managing safety

Prepared on behalf of the CONCAWE Major Hazards Management Group by the Special Task Force on Managing Safety (MH/STF-3)

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ABSTRACT

Managing safety is an integral and essential part of the total management of a successful enterprise in the oil industry. Company safety policies set the objectives to achieve this, and this report includes an outline of the principles and provides typical aspects of the approach generally adopted.

This document has been prepared to contribute to dialogue between industry and authorities on how the oil industry manages safety.

CONTENTS

1. PRINCIPLES OF APPROACH TO MANAGING SAFETY

1.1 POLICY AND OBJECTIVES

Managing safety is an integral and essential part of the management of a successful enterprise in the oil industry. Safety is a key element of business with other primary aspects such as production, quality control, and cost management. Safety is also a legal obligation.

For these reasons, company safety policies specify objectives for the protection of people and the environment. While recognising that there will always be a residual risk from hazardous activities, oil companies base their approach to safety on the principle that all accidents can be prevented.

Company safety policies apply to all company activities and in every type of location; emphasis is placed on adherence to safety rules and procedures at all levels, and effective communication is used to gain the commitment of all those involved in company activities.

Safety performance is a chief executive and line management accountability. In many cases, this accountability for safety is specifically defined in job descriptions, and individual performance is assessed accordingly. A major factor in achieving a good safety performance is the visible commitment of management.

Management strives to motivate their people, employed or contracted, to work safely. The active development of a 'safety culture', thereby raising the level of awareness, is seen as an essential part of preventing accidents. Management also responds effectively to good or poor performance of their staff in maintaining legal requirements, company standards and safe working conditions, and reacts promptly to work place accidents. It is fundamental that all company employees and contractors carry a responsibility for working safely, so protecting themselves, their fellow workers, the local population and the environment.

1.2 MANAGING SAFETY

The intrinsic nature of the industry's activities involves the storage, handling and processing of dangerous substances. Therefore, accidents might cause harm to people, property and the environment, both inside and outside installations.

The challenge to the industry is to conduct its activities in such a manner that the associated risks are acceptable to the national authorities, to the community and to the industry itself. The oil industry meets this challenge by developing high standards in all facets of its business, and by constantly striving to reduce the likelihood of accidents.

Several techniques to structure this risk management process are used by the industry. Safety management measures are applied from the initial project development and throughout the life of an installation. This requires input of safety expertise throughout all stages of a project and its operational lifetime.

A particularly high level of technical expertise is devoted to the design, engineering, and construction of the processes and plants used to store, handle and refine crude oil and its products. Once commissioned and operating, the plants are maintained and inspected according to severity of operating conditions and codes of practice. Further, it is recognised that all plant changes must be designed and implemented in a way that retains safety integrity.

It is also evident that managing the human element is critical in achieving a safe facility. Consequently, personnel involved in operating or maintaining oil installations are subject to a range of management controls.

Employees and contractors are carefully selected, informed of their responsibilities, and monitored in their safety performance. Safe working procedures are developed and effective training is provided in the detail of work practices for both normal and emergency conditions. Reporting, analysis and communication of findings about any accidents and incidents is an invaluable part of this process, so that lessons are learnt and reinforced.

Companies apply similar principles to meet the specific needs of refining and marketing installations of different sizes and complexity. Though it is not feasible to describe or refer to every individual company's policies and procedures in this report, typical aspects of the oil industry's approach to managing safety are illustrated in the following sections.

2. APPLICATION OF PRINCIPLES OF APPROACH

2.1 DESIGNING PLANT FOR SAFE OPERATION

This section deals with the way that safety is built into plant at the design stage by feeding back accumulated operational experience of both safe operation and incidents.

2.1.1 Developing and recording experience

Accumulated experience forms the mainstay for the achievement of safe plant operations. In view of its paramount importance of actual experience, there is a need to record how it has been required and how it is maintained and used within the oil industry.

Those experienced in plant operations and maintenance are brought together with design engineers and safety specialists to work as a team familiar with a wide variety of operational matters in different types of installations. Thus, experience gained in plant operations about the effectiveness of safety systems and equipment or from incidents, can be made available for the design of new plants, or for incorporation in existing plants.

Many companies actively promote the interchange of engineers between positions in design offices and in plant operation. This gives designers direct experience of the practices and problems of plant operation, and enables them to take better account of the practical situation. Similarly a project manager for a new installation may subsequently be put in charge of operation of the plant when built. Experience is then used to promote safe operation of the plant.

The experience that the industry builds up in this way is laid down for collective use in standards and codes of practice of institutes such as the Institute of Petroleum and the American Petroleum Institute. Companies contribute to national and international standards/codes dealing with general practice and specific issues such as the safety of electrical equipment, vessel construction, and the design/siting of storage tanks. Some companies have also developed their own stringent design standards, which form part of specifications for new installations.

This knowledge and experience accumulated within the oil companies and the specialist companies they employ, backed by formal documentation, form the basis for the ongoing assessment of the safety of plants.

2.1.2 Safety in design

The design of a process installation or storage terminal is a continuous effort which involves safety-related decisions as the design progresses. At certain stages in the design, the safety aspects can be subjected to a formal review. Towards the end of the engineering phase the integrity of a design can be reviewed as a whole, while at the same time the documentation of the safety features can be finalised. This information will often form part of the project documents that are made available to those involved in the future operation and maintenance of the plant.

The principles described apply not only to the design of new plants, but equally to the design of modifications to existing plants.

2.1.3 Safety studies

At discrete stages in the development of a project, a number of safety studies of identified content and scope can be carried out, perhaps by teams including people not involved in the original design.

The objective of these studies is to confirm that all safety aspects have been identified and properly considered. This involves ensuring that the applicable codes of practice and legal requirements have been followed, up-to-date safeguarding practice has been incorporated, and that experience from similar running units is built into the design.

A number of established techniques are available, which will be applied especially where it is considered that the potential hazard is very serious, or the process technology has developed to the extent that the experience from existing units is insufficient. Examples of techniques that can be used are: Process Safety Studies, Hazard and Operability (HAZOP) Studies, Failure Mode and Effects Analysis, "What If" Methods, Check Lists, and Cause Consequence Diagrams.

Applying these safety studies may lead to design changes being introduced during the development of a project.

2.1.4 Risk assessment

However carefully safety studies are carried out, there will always be a residual risk that some chain of events might occur that could result in a major release of flammable or toxic material.

The oil companies recognise the need to be able to answer questions about the potential for major accidents.

A considerable amount of research work has been done in the fields of heavy gas dispersion, thermal radiation from fires, and in other areas associated with releases of hydrocarbons. As a result of this work the possible effects that releases from plants may have on people and buildings in the vicinity can be estimated. The estimates may lead to a closer review of plant design and method of operation, which in turn may prompt engineers to study how such a release can be reduced, or its possibility minimized. In many cases the risk is reduced by addressing both the size of a possible release and its probability.

Risk management decisions may be assisted by quantifying the risk. Quantified Risk Assessment (QRA) calls for estimates of both the physical consequences and the probability of postulated events. Each of these estimates contains a degree of uncertainty, which becomes part of the assessed risk. This must be taken into account when interpreting the results of QRA.

2.1.5 Safety checks on the physical arrangement

In the course of the detailed design, the physical arrangement of piping and equipment is checked for safety. Examples of aspects to which careful attention is paid are:

- ease of access and escape
- safe location of vents with respect to flammable and toxic vapour release
- avoidance of low points and dead ends in piping systems
- location of gas detection and other safety and firefighting equipment in the plant.

2.1.6 Pre-startup safety reviews

Before a plant is commissioned, a safety review is carried out, often by a multi-disciplinary team. Such a review gives the opportunity to confirm that safety features are in place and that design information has been properly transmitted to those in charge of the plant (see also Section 2.2). It also allows a follow-up of any queries raised during the reviews which could not be answered solely by referring to design documentation.

2.1.7 Post-commissioning changes to plant design

Any changes to the plant design or procedures should be fully investigated and documented to ensure that they do not affect the integrity of the design. A detailed review procedure sets out the actions to be taken to ensure that safety implications are correctly incorporated. This can take the form of a safety study for a major modification (see Section 2.1.3), or a more simplified drawing approval procedure for minor changes. It is important that drawings and procedures are amended to reflect any change and that the plant records are kept up to date.

2.2 OPERATIONS

2.2.1 Organization

The common pattern of oil company operations is to implement responsibility for safety through line management, (see Section 1.1). Plant management may range from an individual at a smaller marketing terminal, to many people in an organization structure at a larger refinery. Line management are typically day staff but, where the operation is continuous with operator coverage on a shift system, supervision is also continuous.

A number of functional groups are available to support the oil operations line organization in effectively carrying out its responsibility for safety. For a large refinery these would typically be available on the site. For a small oil installation, most of these service functions would be supplied from a central company support group or through a contractor.

2.2.2 Management

At the first line management level, whether it is a process unit in a refinery or a small marketing terminal operation, the unit supervisor is responsible for the day-to-day operation of a plant area, for the operating strategy and its implementation. Suitable holders of these functions meet that responsibility with practical operations experience and appropriate technical knowledge.

At an installation which operates outside normal working hours, shift supervisors are the senior on-site staff, responsible for the total operation. During this time a shift supervisor would be in charge of managing any emergency. Accordingly, a shift supervisor will normally have an extensive experience of leading operating groups.

2.2.3 Operational safety

At many oil company sites, in particular where oil processing takes place, operating staff work in shifts to provide continuous coverage. Operators are given training on and off the job, and may qualify to become operating group leaders. Such individuals will generally have had several years experience working on plant.

The main safety responsibilities of an operating group leader are to ensure that:

- established safe operating procedures are used
- safety rules and standards are obeyed by all
- routine safety checks are implemented, including critical instruments and equipment
- faulty equipment or procedures are identified and corrected
- safe conditions for maintenance work are achieved by use of a work permit system
- all the operating group know their roles and actions required in emergency situations.

2.2.4 Service functions

Of the functions which support site operations, the key functions of Training, Maintenance and Inspection are covered in Sections 2.3, 2.5 and 2.6 respectively. Other necessary functions are outlined below.

Occupational Health advises on the potential health implications of activities and recommended protection measures.

Safety advises on and audits the correct use of safety procedures and equipment, and records and analyses accident and injury data (see Section 2.8).

Security ensures that site access is continuously controlled.

Environmental Protection advises on the control of industrial discharges to air, to water or to ground, and monitors operation of the effluent treatment processes and procedures for the safe disposal of any waste products.

Technical Services provide information and advice on both the processes themselves and the equipment involved, which include the safety implications, for example in reviewing changes to process operating conditions.

2.2.5 Operating procedures

Safe operating procedures may be defined as those instructions which prevent or minimize the risk of accidents by maintaining stable plant operation, or by changing the plant operation from one stable state to another, in a manner consistent with the equipment design and condition.

Safe operating procedures are essential guidance for normal or alternative operations, as well as for controlled startup and shutdown. Strategies for handling the range of emergency conditions are also required; those covering the loss of major utilities or critical equipment failures are typically prepared in detail. Such strategies for emergency conditions are aimed at moving the upset operation to a safe operating state or shutdown.

2.2.6 Development of procedures

Considerable attention is paid to the development of operating procedures in order to reduce the likelihood or consequences of operator error. Well-designed procedures will facilitate training when an operator is relocated to a different unit and, most importantly, will enhance response in an emergency.

Consistent procedures across the site are most important, based on a company's engineering standards. This is vital for the most basic procedures which the operator memorises, such as the switching of pumps. With refinery processes, procedural variations will inevitably arise from unit to unit because of the different relationship between equipment items, the process characteristics, or the design of the control system. Moreover, a mechanism is typically available whereby the special safety considerations of a new design can be incorporated into its operating procedures (see Section 2.1.2).

Well-designed procedures need to:

- include clear, precise and logical instructions
- include actions linked to process parameters or alarms
- identify sequenced and conditional actions
- highlight critical safety steps

- arrange sequences so that hazardous consequences of error are minimized.

An important part of the design of operating procedures is the full involvement and commitment of staff responsible for operation, who are generally encouraged to contribute to improvements based on their field experience. A particular aspect of this is providing input to a design review system (see Section 2.1).

2.2.7 Documenting procedures

There is continuing communication to ensure that plants are operated within their capacity and other design constraints. In particular, documents are passed between supervision and the operating crew. These communications relate to individual standing orders which cover all aspects of plant operation, and to the task descriptions of plant personnel. Copies of procedures are typically kept in the control room and by direct supervision and management. Additions are made as plant equipment and operations are changed. Periodic updates and reissues fully incorporate all changes.

Incidents are rare, so the updating of operating procedures in the light of experience is a critical aspect of documentation. Such documentation provides a memory of lessons learnt which might otherwise be lost.

The oil industry is always searching for improvements in documenting procedures to make them more helpful to operators. Developments in layout, tabulation, use of language and use of charts are typical areas where work is currently being done. Current growth in computer instead of paper documentation assists updating and control, operator training, and allows on-line interactive monitoring. Also, there is now the prospect of "expert systems" being developed which could optimize an operating strategy during an emergency.

2.3 SAFETY TRAINING

2.3.1 Introduction

Oil industry policy is that all employees in the organization are trained to carry out their work in an effective and safe manner. Job training is determined by the nature of the work carried out and the responsibilities of the position held. Safety training is given at industry installations by persons with field experience and by safety specialists.

2.3.2 Management training

Line managers receive detailed briefings on safety legislation relating to the company's business, on safety policy and objectives. Detailed guidance for applying safety programmes, and an overview of specific accountabilities on which their performance will subsequently be judged, are included. The following topics may also be included:

- personal protection equipment
- control, causes and effect of accidents
- occupational health and industrial hygiene
- emergency contingency plans
- safety auditing methodologies
- work permits
- plant change procedure.

2.3.3 Supervisor training

In addition to the topics for line management the supervisors need to understand their specific responsibilities for safety. For example the following additional subjects may be covered:

- operating procedures to protect personnel and equipment
- proper job or task instruction
- job observation of critical tasks
- accident investigation and reporting.

2.3.4 Training for operations and maintenance personnel

All employees who will be involved in plant operation or maintenance receive safety induction training. Training of contractors is reviewed in Section 2.9.

Formal and refresher training in plant procedures, in particular for unit startup and shutdown, includes both classroom and on-the-job tuition.

Employees exposed to recognised health hazards, e.g. lead, regularly receive specific instruction with emphasis on occupational health matters. A proportion of the workforce is trained in first aid action to be taken if exposure to the specific hazardous materials should occur. Proper use of personal protection equipment, e.g. breathing apparatus, is also an important part of their training.

Employees engaged in plant operation or maintenance need to receive training in safety awareness and work permit systems (see Section 2.5). People carrying out activities which involve a particular hazard may require specific training before becoming qualified to work, for example in welding or driving mobile equipment.

Employees are involved in training and drills for responding to a fire and in the use of firefighting equipment. For those employees who form the accident emergency team, more extensive training on deployment, maintenance and use of equipment is organized on a regular basis using different accident scenarios. This typically includes live fire drills conducted under the supervision and strict control of emergency service professionals.

2.4 PLANNING FOR EMERGENCY RESPONSE

In spite of the many precautions taken to ensure the safe design, operation and maintenance of plant in refineries and marketing terminals, from time to time accidents may occur. Fires, spills and releases of flammable or toxic materials can lead to serious consequences for both man and the environment unless quickly brought under control. Such accidents are possible during maintenance and construction work, as well as normal operations. The consequences from such accidents more commonly stay within the plant fence (on-site), but occasionally may also extend beyond the boundaries (off-site). Planning must be geared to take account of other people and organizations likely to be involved in the emergency.

The overall objectives of emergency planning may be summarized as follows:

- to contain and control emergency incidents
- to safeguard people on-site and off-site
- to minimize damage to property and the environment.

A CONCAWE group has developed a series of guidance notes on emergency planning:

- "Content of emergency plans" (Report No. 5/88) presents an annotated reference list of items which need to be addressed.
- "Refinery emergency planning" (Report No. 6/88) provides a more comprehensive review of emergency organization.
- "Planning for mutual aid" (Report No. 5/88), "Training, exercises and rehearsals of emergency plans" and "Communications during an emergency" (Report No. 2/89) give further separate guidance on these key aspects in any emergency.

- "Selecting the incident scenarios", "Responsibilities of petroleum industry and regulatory authorities", and "Information to public" (Report No. 11/87) cover those special aspects which apply to off-site emergencies.

Together, these notes provide oil companies with guidance on planning for emergency response. While the range of events that can give rise to a major emergency can be large, the effects of potential accidents can be substantially reduced by systematically prepared and thoroughly tested plans.

2.5. MAINTENANCE AND MAJOR OVERHAULS

2.5.1 Maintenance strategy and organization

Management needs to ensure that maintenance strategy reflects the oil company's objectives for safety, production and quality assurance. This strategy can be translated into a maintenance plan which may include the use of contractors to supplement the in-house maintenance workforce. The safety implications of the use of contractors are covered in Section 2.9. A system will also be available to support the agreed maintenance plan with regard to preventive or predictive maintenance, and to help schedule work and resources to meet operational priorities. Planning is essential to ensure that the interface between maintenance work and operating plant does not give rise to a hazardous situation.

The maintenance function has qualified professional engineering leadership with trained personnel at all levels.

Clearly defined codes and standards are used to ensure that the plant is maintained correctly, and a records system is provided to retain details of all inspections and repairs to plant and equipment (see Section 2.6). It is essential that all maintenance activities maintain the integrity of the design. Material specifications need to be rigorously followed for any replacement parts, and certification should be held as supportive documentation where necessary.

2.5.2 Safe systems of work

Clearly defined procedures are needed to ensure that all non-routine activities, such as maintenance work, are carried out safely. Formal Work Permit systems, developed through many years of experience, are applied throughout the oil industry.

The Work Permit is a written document authorizing persons to carry out the work concerned, warning them of the possible dangers and spelling out precautions needed if the job is to be done safely. Use of the Work Permit enables proper consideration to be given to the risks prior to work commencing. The objectives are:

- To ensure the proper authorization of non-routine work,
- to make clear to the person(s) carrying out the job the risks involved and precautions to be taken,
- to ensure that the operator responsible for an area of the installation is aware of all work being done there,
- to provide a record showing that the method of work and the precautions needed have been checked by the appropriate person, and if deemed necessary, to ensure a second opinion is obtained to prevent errors of judgement or the taking of short-cuts which may increase the risks.

A systematic approach applied to control non-routine activities in oil facilities might include the following steps:

- Specifying the work to be done, the method and sequence of work, and the equipment to be used, when applying for the permit.
- Specifying the precautions to be taken, by completing the relevant section of the Work Permit.
- Completing preparatory work, including certificates, to check that the facility can safely be worked on and that prescribed personal safety precautions are taken.
- Giving permission for work to start by signing the Work Permit.
- Checking the safety of work in progress, the continuing validity of permits and certificates, and adherence to the precautions specified.
- Checking that the job has been left in a satisfactory condition on the completion of work and withdrawing the Work Permit.

The Work Permit system formalizes this step-wise approach, each step being started only when the preceding step has been completed.

2.5.3 On-line maintenance

With modern high cost process plant, designed for high reliability and with a minimum of reserve capacity, emphasis is being placed on predictive maintenance (on-line testing including condition monitoring, see Section 2.6, to predict when maintenance is required) and on preventive maintenance (regular maintenance at predetermined intervals to inspect and replace critical components). This reduces the likelihood of breakdown which may give rise to hazardous conditions. The type of maintenance used may vary from plant to plant, and also within each plant different items of equipment may be treated differently.

The type of maintenance adopted will be dependent on the criticality attributed to the equipment from both its effect on safety and on production should it break down.

Of particular importance is the maintenance and testing of safety systems. In some countries certain items are required to be inspected or tested on a statutory basis. In addition, there are increasing numbers of mechanical and instrumented shutdown and safety systems in use, which also require regular and documented testing. These include high integrity instrumented shutdown systems, machinery trips, gas detectors, and other fire detection and automatic fire protection systems.

2.5.4 Major shutdowns

Major plant shutdowns at predetermined intervals are carried out for the inspection, repair and cleaning out of equipment that cannot be released during normal operation. The timing of these shutdowns will be determined by good engineering practice, as defined in standards and guided by inspection/repair reports generated in previous shutdowns. Shutdown frequencies may be specified by statutory authorities for some items of equipment.

Major shutdowns require a large workload to be completed in a short period. Therefore it is often necessary to use contractors, whose employees may not be experienced in working in oil installations (see Section 2.9). Consequently, changes will be required to organization, supervision, and safety coordination to maintain the effectiveness of safety controls.

2.5.5 Returning plant to service

Recommissioning plant following maintenance is a critical operation. Strict procedures need to be followed to ensure that

all final inspections and tests are carried out before plant is handed over to the operating group for recommissioning. Normal maintenance activities on single items of plant are usually handed back to and accepted by operators through the work permit system (see Section 2.5.2). For major shutdowns this handover is more normally carried out plant by plant.

Both the maintenace and operating groups need to be satisfied that the plant is in a safe condition for recommissioning, and this will be incorporated into handover procedures.

2.6 INSPECTION AND RECORDS

2.6.1 Aims and objectives

Every effort is made to eliminate failures at source by introducing effective inspection procedures during the construction of plants, and in the selection and quality control of materials and fabrication.

Regular inspection of equipment during its lifetime and recording of the results are important for continuing safe operation of oil industry plant. This needs to be done by experienced professional and technical staff.

Such inspection and recording programmes may identify and monitor potential causes of failure like internal fouling (e.g. coke in furnace tubes), vibrations in rotating or reciprocating machines, creep of material after considerable working periods at high temperature, and corrosion.

2.6.2 Quality control

Oil companies are increasingly adopting quality control measures in many areas of activity including materials supply relating to both new plants and replacement items. In the quality control process, raw and semi-finished materials should be systematically checked for chemical analysis and mechanical properties and, whenever appropriate, structural integrity as well. Results need to be accurately recorded.

These control checks will be performed as indicated in design codes and recommended practices, issued for instance by the American Society of Mechanical Engineers (ASME), British Standards Institution (BSI), American Petroleum Institute (API) DIN or ISO. In many European countries, manufacturing procedures and relevant checks are statutory requirements for equipment operating under pressure, and quality control tests are

officially certified by the authority. A full record is thus produced serving to certify the soundness of the original equipment, and which also giving baseline data for subsequent monitoring.

Prior to commissioning, meticulous internal and external checks of the main pieces of equipment and other components are carried out to confirm that they correspond to the project specifications and design drawings. Moving equipment, electrical instrumentation and safety control systems will be fully tested by functional tests.

2.6.3 Inspection

Main components, including pipework, need to be subjected to periodic inspection throughout the plant lifetime. The objective of these inspections is to confirm both that the equipment is structurally adequate for continued operation, and that components or systems are still functioning according to the design intentions, for example electrical and instrumentation trips. In this way it is possible to identify potential unreliability arising from defective manufacture, construction, engineering faults or corrosion, before a problem arises.

Inspection programmes and procedures can be applied in two ways to oil industry refining and storage plants. The first is when the particular plant or section of plant is shut down and off-stream inspection can take place. The second is the application of techniques which allow on-stream inspection.

Inspection techniques used in the oil industry range from the simple to the highly sophisticated. The level of application differs depending on the overall hazard level associated with the process and the plant, and on the particular operating conditions. The effectiveness of these periodic inspections can be greatly enhanced by observing trends which allow the opportunity to introduce timely preventive maintenance programmes. For a comprehensive interpretation of inspection results, highly qualified company or independent experts are needed.

2.6.4 Records

Records are necessary for keeping refinery and storage plants under an effective and accurate control. They are an invaluable source of information for rational scheduling of maintenance during plant shutdowns. For machinery they are an essential tool for planning short-term maintenance based on condition monitoring.

2.7 SAFETY AUDITS

2.7.1 Objectives

Safety audits are used to identify potential hazards and levels of risk, and to check that standards are being maintained and that operations are performed in a safe way. The nature and complexity of an appropriate audit depends on the local situation and requirements, and the size of the installation.

An audit may cover any aspect or section of company activities, such as research and development, design, occupational health and hygiene, environmental control, product and public safety (including storage, packaging, labelling and transportation), as well as those associated directly with production, e.g. technical operation, maintenance, emergency procedures and operating instructions. Training, general housekeeping, and personal attitudes are typically included.

An audit aims to disclose the strengths and weaknesses and the main areas of vulnerability or risk. It is carried out by experienced personnel, including safety professionals. A formal report and an action plan is prepared, and its implementation monitored. Audits will promote contact with individual employees, demonstrating management's interest and concern, encouraging staff involvement, stimulating comments and suggestions relating to safety, and promoting cooperation in identifying situations which need correction.

2.7.2 General approach to audits

Safety audits may be initiated by any level of management. It is essential that the procedure and objectives enable line management to understand and accept the aims and methods of the audit, and to adjust their safety activities to its findings and recommendations.

The appropriate frequency of safety audits will depend on the nature and type of activities within each area of operation. Audits may be designed to provide a quantitative result in the form of a performance related score. A comparison of these scores from one audit to the next can be adopted to determine progress, or to compare multi-plant operations between similar installations of the company.

As part of the pre-planning for the audit, a questionnaire or checklist of matters to be covered needs to be developed, and time spent on its preparation is as valuable as that taken for the audit itself.

2.7.3 Safety audit team

The scope and complexity of an audit will determine the size and composition of the audit team. For example, the installation management or supervision may conduct frequent safety inspections themselves. Outside experts from other company functions or outside consultants might be used where there is a need for independence, or when specialised knowledge is required.

Careful selection and preparation of those taking part in audits is important. Preparation may consist of simple informal discussions before the first approach to the task is made. For more complex audits a period of formal training may be necessary.

2.7.4 Evaluation of results and follow-up

Safety audit results are usually presented as a report from the audit team, which will include conclusions and recommendations. This report would be addressed to the initiating manager who will decide on the implementation and timing of the recommendations. An essential feature of any safety audit is to ensure that recommendations are communicated and understood, and those agreed are implemented.

2.8 ACCIDENT ANALYSIS AND RESPONSE

2.8.1 Introduction

All accidents which cause human injury or plant damage are investigated and details recorded. The record built up in this way has proved invaluable to the industry, since the lessons learned have helped in improving plant design and operation. The depth of the investigation and the extent to which any subsequent report is distributed will depend on the severity, type and significance of the accident.

2.8.2 Accidents leading to fatalities, serious injuries or major damage to plant or the environment

For these types of accident a formal procedure is generally adopted to investigate what happened, why it happened, and to derive any lessons to be learned.

Investigation procedures typically contain two distinct elements:

- the first element aims to assemble the facts
- the second element analyses the causes of the accident and develops recommendations.

It is common practice to include in the investigating team staff independent of the incident.

First stage of investigation

The investigation should commence as soon as is practicable after the event, and seek to produce a report which provides a factual description of the incident.

Second stage of investigation

This stage should consider the event in depth, seeking to identify direct and contributory causes, and includes as necessary such aspects as design, operation, training, work procedures and maintenance. The adherence to and effectiveness of emergency procedures, and hence the control of the incident will also be reviewed. The report should include recommendations and, if necessary, identify items requiring further investigation.

2.8.3 Less serious accidents

Accidents of a less serious nature can be investigated less formally, but lessons learnt may be as important. The supervisor responsible for the immediate area concerned will write the report, which in general terms should include:

- a description of the accident
- basic causes (technical factors, incorrect actions, human behaviour factors, environmental factors, etc.)
- recommendations to prevent a recurrence
- a list of the persons who should implement the various recommendations.

The accident report should be copied to management, who are responsible for confirming the recommendations and ensuring that corrective action is expeditious.

Companies maintain a close watch on all accident reports so that common factors can be identified and wider actions initiated.

2.8.4 Near misses, and unsafe acts and conditions

Experience shows that accidents which cause damage or injury are recorded, but unsafe acts or conditions that result in near misses are less likely to be reported. Nevertheless, these are all potential accidents as graphically illustrated by Heinrich's Triangle which relates the number of serious injuries to greater numbers of minor accidents, near misses, and unsafe acts and conditions.

The industry therefore, seeks to identify near misses, unsafe acts and conditions, and to take corrective action so that the potential for an accident involving injury or damage is reduced. This emphasises the need to motivate employees to investigate and report near misses in a manner similar to that for accidents.

2.9 CONTRACTOR SAFETY

2.9.1 Selection and assessment

The industry aims to employ only those contractors who are able to demonstrate the necessary competence for the work to be done, which includes the management of health and safety. Only contractors considered competent are invited to tender, and are made aware of the employing company's safety standards and the nature of site hazards. When bids are received a review is carried out, which can involve interviewing, to confirm that the contractor understands the employing company's requirements and can demonstrate that he has the ability to meet them.

2.9.2 Creating safety awareness

It is necessary to create safety awareness in each of the contractor's personnel by providing instruction in the employing company's safety and environmental protection practices and procedures. Contractor's supervisors need to receive additional instruction in safety procedures. Care should be taken to ensure that all relevant information is included and that this is put across in a clear manner and in terms readily understood by the contractor's workforce.

Before work begins on a site, the employing company should identify a qualified person who will monitor the work and safety standards of contractors. This qualified person is normally an engineer or supervisor of the employing company with special training in the control of contractors. All relevant safety and environmental rules and procedures should be defined, including contingency plans for dealing with major incidents.

The qualified person will be expected to monitor the contractor's performance to ensure the correct level of supervision is given, and that all control procedures, for example the work permit system, are operating properly.

Where sub-contractors are employed, the employing contractor needs to inform the employing company of the names of the sub-contractors and obtain agreement to their engagement. The same attitude to safety instruction needs to be applied to sub-contractors as is given to the main contractor's personnel.

2.9.3 Reporting and evaluating performance

Contractors should be required to notify the employing company of all accidents resulting in or having potential for injury, damage or loss. Reports of these accidents would be evaluated by the employing company and discussed with the contractor management. An assessment of contractor performance, which includes review of accident reports and observation of the work, should be taken into account when new contracts are being considered.