectively communicate the beliefs which underlie the health, safety and environmental policy.

- Health, safety and environment is a management responsibility of equal importance to production and quality.
- Effective control and safety is achieved through co-operative effort at all levels in the organisation.
- Effective health, safety and environmental management is based on a common understanding of hazards and how to control them.
- Competence in managing health, safety and environment is an essential part of professional management.

Consideration must be given to the health, safety and environmental aspects of every part of the business.

An organisation demonstrates its commitment to health, safety and environment by establishing and displaying a written health, safety and environmental policy for all staff to follow.

Such written statements of policy will need to be supported by:

- Clear allocation of responsibilities for policy formulation and development, for planning and reviewing health, safety and environmental activities, for the implementation of plans, and for reporting on performance and setting the example.
- The delegation of health, safety and environmental responsibilities to line managers.
- The assignment of health, safety and environmental responsibilities to people with the necessary authority and competence who are given time and resources to carry out their duties effectively.
- Ensuring that individuals are held accountable for their health, safety and environmental responsibilities measured against targets.
- The provision of supervision, instruction and guidance.
- The avoidance of conflict between achieving production targets and health, safety and environmental requirements.
- The involvement of employees in policy formulation and the development of procedures in planning, implementing, measuring, and auditing performance.

- Securing effective communication and visible commitment through:
 - regular health, safety and environmental tours by managers;
 - participation in meetings on health, safety and environment;
 - managers becoming involved in accident and ill health investigations.
- Ensuring competence through selection, recruitment, training, placement, transfer and the provision of adequate specialist advice.

APPENDIX 5: EXAMPLES OF HAZARD MANAGEMENT SYSTEMS

Several companies have developed systems for managing safety. Below are examples. Every installation should develop those elements most appropriate to their individual situation.

COMPANY 1

1. Management commitment to safety
2. Safety policy and objectives
3. Legal requirements and corporate guidelines
4. Organisation and responsibilities
 - managers
 - employees
 - contract holders
 - specialists
 - functional groups
5. Communication and involvement
6. Competence
 - training
 - selection
 - assessment
 - targets and tasks
7. Standards
 - management, business
 - engineering, equipment, materials
8. Change control
9. Emergency and contingency planning
10. Performance monitoring
11. Accident reporting and investigation
12. Auditing and inspections
13. Management review and control

COMPANY 2

1. Process safety information
2. Process hazard analysis
3. Management of change
4. Operating procedures
5. Safe work practices
6. Training
7. Assurance of the quality and mechanical integrity of critical equipment
8. Prestart-up safety review
9. Emergency response and control
10. Investigation of process-related incidents
11. Audit of process hazards management systems

COMPANY 3

1. Safety, health and environmental commitment
2. Management and resources
3. Communication and consultation
4. Training
5. Material hazards
6. Acquisition and divestments
7. New plant, equipment and process design
8. Modifications and changes
9. Health, safety and environmental assurance
10. Safe systems of work
11. Emergency plans
12. Contractors and suppliers
13. Environmental impact assessment
14. Resource conservation
15. Waste management
16. Soil and groundwater protection
17. Product stewardship
18. Health, safety and environmental performance and reporting
19. Auditing

COMPANY 4

1. Personnel
 - training and performance
 - contractors
 - incident investigation and reporting
 - management of change
 - emergency planning and response
 - auditing
2. Technology
 - process safety information
 - operating procedures and safe practices
 - management of change
 - process hazard analysis
3. Facilities
 - quality assurance
 - prestart-up safety reviews
 - mechanical integrity
 - management of change

APPENDIX 6:

HAZOP STUDIES

Hazard and Operability Studies (HAZOPs) are a rigorous and widely accepted technique for hazard identification. A system or process is studied by a team who systematically look for the cause and effect of deviations from the norm. The key to performing an effective HAZOP study is to have a competent leader as co-ordinator, and the correct blend of experience within the team. While it helps for the team members to be familiar with the technique of HAZOP, it is not absolutely necessary provided that the leader is.

It is not intended to identify all the necessary skills required to carry out an effective HAZOP study as this requires training, in particular for leaders, and preferably for participants. Some of the key steps are:

THE INVITATION

HAZOPs require time, the correct blend of skills and experience *and* a constructive attitude. It is reasonable that participants should be given enough warning, plan for the time required, have the approval of their supervisor, carry the authority of the department they represent *and* have enough information to prepare for the HAZOP.

Figure 6.2 is one form of invitation which should be directed to the department head (or equivalent) of each participant, and to the participant. Other than in an emergency, this should be issued at least five working days before the meeting.

CONCEPTUAL HAZOP

This is undertaken early in a project with the objectives of:

- Identifying the inherent hazards of the raw materials, in-process products, wastes and processes proposed;
- Defining the criteria to meet legal, safety and environmental requirements;
- Defining design guidelines, codes and standards for inclusion in the technical specification.

Although it is carried out early in the project, some information is necessary on which to base the conceptual HAZOP. Typically a block or preliminary flow diagram will be available, together with the options for siting. Basic information on the inputs (e.g. raw materials), in-process materials and outputs (e.g. products and wastes), must be available, e.g. material safety data sheets, product specifications, throughputs, method of operation, environmental constraints, safety and health constraints.

As with the design HAZOP, the minutes must be complete and formally filed (see figure 6.3).

DESIGN HAZOP

The exact method of proceeding through a HAZOP will vary depending on the subject. Process, piping, electrical, computer, instruction, all differ in detail. It is important that a basic structure be maintained, the steps of which are as follows for “process” type equipment.

When a detail design has been completed to the piping and instrumentation diagram stage, general layout and isometrics agreed and preliminary standard operating procedures prepared, a formal HAZOP can be undertaken. The design is subjected to a systematic and detailed review by a team with varying backgrounds who are looking for ways in which upsets could occur. HAZOPs are intended to *identify* and not *solve* problems.

THE TEAM

The team may consist of 4-10 persons and should comprise the:

1. Leader (trained, independent — not the design engineer or project engineer);
2. Design engineer;
3. Safety/environmental representative;
4. Operations representative;
5. Maintenance representative;
6. Specialists/interested parties as necessary;
7. Recorder (may be one of the specialist engineers, but not the leader).

THE PROCESS

Figure 6.1 shows the process.

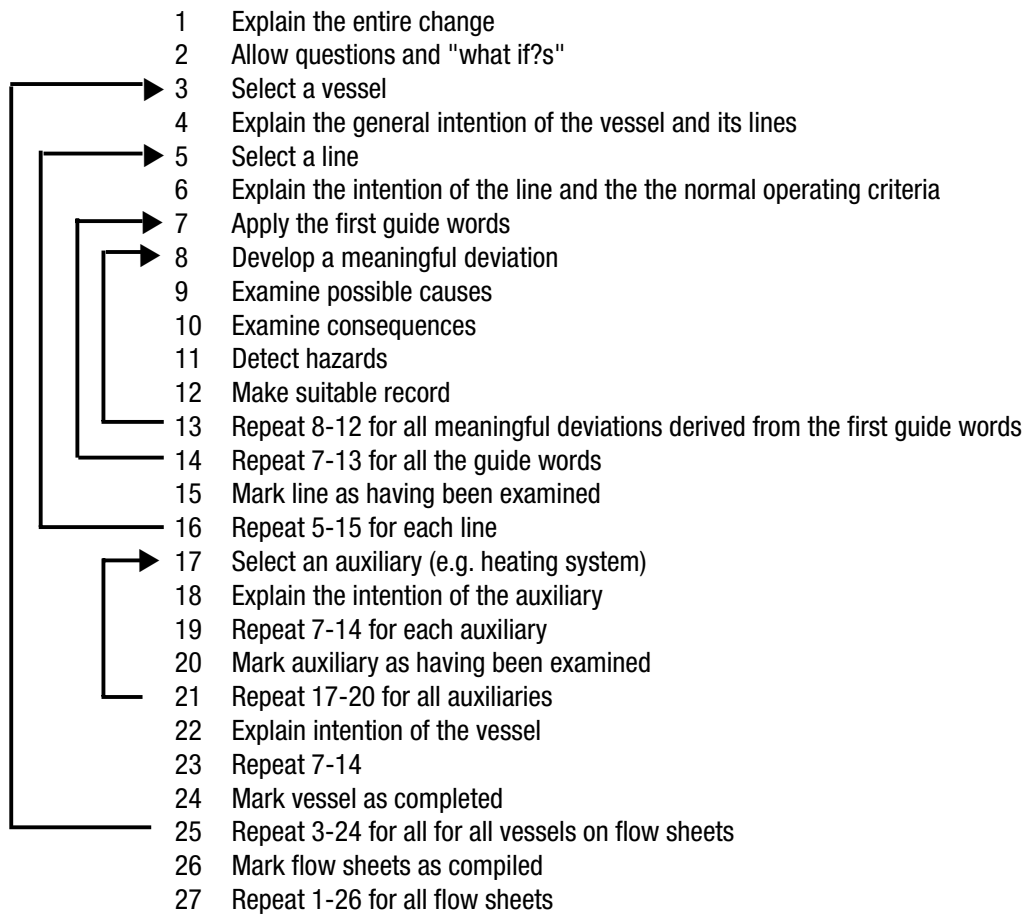
RECORDS

The records required are the minutes and the marked up piping and instrumentation diagrams.

Opinions differ as to the detail needed in the minutes. It is recommended that every deviation and line be recorded, together with any reasons for inaction or acceptance of consequence. This prevents the competency of the HAZOP team being brought into question at a later date.

Figure 6.3 is one option for a HAZOP record sheet. The HAZOP is not formally complete until all the actions are completed.

The HAZOP Process



The type of project (new process, computer logic change, electrical protection philosophy) will determine the type of guide words to be contained in the review and it will be the HAZOP leader's responsibility to produce these appropriately.

Figure 6.1: The HAZOP process.

DATE: 28 Jan 1994

FILE NO: TECH 94-M-21

TO: Alan Brown (Tech. Mgr) (Participant's immediate supervisor)

COPY TO: John Sharp, Lyall Franks

SUBJECT: XYZ Underground Storage Upgrade

A HAZOP on XYZ Underground Storage Upgrade has been scheduled as follows:

Venue: Tech. Conf. Room

Time: 0800 Hrs

Date: 5 Feb. 94

Duration (approx): 4 Hours

The nominated HAZOP team is:

Leader: T Kent

Design Engineer: J Sharp

Maintenance Mech: I Dunne

Maintenance Elect: R Bines

Mechanical Eng: -

Process Engineer: -

Electrical Eng: L Franks (Scribe)

Civil Engineer: -

Other: A Smith (Safety and environment)

Please ensure that the nominated person or deputy acceptable to yourself is in attendance and available for the duration of the review.

Thankyou for your co-operation.

Janet Fremis
(Senior Project Manager)

Attached documentation (to participants only):

Piping and instrumentation diagrams ✓

General description ✓

Layout ✓

Other (specify) e.g. Operation logic MSDS for XYZ

SOP- Raw material charging

Figure 6.2: Invitation to attend a HAZOP meeting.

HAZOP STUDY REPORT/MINUTES

SHEET 1 of 17

PROJECT TITLE XYZ Underground Storage Upgrade

PROJECT NO: E94/21 LINE DIAGRAM NO: P10917 1 of 2 DATE: 05/02/94 MINUTES BY: L. Franks

REVIEW TEAM: T Kent I Dunn

J Sharp A Smith

R Bines L Franks

Line No.	Process Deviation	Cause/Consequence	Action Required/Queries	Action by:	Follow-up Review Comments and Outcome
P4006 -100 3W Tank -Delivery Pumps					
	Low Press	Vent blocked and pump running	Local P1 with Low range	J.S.	Done -incorporated in spec.
	High Press.	See High Flow	Consider High Press. Alarm (Low Press)	J.S.	No room on PLC Low Risk - accept
	High Temp.	Flashpoint XYZ 15° - Summer? Pump dead head Air ingress from bubbler.	Consider nitrogen blanket. Will air ingress at low level? Investigate.	JS/ID/AS JS/ RB	Throughput makes unlikely - review in 6 months Bubbler reposition

Figure 6.3: Typical HAZOP study report/minutes.

APPENDIX 7: GUIDELINES ON RISK ASSESSMENT

The flowchart 7.1 shows how hazard assessment fits into risk management.

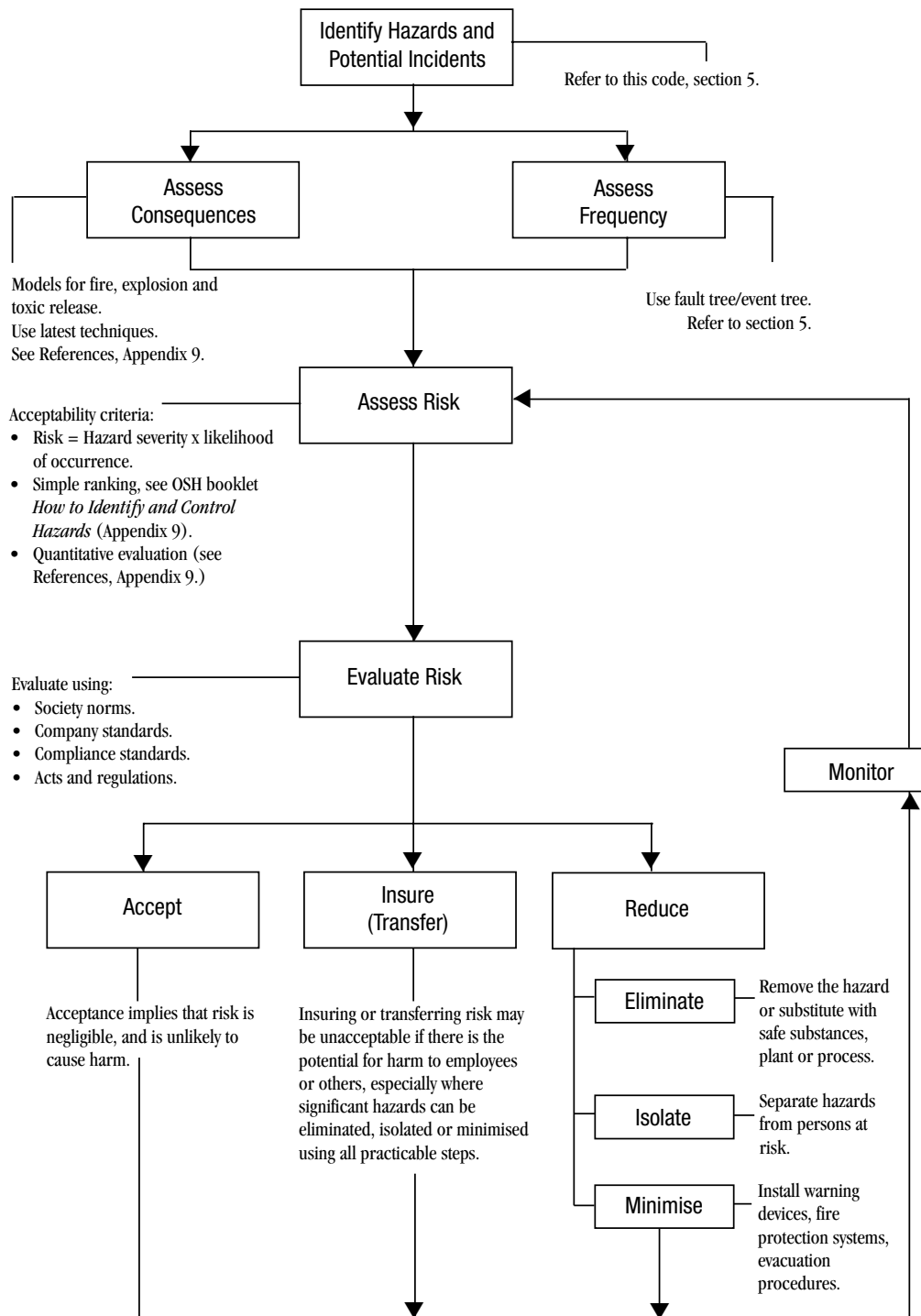


Figure 7.1: Flowchart showing hazard management.

At its simplest level, risk assessment can be used to determine the relative significance of hazards (see Figure 7.2). On a more complex level, the OSH booklet *How To Identify and Control Hazards* (see appendix 9) provides additional information. At its most complex level, risk assessment can result in the production of risk contours produced by summing the risks from a number of sources and involving failure models, probit methods, etc. These techniques continue to evolve and the most valid ones should always be sought out and applied.

Hazards vary in severity. The effect of a hazard may, for example, be rated to help identify those which are most significant:

- 3 SERIOUS for example, death or serious harm (as defined in the first schedule of the HSE Act).
- 2 MODERATE for example, injuries where people may be off work for more than three days.
- 1 SLIGHT for example, all other injuries including those where people are off for periods of up to three days.

Harm may not arise from exposure to a hazard in every case and in practice the likelihood of harm will be affected by the organisation of the work, how effectively the hazard is controlled and, the extent and nature of exposure to it.

In the case of health hazards, the latent effects and the susceptibility of individuals will also be relevant. In this case, regular reviews are recommended to assess risks in light of the current knowledge of hazard and harm. Judgements about likelihood will also be affected by experience of working with a hazard. For example, the analysis of accident, ill-health and incident data may provide a clue. The likelihood may be rated:

- 3 HIGH where harm will certainly occur.
- 2 MEDIUM where harm will probably occur.
- 1 LOW where harm will seldom occur.

Risk can be defined as the combination of the severity of the hazards with the likelihood of its occurrence or:

$$\text{RISK} = \text{HAZARD SEVERITY} \times \text{LIKELIHOOD of OCCURRENCE}$$

By multiplying together those numbers which represent the severity of a hazard and the likelihood of occurrence, a single figure is obtained which allows risks to be ranked. Where hazards affect more than one person, the resulting multiple could perhaps be multiplied by the number of people exposed to obtain a better comparison.

Figure 7.2: A simple risk assessment model.

For references, see appendix 9. These provide guidance on both hazard identification/analysis and risk assessment.

APPENDIX 8: ONE TYPE OF ROUTINE MONITORING OF PROCESS SAFETY

This systematic three-step programme used in a chemical factory is described here to illustrate the principles.

STEP 1

Set up easily measured performance indices for each area, for monitoring and reporting monthly, on topics such as:

- Number of permits-to-work checked and found to be defective (compared with the previous month);
- Number of leaks of process materials found on inspection at the end of the month (compared with the previous month);
- Percentage of operating procedures prepared and up-to-date (compared with the previous month).

The aim is to get started on a preliminary monitoring system, then to improve it by a more thorough and systematic study. All employees are involved.

STEP 2

Using worksheets, identify the critical features of each area in relation to containment of materials and control of processes and define an appropriate monitoring programme. It could include:

- Frequency of actuation of critical alarms compared with the previous month (this can be a simple number to collect on a computer-controlled plant);
- Number of alarms and trips due to be tested each month, and the number which fail the test;
- Number of control instruments recalibrated and the number which were out of calibration by a defined significant amount, the number of points to be inspected for corrosion or thickness, and the number found to be in need of attention.

STEP 3

By undertaking HAZOP studies on each area, further refine the understanding of critical features and procedures.

Concurrently, a programme of internal auditing should be set up, involving people from within the company and including those from the area under study.

The above steps progressively improve the routine monitoring of process safety. As implemented, there will be changes in the nature of the audits involving non-company staff. The objectives are:

- To review the quality of the monitoring and reporting systems and internal audits;
- To review whether revisions are occurring to account for accident experience on the installation or elsewhere;
- To probe one or two selected areas in detail to keep the internal audit system honed;
- To review progress on major hardware improvements.

See appendix 9 for references.

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