



Planning

Hazardous Industry Planning Advisory
Paper No 3

Risk Assessment



January 2011

HIPAP 3: Risk Assessment
© State of New South Wales through the Department of Planning
2011

23–33 Bridge Street
Sydney NSW Australia 2000
www.planning.nsw.gov.au

ISBN 978-0-73475-878-1
DOP HAZ_006

Disclaimer: While every reasonable effort has been made to ensure that this document is correct at the time of printing, the State of New South Wales, its agents and employees, disclaim any and all liability to any person in respect of anything or the consequences of anything done or omitted to be done in reliance upon the whole or any part of this document.

Foreword

Since the 1980s, the New South Wales Department of Planning has promoted and implemented an integrated approach to the assessment and control of potentially hazardous development. The approach has been designed to ensure that safety issues are thoroughly assessed during the planning and design phases of a facility and that controls are put in place to give assurance that it can be operated safely throughout its life.

Over the years, a number of Hazardous Industry Advisory Papers and other guidelines have been issued by the Department to assist stakeholders in implementing this integrated assessment process. With the passing of time there have been a number of developments in risk assessment and management techniques, land use safety planning and industrial best practice.

In recognition of these changes, new guidelines have been introduced and all of the earlier guidelines have been updated and reissued in a common format.

I am pleased to be associated with the publication of this new series of Hazardous Industry Advisory Papers and associated guidelines. I am confident that the guidelines will be of value to developers, consultants, decision-makers and the community and that they will contribute to the protection of the people of New South Wales and their environment.

A handwritten signature in black ink that reads "S Haddad". The signature is written in a cursive style with a horizontal line underneath the name.

Director General

Contents

Executive Summary	v
1 Introduction	1
1.1 Background	1
1.2 Purpose and Scope of the Guidelines	1
2 Requirements	3
2.1 Risk-based Land Use Safety Planning	3
2.2 Principles of Application	7
2.3 The Assessment Process	8
2.4 Operating Phase Requirements	12
3 Implementation	13
3.1 Guidance Notes	13
Appendix 1	14
Potentially Hazardous Development	14
Appendix 2	15
Sample Hazard Identification Word Diagram	15
Appendix 3	17
EIS Considerations for Potentially Hazardous Development	17
Appendix 4	19
Conditions of Consent for Potentially Hazardous Development	19
List of Figures	
Figure 1: The Hazards-Related Assessment Process	vi
Figure 2: Basic Methodology for Hazard Analysis	4
Figure 3: Example of Individual Fatality Risk Output	6
Figure 4: Example of Societal Risk Output	7

Executive Summary

Background

The orderly development of industry and the protection of community safety necessitate the assessment of hazards and risks. The Department of Planning has formulated and implemented risk assessment and land use safety planning processes that account for both the technical and the broader locational safety aspects of potentially hazardous industry. These processes are implemented as part of the environmental impact assessment procedures under the Environmental Planning and Assessment Act 1979.

The Department has developed an integrated assessment process for safety assurance of development proposals, which are potentially hazardous. The integrated hazards-related assessment process comprises:

- a preliminary hazard analysis undertaken to support the development application by demonstrating that risk levels do not preclude approval;
- a hazard and operability study, fire safety study, emergency plan and an updated hazard analysis undertaken during the design phase of the project;
- a construction safety study carried out to ensure facility safety during construction and commissioning, particularly when there is interaction with existing operations;
- implementation of a safety management system to give safety assurance during ongoing operation; and
- regular independent hazard audits to verify the integrity of the safety systems and that the facility is being operated in accordance with its hazards-related conditions of consent.

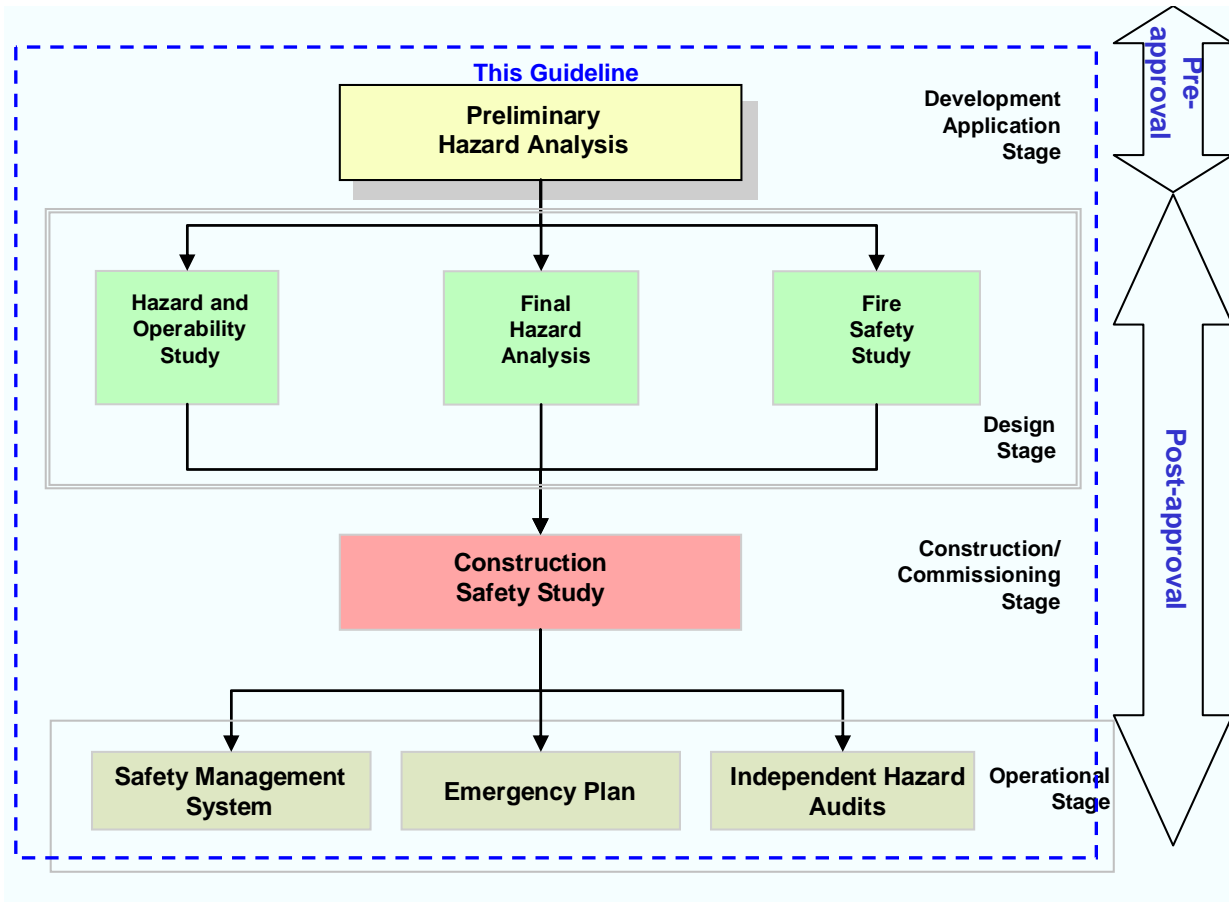
The process is shown diagrammatically in Figure 1.

A number of *Hazardous Industry Advisory Papers (HIPAPS)* and other guidelines have been published by the Department to assist stakeholders in implementing the process. All existing HIPAPs have been updated or completely rewritten and three new titles (HIPAPs 10 to 12) have been added.

A full list of HIPAPs is found at the back of this document.

The part of the process covered by this guideline is highlighted in Figure 1.

Figure 1: The Hazards-Related Assessment Process



The Land Use Safety Planning Framework

These guidelines describe the overall land use safety planning framework for potentially hazardous industrial developments. They provide advice relevant to developers, consultants, local and State government, and the community.

The guidelines outline considerations for siting a potentially hazardous development and describe the assessment studies which need to be carried out at various stages of the development process - from concept, through initial design and examination of environmental impact, to detailed design and operation.

A more detailed discussion of land use safety planning issues is found in HIPAP 10: *Land Use Safety Planning*.

The environmental risk impact assessment requirements outlined in the guidelines are as shown above in Figure 1. They include:

- A preliminary hazard analysis study to be undertaken at an early stage of a project and as part of the development application and environmental impact statement (EIS) processes. The study should:
 - identify all potential hazards
 - analyse both their effects on people and the environment and their probability of occurrence
 - following the principles of multi-level risk assessment, quantify resultant risk levels to surrounding land uses and environment where hazard identification has indicated potential for significant off-site risk. An assessment of resultant risk levels on a cumulative basis should be undertaken at the development

application stage to establish the suitability of the proposed location as well as the relevancy and adequacy of proposed safeguards.

- A hazard and operability study, fire safety study, emergency plan and an updated hazard analysis which are appropriate assessment studies and safety procedures to be undertaken as part of the detailed design of the proposed development. These studies should specifically relate to the particular development at the proposed location. The requirements for these studies may be adopted in part or in whole through conditions of consent (see Appendix 4).
- A construction safety study prepared to ensure safety during construction.
- Implementation of a comprehensive safety management system which incorporates independent hazard auditing at regular intervals during the operation of the development. This is appropriate to ensure continued safety of the development and of the development and of surrounding land uses.

Further details of the studies and systems are provided in the other guidelines in this series, which are listed at the back of this document.

The systematic approach summarised above has proved to be useful in securing safer plants at safer locations, in optimising resources and in ensuring the complementary implementation of the various safety regulations and requirements. Early consultation with the consent authority, and use of the risk assessment approach at the initial stage of site selection and project formulation, will maximise its benefits to all parties.

1 Introduction

SECTION SUMMARY

Locational safety considerations and land use planning have long been an essential part of risk management in NSW and *State Environmental Planning Policy No. 33 (SEPP 33) - Hazardous and Offensive Development* specifically requires a formal assessment of hazards and risks to accompany all applications for potentially hazardous development.

These guidelines provide an overview of the NSW assessment framework for potentially hazardous development.

1.1 Background

Government, industry and the community now recognise the need to identify, assess and control the risks to people and the environment which come from potentially hazardous industries. Appropriate siting and comprehensive environmental and risk impact assessment are therefore essential in ensuring orderly development which, at the same time, secures the safety of people and the environment.

For many years, locational safety considerations and land use planning have been an essential part of risk management in NSW. Risk assessment procedures for development projects of a potentially hazardous nature have been formulated and implemented in NSW since the mid-1980s. This has been an integral part of the overall development approval procedures under the Environmental Planning and Assessment Act 1979 (the Act).

These procedures have been refined over the years to:

- reflect new experience
- optimise resource use
- ensure the integration and coordination of land use safety requirements with other engineering and technical safety controls.

1.2 Purpose and Scope of the Guidelines

These guidelines are designed to broadly inform decision makers - particularly local councils – as to the range of issues that should be considered in the assessment of risks associated with possible accidents at a facility. The guidelines also indicate the range of conditions which may be appropriate to impose should development consent be granted.

Although many of the principles in these guidelines can be applied to existing industry of a potentially hazardous nature, their main focus and scope of application is on proposed development projects, including major projects falling within Part 3A of the Act and designated development falling within Part 4 of the Act.

In particular, they apply to development which is subject to *State Environmental Planning Policy No. 33 (SEPP 33) - Hazardous and Offensive Development*. If a development under SEPP 33 has potential for risk impact, a preliminary hazard analysis is required to be prepared and considered before approval is given.

SEPP 33 introduces a systematic approach to the consideration of hazards when planning for industrial developments. Through the policy, a link is made between the permissibility of a proposal and its environmental and safety performance. The policy also introduces a new definition for hazardous industry as well as the concept of

potentially hazardous industry (see Appendix 1). These definitions are based on consideration of the specific hazards of a particular project, rather than a generic industry classification.

The principal focus of these guidelines is off-site risk impacts; that is, impacts outside the boundaries of a proposed facility which affect people, the environment, property and surrounding land uses. The guidelines specifically apply to atypical and abnormal hazardous events and conditions. They are not intended to apply to continuous or normal operating emissions of air or water pollutants which are more appropriately dealt with by pollution control mechanisms and legislation. It should be noted, however, that consideration of the impact of such emissions is a routine part of environmental impact assessment of development proposals.

These guidelines provide an overview of the assessment framework for potentially hazardous development. They are not intended to be used alone but rather, in conjunction with the other more detailed advisory papers published by the Department (see page 22).

2 Requirements

SECTION SUMMARY

Here you will find a summary of the main elements of the assessment framework for potentially hazardous development. The section summarises and provides the context for the detailed guidance found in the individual HIPAPs.

Rather than relying primarily on the application of safety standards and codes of practice, the approach is one of identifying hazards, assessing risks in the light of surrounding land uses and applying locational, technical and management controls through conditions of consent to ensure ongoing level of safety. Topics covered include:

- hazard analysis and risk assessment principles;
- safety assurance requirements during the design, construction and operational phases of a development; and
- summaries of the various studies and systems that form part of the safety assurance process.

KEY MESSAGE

- Safety assurance requires a systematic analysis and assessment of the hazards and risks posed by a development and the application of tailored locational, technical and management controls.

2.1 Risk-based Land Use Safety Planning

In the past, the decision-making process concerning the location and safety of potentially hazardous installations and surrounding land uses relied almost entirely on technical engineering standards, codes and associated safety controls.

That approach was based on the belief that such engineering safety controls can adequately cope with all hazards. Broader land use planning aspects - including the nature and extent of existing and future land uses - were largely ignored.

In many cases worldwide, this approach has meant that potentially hazardous industries have been developed close to residential, recreational and other environmentally sensitive areas.

Since the 1970's, however, there has been an increase in environmental and safety awareness, spurred on by an increasing number of reported industrial accidents and incidents with major consequences. There has also been a fundamental recognition of the practical, technological and economic constraints and limitations of engineering safety controls when applied in isolation. As a result, tools such as hazard analysis and risk assessment were developed, initially to address issues of a technical nature. These tools were subsequently applied in land use planning. Their use involves a formal identification of the relevant hazards and quantification of the consequences (effects) and probability (likelihood) of possible hazardous incidents.

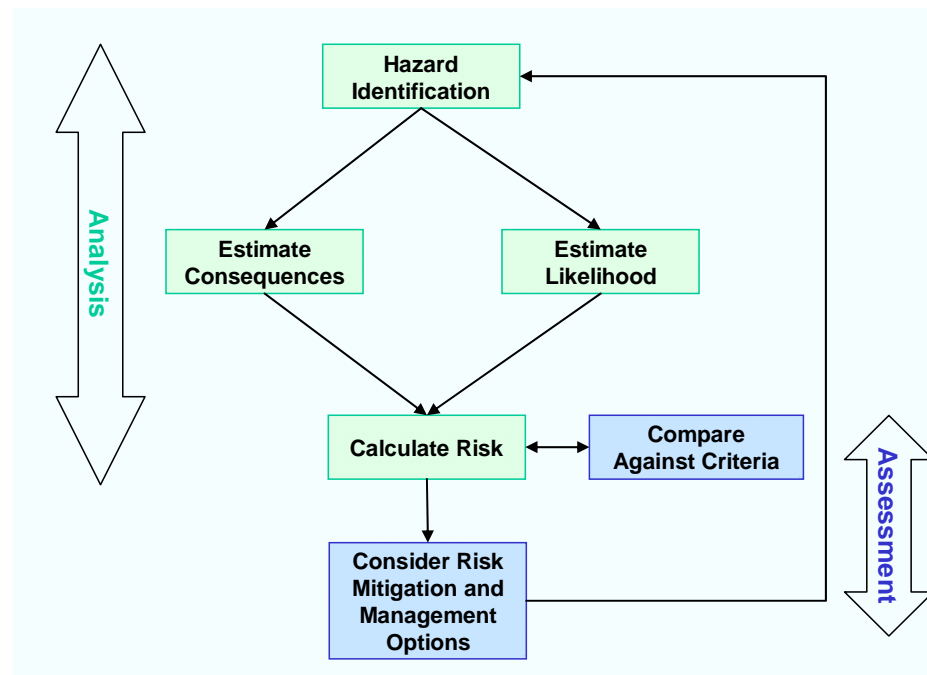
The hazard analysis and risk assessment approach acknowledges the fact that hazard and risk (defined in terms of both the consequence and likelihood of hazardous events) from activities involving hazardous materials cannot be entirely eliminated. There will always be a 'residual' risk which in many cases will extend beyond site boundaries. It is necessary to understand the nature of this residual risk and to formulate and implement land use strategies and controls to cope with it.

Decisions concerning the location of a hazardous materials facility and surrounding land uses are planning decisions and, properly implemented, land use planning becomes an essential and integral component of hazard and risk management. In this process, land use safety conflicts are prevented by identifying and qualifying risks associated with a particular site, quantifying risks with the potential for off-site impacts and managing significant hazards in the context of broader considerations.

Land use safety planning principles are discussed in greater detail in HIPAP 10: *Land Use Safety Planning*.

The basic methodology of hazard analysis and quantified risk assessment is illustrated in Figure 2. In applying requirements for hazard analysis and quantified risk assessment, the Department has advocated a merit-based approach. That is, that **the level and extent of analysis must be appropriate to the hazards present and therefore, need only progress to the extent necessary for the particular case.** The principles of this approach are outlined in *Multi-Level Risk Assessment*.

Figure 2: Basic Methodology for Hazard Analysis



Five elements are involved in hazard analysis: hazard identification; consequence estimation; likelihood estimation; risk assessment; and assessment of risk reduction options.

Hazard identification involves the systematic identification of hazardous events, their potential causes and the consequences (in qualitative terms) of such events. Reference is also made to the proposed operational and organisational safeguards that would prevent such hazardous events from occurring or, should they occur, that would protect the plant, its equipment, people and the environment. This process enables the establishment, at least in principle, of the adequacy and relevancy of proposed safeguards.

The Department's publication *Applying SEPP 33* provides screening guidelines to assist in determining whether hazardous development poses significant risks to surrounding land uses. Risks identified as having significant off-site impacts may require more detailed, quantitative analysis, according to multi-level risk assessment.

Consequences Estimation relates to the assessment of the effects of potentially hazardous incidents associated with the operations of a proposed development. Mathematical models and computerised tools are available to enable the estimation of the effect of such incidents as fires, explosions or the release of toxic substances on the people, buildings and the environment.

It is essential to take into account the likelihood that hazardous incidents, while possible, may in fact never occur during the operating life of the development. This is because of the availability of design, standards of the construction and other operational safety controls which would prevent their occurrence. Estimating

consequences is therefore not in itself sufficient for determining the location and assessment of potentially hazardous facilities.

The assessment process must, however, fully account for the likelihood or probability of hazardous incidents occurring, as well as for the likelihood of the effects of such incidents. Likelihood estimation is therefore necessary.

Likelihood Estimation involves the derivation of both the probability of incidents occurring and the probability of particular outcomes (or effects) should those events occur. For example, in the case of toxic gas storage, probability of failure of items such as storage vessels, transfer pipes and pumps with the resultant releases should be established. The frequency of such elements as wind and stability conditions is also necessary to determine the probability of concentrations in the air or water, and hence of fatality, injury or other effects of exposure of people or the environment.

The consequence and likelihood estimations are cumulatively combined for the various hazardous incident scenarios and events to give a quantified risk level. Quantified risk assessment need only be performed if, according to the principles outlined in Multi-Level Risk Assessment, full or partial quantification is warranted.

Risk results are most commonly expressed in terms of human fatality. The analysis and results can, however, also be expressed in other terms such as levels of injury, property damage or environmental damage.

Human fatality risk results are expressed in two forms, individual risk and societal risk. Individual risk is the risk of death to a person at a particular point. Societal risk is the risk of a number of fatalities occurring. Figure 3 is an example of individual fatality risk contour presentation, taken from the Department's 2007 *Kurnell Peninsula Land Use Safety Study*.

The societal risk concept is based on the premise that society is more concerned with incidents which kill a larger number of people than incidents which kill fewer numbers. Figure 4 is an example of a societal risk curve, taken from another land use safety study.

Figure 3: Example of Individual Fatality Risk Output

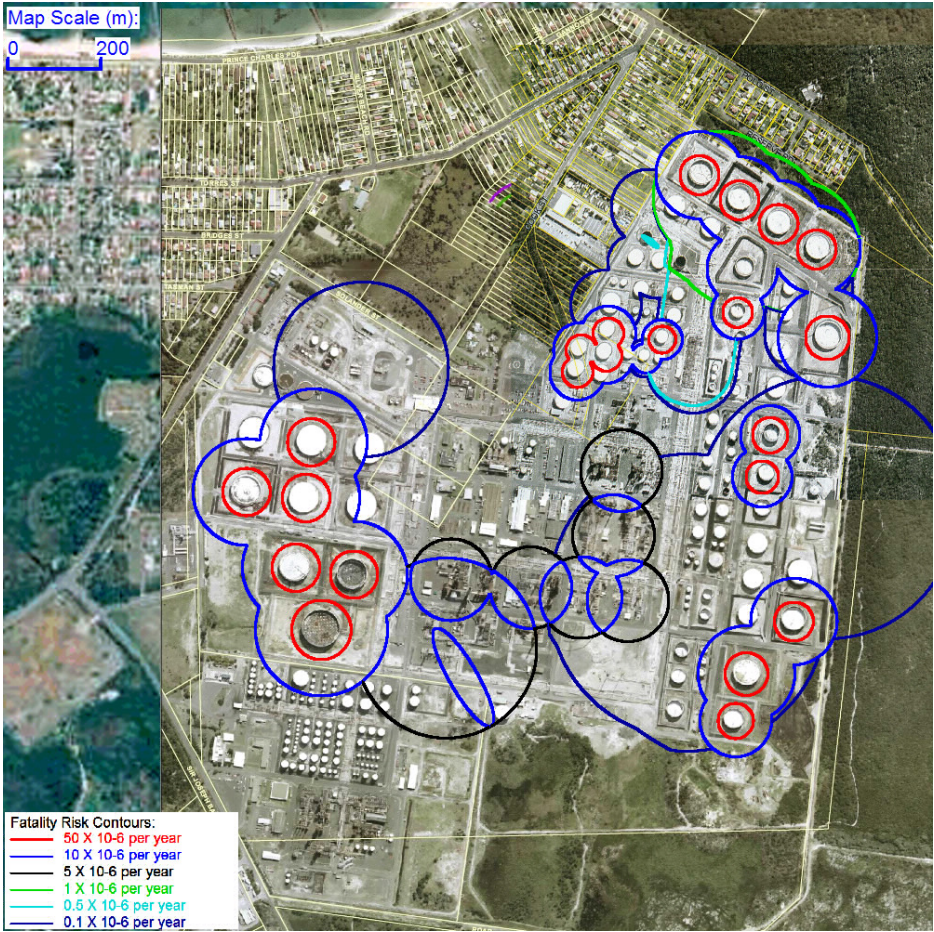
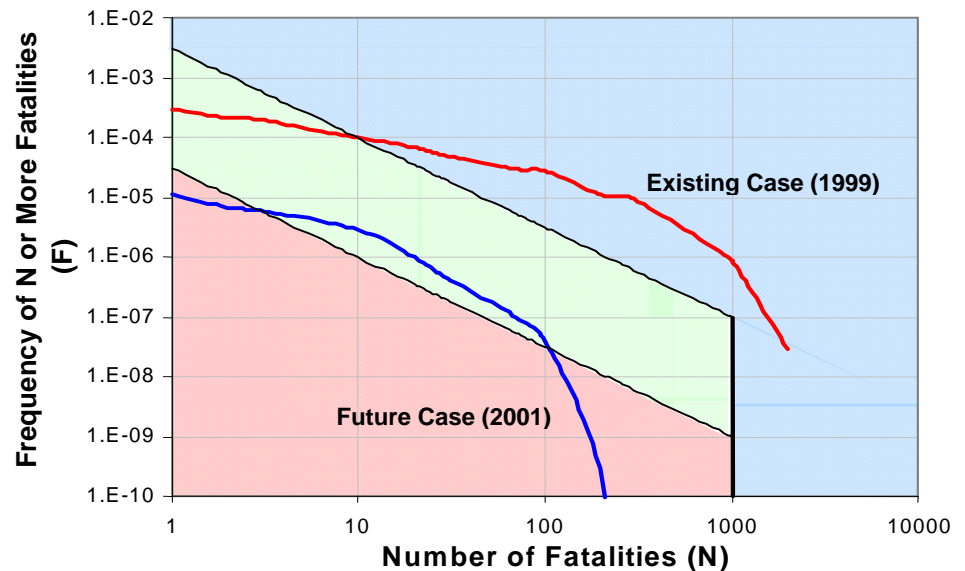


Figure 4: Example of Societal Risk Output

The qualitative and quantitative results of the analysis, depending on the level of analysis necessary, can be applied in the assessment process as follows:

- Risk impacts, at various distances from the proposed development and, on various land uses and the environment in the vicinity of the development, can be measured against land use safety planning criteria. A judgement can then be made about the suitability of the proposed development's location, in relation to existing and likely future land uses in the area. A general principle of assessment is that the risk impacts from the proposed development should be well below the levels of risk which people and the environment are regularly exposed to from other sources. Guidelines for safety planning criteria are provided in *Hazardous Industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Safety Planning*.
- The analysis should highlight, firstly, the major contributors to risk, their nature and extent; and, secondly, areas where risk can be eliminated or cost-effectively reduced. These results can be used to develop prevention and protection safeguards. One principle used here is that where safer alternatives are available, without significant technical or economic cost, they should be used regardless of the risk levels.

2.2 Principles of Application

- The integrated approach to risk assessment and management is based on the methodology outlined above and also in the following principles:
- It is necessary to identify hazards and in some cases quantify at an early stage of the project formulation and as an integral part of the site selection process.
- Formal hazard identification and analysis determine the risk contributors and also the relevancy of the proposed and their adequacy in mitigating impact for the specific development at the specific location.
- Quantified risk assessment determines off-site residual risk - risk to people, the environment and other land uses - while accounting for the effectiveness (as well as the limitations) of technical hazards control. Quantified risk assessment is therefore the central tool in determining the suitability of a proposed site to

accommodate a potentially hazardous activity and, as importantly, the strategic planning implications to surrounding land uses of such decisions.

- It is essential to account for the community's perception of risk in the location and assessment processes for potentially hazardous industry. Hazard analysis and multi-level risk assessment are valuable tools in communicating risk and accounting for community perception issues.
- It is necessary to ensure that safety requirements are accounted for through the complete development process for a potentially hazardous facility - including siting and feasibility study, design, construction and operation. It is also necessary for the requirements to cover both fixed safety equipment (hardware) as well as organisational safety measures (management, training, emergency planning, etc.)
- The safety requirements should ensure the efficient coordination of various statutory requirements to avoid duplication and maximise their complementary implication.

2.3 The Assessment Process

For development of a potentially hazardous nature early consultation with the council, the Department of Planning and other relevant authorities is encouraged.

The consent authority - usually the council - will need to consider whether the development is designated or otherwise covered by the provisions of the *Environmental Planning and Assessment Act 1979* requiring the preparation of an environmental impact statement (EIS). Where such a statement is required, the Department should be consulted and Director General's requirements for the scope and content of the EIS for the proposal will be issued.

The *Environmental Planning and Assessment Regulation 2000* outlines in general terms the requirements for the scope and content of EISs. If the designated development is potentially hazardous, the Director General's requirements will include the requirement for a preliminary hazard analysis to be prepared.

Where an EIS is not required, but the proposal is still considered potentially hazardous, SEPP 33 requires a preliminary hazard analysis to be prepared. Council or other consent authorities have to determine the extent to which the whole or parts of the process set out here should be applied. Such authorities may wish to consult the Department on this and should have regard to relevant circulars and advisory documents.

Under section 111 of the Act, a Part 5 determining authority must consider the environmental impact of proposals that it plans or regulates. If the authority considers that an assessment of hazards issues is relevant to its environmental considerations, it could use the assessment procedure included in SEPP 33 to assess these issues as well as the advice in this document.

2.3.1 The Preliminary Hazard Analysis

The first element of the environmental risk assessment process is the preliminary hazard analysis (PHA). This should be undertaken as part of the EIS where an EIS is required or as a stand-alone PHA in the case of SEPP 33. PHA is preliminary in the sense that detailed design information is not available at this stage.

The PHA involves a comprehensive hazard identification including the identification of hazardous incident scenarios and reference to the proposed operational and organisational safeguards.

These should be carefully and clearly documented with assumptions and uncertainties (in terms of final design and operation) spelled out.

The results of hazard identification in the context of a preliminary hazard analysis are usually presented in the form of a table or word diagram. Appendix 2 is an example of a hazard identification word diagram.

It is necessary for the preliminary hazard analysis to document (separately) the results of consequence computations for all hazardous scenarios and to include all major and minor hazardous incidents that could potentially occur as the result of facility operations. Consequence estimation should also relate to the hazard identification table and cover all incidents identified through the hazard identification process.

The likelihood estimation should involve the analysis and estimation of the probability of each incident scenario being translated into particular outcomes, having regard to all the proposed technical, organisational and operational safety controls.

Generally, the failure frequency information related to various plant items may be based on generic data applicable to similar equipment under similar operating environments. In some cases, however, proponents may adopt failure frequency data that vary from such generic data. In such cases, a full justification of the data used should be provided as part of the study.

The results of the consequence and likelihood estimation should be combined and the risk results presented in the form of contours, societal risk curves or other appropriate format. The results should address, where appropriate, impacts on people, property and the environment.

The consent authority should be able, from the PHA and other relevant information, to assess whether the proposed development is capable of operation and is likely to be operated by the particular proponent in the particular location without unacceptable risk impacts.

Other land use safety related issues that should be addressed in a PHA include:

- a comprehensive description of all proposed safeguards and hazards control systems, with particular emphasis on the relevancy and effectiveness of such safeguards
- a comprehensive outline of organisational safety controls including: the principles of emergency procedures and plans; fire prevention and protection measures; and, monitoring, auditing, operators' training and safety management systems.

2.3.2 Development Consent Requirements

It is essential that the safety assessment process continues throughout the design, construction and commissioning of a potentially hazardous facility to refine and update the outcome of the development approval/ environmental risk assessment process.

The following requirements are recommended for inclusion in the overall safety assurance process through conditions attached to development consent:

- Four studies should be done at the detailed design stage:
 - (a) the hazard and operability study
 - (b) the fire safety study
 - (c) the preparation of an emergency plan and procedures
 - (d) the final (updated) hazard analysis.

These studies are best carried out at this stage to optimise the safety of the final development. Ideally, they should be carried out concurrently and interactively; that is, the output of one study should be used as an input to the others and all in turn as inputs to the design refinement process.

- Prior to the commencement of any construction:
 - (a) a formalised construction safety program should be documented by the company and submitted for approval.

(a) Hazard and Operability Study (HAZOP)

At the design stage of the development project, when detailed design information is available, hazard and operability (HAZOP) studies are required as an integral part of the design process.

HAZOP studies are one particular form of hazard identification. They involve the comprehensive and systematic examination of the facility, section by section (usually on the basis of the flow/ piping and instrumentation diagrams) and in most cases using 'guide words'.

HAZOP studies are carried out by a team which should be chaired and coordinated by a qualified person independent of the developer. Design engineers and personnel who will operate the facility should form part of the HAZOP study team.

This examination identifies possible deviations from normal operating conditions which could lead to hazardous occurrences. The consequences and likelihood of such deviations are examined. Also, the adequacy and relevancy of available safeguards to detect such deviations and prevent/ or protect against their resultant effects are evaluated in detail. This process enables a comprehensive evaluation of hazard control systems and produces recommendations for any necessary modifications.

It is essential that the HAZOP relates to the preliminary hazard analysis and risk assessment undertaken at the development approval stage. Information from the hazard analysis relating particularly to the consequences of various hazardous incidents and to risk contributors should be used as an integral part of the HAZOP process. Where appropriate, the input should also be drawn from the fire safety study and emergency plan preparation.

HAZOP studies should be completed and approved prior to the commencement of substantial construction on-site and certainly before the completion of design. Guidelines for HAZOP studies are provided in *Hazardous Industry Planning Advisory Paper No. 8 - Hazard and Operability Studies*.

(b) Fire Safety Study

A fire safety study's objective is to ensure that the proposed fire prevention, detection, protection and fighting measures are appropriate for the specific fire hazard and adequate to meet the extent of potential fires for the development at the particular location.

These studies involve case specific hazard analysis and design of fire safety arrangements to meet that hazard so that fire systems design does not rely on the application of general codes and standards in isolation. The case specific approach offers the benefit that fire safety measures can be tailor-made and cost effective.

The fire safety study should be concerned with all the effects of fire. It therefore should not only address the direct effects of flame, radiant heat and explosion but also the potential for the release of toxic materials and combustion products in the event of fire and the potential for the release of contaminated fire fighting water.

The results of HAZOP, PHA and updated hazard analysis should provide the basis for fire safety requirements. The relationship between fire safety systems and emergency plans and procedures should be clear. The *Hazardous Industry Planning Advisory Paper No. 2 - Fire Safety Study Guidelines*, published jointly by the Department of Planning and Fire and Rescue NSW, details the relevant scope, content and procedures.

the safety studies should be prepared and approved by the Fire Prevention Unit of Fire and Rescue NSW in liaison with the relevant local council. They should be done at an early stage - prior to substantial construction on-site and certainly well before the start of operations.

(c) Emergency Procedures and Plans

The ongoing safety of a development of a potentially hazardous nature necessitates the preparation of plans and procedures to deal with emergencies.

Emergency planning can both reduce the likelihood and the magnitude of potentially hazardous incidents and reduce the consequences of incidents which do occur. The range of possible incidents involving potentially hazardous industries can be large. The smallest, if promptly detected and dealt with, will have virtually no adverse effects. If

allowed to grow, however, incidents may have serious consequences both on and off the site.

Emergency planning can reduce the likelihood of incidents by ensuring that when potentially dangerous situations develop the response is both quick and appropriate. The magnitude can be reduced through early control which, for example, limits the size of a spill or fire. The consequences of any given incident can be reduced by such measures as control, evacuation and clean up.

It is essential that emergency procedures and plans not be of a generalised nature, but be specifically developed and tailored to the needs and hazards at each facility, and at each locality. Hazard analysis and HAZOP should provide the basis of hazard identification and the nature and extent of consequences for the formulation of relevant emergency procedures; and, resource requirements and their implications. The results of the fire safety study should also be used as an input.

The *Hazardous Industry Planning Advisory Paper No. 1 - Industry Emergency Planning Guidelines* published by the Department of Planning provides a comprehensive outline of the scope and content of emergency plans and guidance for their preparation by industry.

Formalised emergency plans should be prepared and approved before the commencement of operations.

(d) Updated Hazard Analysis and Risk Assessment (Final Hazard Analysis)

Throughout the detailed design phase, regard should be given to the effect of design and procedures decisions and modification on hazard and risk as assessed in the preliminary hazard analysis.

When detailed HAZOP, fire studies and emergency plans are completed, the design finalised, and the safety control systems determined to a final stage, the preliminary hazard analysis and risk assessment should be updated. The final hazard analysis and risk assessment should follow the same principles as the preliminary studies, but assumptions and results reworked to fully account for the detailed design information and precise safeguards. The principles of multi-level risk assessment apply to the final hazard analysis, as with the preliminary studies.

The final hazard analysis should determine risk levels to be used as the basis for future plant operations, updates, extensions, etc. Refinement to earlier safety control commitments should result in improvements to the risk levels. The risk impact should improve upon that predicted as part of the decision making process to approve the whole plant, and should in all cases not be significantly worse. *Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis* should be used as a basis for hazard analyses.

Updated (final) hazard analysis and risk assessment studies should be finalised and approved before the commencement of any operations.

(e) Construction Safety

A construction safety study should result in formalised arrangements which ensure during the construction phase the safety of workers and of surrounding land uses. These studies should focus on the potential for hazardous materials incidents.

Construction safety codes and regulations are available and must be complied with. Company procedures covering hot and cold work permits are also governed by regulations.

In terms of land use safety planning, however, more specific procedures are appropriate, particularly for cases where construction involves the modification of existing facilities or the construction of new plants near existing operating hazardous facilities. In such cases in particular, formal procedures should be established and documented to account for potentially hazardous incidents and interaction.

Provision should be made, for example, to ensure atmospheric testing before certain construction activities involving welding or cutting take place. The study should cover

commissioning operations, as outlined in *Hazardous Industry Planning Advisory Paper No. 7 - Construction Safety Study Guidelines*.

2.4 Operating Phase Requirements

It is essential that the continuing safety of the plant and its operations be ensured through a comprehensive safety management system, which incorporates periodic hazard auditing during the operational stage of the plant. Implementation of a safety management system and auditing should therefore be required by way of conditions of consent.

The safety management system will include safety policy, organisational structure and responsibilities, emergency and operating procedures, document control, change management procedures and performance auditing.

Safety audits are most efficient and reliable when undertaken by an independent third party. The frequency of auditing would vary depending on the nature of the plant, its location and the corporate safety philosophy and performance of the organisation. In all cases, however, it is essential that the first safety audit be undertaken towards the end of the first year of operation. It is advisable that subsequent safety audits be undertaken at least every second year.

Other post-operation safety requirements which are also inputs to the audits include:

- monitoring of the operation's critical safety parameters and maintaining adequate records of monitoring outputs;
- documented maintenance programs and maintenance records;
- and recording and analysis of hazardous incidents, accidents and near-misses in a readily accessible format. Further details of safety management systems can be found in *Hazardous Industry Planning Advisory Paper No. 9 - Safety Management*.

The regular review, revision and update of operating and maintenance procedures, emergency plans and procedures and other documentation relevant to safety is also essential.

3 Implementation

SECTION SUMMARY

The guidance notes in this section emphasise the importance of an integrated framework when assessing the environmental impacts of potentially hazardous development.

The notes highlight the role of conditions of consent in ensuring that safety is maintained throughout the operating life of a facility.

3.1 Guidance Notes

The process described in these guidelines and summarised above in Figure 1 has been developed to ensure the integration of the various components of the risk assessment process for potentially hazardous development into one overall framework. The framework covers the safety assessment requirements for a facility from the conceptual, locational and environmental impact assessment and development application stages through to its design, construction and ongoing operation.

In implementing the various requirements, the following principles should be noted:

For potentially hazardous development, SEPP 33 requires that a preliminary hazard analysis (PHA) should be prepared at the development application stage. The PHA should be viewed as integral to those matters that need to be considered under section 79C of the Environmental Planning and Assessment Act 1979 and the Assessment Regulation 2000 (particularly schedule 2).

Consent authorities should ensure that statements of environmental effects, environmental impact statements and PHAs for potentially hazardous activities cover the issues outlined in Appendix 3 that are relevant to the proposed development.

For designated development, requirements issued by the Director General of Planning as part of the necessary consultation process for EIS preparation will typically include the matters outlined in that appendix. The same is true of the Director General's requirements for the preparation of an Environmental Assessment (EA) for major projects determined under Part 3A of the Environmental Planning and Assessment Act 1979.

The requirements for hazard and operability (HAZOP) studies, fire studies, emergency procedures, construction safety, updated hazard analysis, hazard audit and associated requirements should be addressed by way of conditions attached to any consent or approval issued for a development project of a potentially hazardous nature. Appendix 4 gives an example of relevant conditions of consent.

The Department's Hazardous Industry Planning Advisory Papers and the other publications listed at the end of these guidelines should be consulted for more detailed guidance on individual components of the assessment process.

Appendix 1

Potentially Hazardous Development

State Environmental Planning Policy No. 33 (SEPP 33) - Hazardous and Offensive Development provides definitions for 'potentially hazardous industry', 'hazardous industry' and 'hazardous storage'. The policy requires specific matters to be considered by authorities for development proposals which are potentially hazardous as defined by the policy. The Department of Planning has published guidelines on the application of SEPP 33, which include advice on how to identify potentially hazardous industry.

The definitions used by SEPP 33 include:

Potentially hazardous industry means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:

- a. to human health, life or property; or
- b. to the biophysical environment, and includes a hazardous industry, and a hazardous storage establishment.

Hazardous industry means a development for the purposes of an industry which, when the development is in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the development from existing or likely future development on other land in the locality), would pose a significant risk in relation to the locality:

- (a) to human health, life or property; or
- (b) to the biophysical environment.

Hazardous storage establishment means any establishment where goods, materials or products are stored which, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the establishment from existing or likely future development on the other land in the locality), would pose a significant risk in relation to the locality:

- (c) to human health, life or property; or
- (d) to the biophysical environment.

For development proposals classified as potentially hazardous industry, the policy establishes a comprehensive test by way of a preliminary hazard analysis to determine the risk to people, property and the environment in the presence of controls at the proposed location.

Appendix 2

Sample Hazard Identification Word Diagram

Facility/Event	Cause/Comment	Possible Results/ Consequences	Prevention/Detection Protection Required
TANK FARM			
Petroleum tank fire	Static electricity build up and spark due to fast filling. Pressure vent valve fails, tank roof fails and ignition.	Tank roof may fail, fire of entire roof area. If not controlled or extinguished may involve other tanks in same compound	Pressure vent valves checked prior to fill/discharge. Foam injection system in all class 3(a) tanks. Water cooling system on each tank.
Petroleum bund fire	Corrosion tank base/floor. Pipeline/ pump leakage/rupture. Tank overfilled.	Leakage of tank contents into bund. If ignited may result in pool or bund fire.	Tanks cleaned, inspected, integrity tested annually. Adequate foam stocks on site. High level alarms to be provided on all storage tanks. Foam/ monitors to be provided in and around bund compound.
Petro-chemical tank(s) (cool fire)	Adjacent tank fire or bund fire heating tank contents to decomposition.	Emission of toxic products or vapours. Downwind effects depend on toxicant released and wind/stability conditions.	Tanks placed in separate bund. Cooling system on all tanks.
LPG ROAD TANKER FACILITY			
Flexible hose failure	Road tanker drives away while still connected. Third party damage or excessive wear.	Gas disperses. If ignited may result in flash fire. Impact local.	Fixed deluge system at road tanker bay. Scully system on tanker loading.
Pipe failure	Mechanical impact. Corrosion.		Area drained. Gas detectors around perimeter of LPG area.

Facility/Event	Cause/Comment	Possible Results/ Consequences	Prevention/Detection Protection Required
WAREHOUSE DANGEROUS GOODS STORE			
Warehouse fire	Wiring not flameproof. Handling equipment not intrinsically safe. Shrink wrapping fired by LPG, undertaken on site. Arson. Lighting not intrinsically safe. Unsafe storage of drums.	Fire involving warehouse contents. Exploding drums/ packets depending on material stored. Toxic combustion products evolved.	All products segregated by class. Thermal/ smoke detectors provided, linked to alarm and local fire station. Warehouse sprinkler system provided. Area bunded. Flameproof wiring used in dangerous goods store. Diesel forklifts only. Security firm employed after hours. All lighting intrinsically safe. Drum storage racked or drum height restricted.
LPG STORAGE			
Catastrophic vessel failure	Direct flame impingement on tank, from pipes, tank fittings or pump failure and ignition.	Pressure inside tank rises, if fire not extinguished, vessel may weaken and fail resulting in a BLEVE/ fireball. Damage widespread.	Vessel fitted with pressure relief valves, discharge vertical to atmosphere. Deluge system. Isolation valves fitted to all main liquid lines. Pump shut-off at two locations.
Large leak	Mechanical impact. Corrosion. Failure of tank or associated fittings, pump or pipework and ignition.	On dispersion, vapour may form a gas cloud. If ignited, may result in UVCE or flash fire.	Isolation valves on all main liquid lines. Pump shut-offs at two locations, local and remote. Gas detection on perimeter of LPG area. Fog nozzles provided. Crash barriers provided around tank.

Appendix 3

EIS Considerations for Potentially Hazardous Development

An environmental impact statement (EIS) for a development project of a potentially hazardous nature is required to address the following risk assessment considerations as part of the requirements under the *Environmental Planning and Assessment Regulation 2000*.

A preliminary hazard analysis to be undertaken as part of the EIS in accordance with *Hazardous Industry Planning Advisory Paper No. 6: Guidelines for Hazard Analysis*. The analysis should include:

- a comprehensive identification of possible sources and causes of potentially hazardous incidents
- a detailed outline of all operational and organisational safety controls, and their basis
- quantification of the risks from the most relevant hazardous incidents identified above
- an assessment of cumulative risk expected from the proposed development and safety implications for surrounding land uses
- a comparison of expected risks against risk criteria set out in *Hazardous Industry Planning Advisory Paper No. 4: Risk Criteria for Land Use safety Planning*
- an assessment of the adequacy of the proposed safeguards in controlling and minimising risks.

In addition, the EIS should include:

- an outline of emergency/ counter-disaster principles for the installation and commitments that any existing procedures will be reviewed and updated before commissioning
- commitments that hazard and operability studies will be undertaken as an integral part of the design
- a comprehensive description of fire prevention and protection measures with details of the basis upon which they have been formulated
- commitments that a detailed fire safety study will be undertaken as part of the design
- criteria used in selecting the proposed site and justification of that selection, (particularly in terms of safety and pollution issues), including consideration of feasible alternatives to the proposal and reasons for their rejection
- a brief description of the type of machinery and equipment to be used
- a description of the safety, pollution and environmental controls incorporated into the plant and process design (including pollution and environmental monitoring), and details of the quantities and types of any emissions (to water or air) proposed
- details of quantities produced, used and stored, and storage arrangements of raw materials and products from the plant, with safeguards proposed to control their impact in the environment, in particular the storage of toxic or hazardous chemicals
- transportation arrangements including means of access to the site, details of on-site parking and loading/ unloading and mode of transport proposed for receiving

raw materials and dispatch of products, including details of proposed transport routes carrying significant quantities of these materials

- an outline of safety management systems to be adopted and commitments that a comprehensive safety management system will be developed before commencement of operations.

Appendix 4

Conditions of Consent for Potentially Hazardous Development

Note: The following standard conditions of consent are taken from *HIPAP 12: Hazards-Related Conditions of Consent*. They should be applied in accordance with those guidelines. In particular, Table 2 of HIPAP 12 should be consulted in deciding which of the following conditions should be imposed.

HIPAP 12 includes suggested conditions of consent for three categories of development:

1. Low Hazard
2. Medium Hazard
3. High Hazard

Section 2.3 of HIPAP 12 sets out principles for deciding into which category a particular project falls. Conditions of consent should be tailored to be “fit-for-purpose” in addressing both the category of development and its hazards and risks. The following conditions of consent are for a medium hazard development determined by Council.

Pre-construction

1. At least one month prior to the commencement of construction of the proposed development (except for construction of those preliminary works that are outside the scope of the hazard studies), or within such further period as Council may agree, the Applicant shall prepare and submit for the approval of Council the studies set out under subsections (a) to (d) (the pre-construction studies). Construction, other than of preliminary works, shall not commence until approval has been given by Council and, with respect to the Fire Safety Study, approval has also been given by Fire and Rescue NSW.
 - (a) **FIRE SAFETY STUDY**
A Fire Safety Study for the proposed development. This study shall cover the relevant aspects of the Department of Planning’s Hazardous Industry Planning Advisory Paper No. 2, ‘Fire Safety Study Guidelines’ and the New South Wales Government’s ‘Best Practice Guidelines for Contaminated Water Retention and Treatment Systems’. The study shall also be submitted for approval to Fire and Rescue NSW.
 - (b) **HAZARD AND OPERABILITY STUDY**
A Hazard and Operability Study for the proposed development, chaired by an independent qualified person approved by Council prior to the commencement of the study. The study shall be carried out in accordance with the Department of Planning’s Hazardous Industry Planning Advisory Paper No. 8, ‘HAZOP Guidelines’. The study report must be accompanied by a program for the implementation of all recommendations made in the report. If the Applicant intends to defer the implementation of a recommendation, justification must be included.
 - (c) **FINAL HAZARD ANALYSIS**
A Final Hazard Analysis of the proposed development prepared in accordance with the Department of Planning’s Hazardous Industry Planning Advisory Paper No. 6, ‘Hazard Analysis’.

(d) CONSTRUCTION SAFETY STUDY

A Construction Safety Study prepared in accordance with the Department of Planning's Hazardous Industry Planning Advisory Paper No. 7, 'Construction Safety'. For developments in which the construction period exceeds six (6) months, the commissioning portion of the Construction Safety Study may be submitted two months prior to the commencement of commissioning.

Pre-commissioning

2. The Applicant shall develop and implement the plans and systems set out under subsections (a) to (c). No later than two months prior to the commencement of commissioning of the proposed development, or within such further period as Council may agree, the Applicant shall submit for the approval of Council documentation describing those plans and systems. Commissioning shall not commence until approval has been given by Council.

(a) TRANSPORT OF HAZARDOUS MATERIALS

Arrangements covering the transport of hazardous materials including details of routes to be used for the movement of vehicles carrying hazardous materials to or from the proposed development. The routes shall be selected in accordance with the Department of Planning's Hazardous Industry Planning Advisory Paper No. 11, 'Route Selection'. Suitable routes identified in the study shall be used except where departures are necessary for local deliveries or emergencies.

(b) EMERGENCY PLAN

A comprehensive Emergency Plan and detailed emergency procedures for the proposed development. This plan shall include detailed procedures for the safety of all people outside of the development who may be at risk from the development. The plan shall be in accordance with the Department of Planning's Hazardous Industry Planning Advisory Paper No. 1, 'Emergency Planning'.

(c) SAFETY MANAGEMENT SYSTEM

A document setting out a comprehensive Safety Management System, covering all on-site operations and associated transport activities involving hazardous materials. The document shall clearly specify all safety related procedures, responsibilities and policies, along with details of mechanisms for ensuring adherence to the procedures. Records shall be kept on-site and shall be available for inspection by Council upon request. The Safety Management System shall be developed in accordance with the Department of Planning's Hazardous Industry Planning Advisory Paper No. 9, 'Safety Management'.

Pre-startup

3. PRE-STARTUP COMPLIANCE REPORT

One month prior to the commencement of operation of the development, the Applicant shall submit to Council, a report detailing compliance with conditions 1 and 2, including:

- (a) dates of study/plan/system submission, approval, commencement of construction and commissioning;
- (b) actions taken or proposed, to implement recommendations made in the studies/plans/systems; and
- (c) responses to each requirement imposed by Council under condition 7.

Post-startup**4. POST-STARTUP COMPLIANCE REPORT**

Three months after the commencement of operation of the development, the Applicant shall submit to Council, a report verifying that:

- (a) transport routes specified under condition 2(a) are being followed;
- (b) the Emergency Plan required under condition 2(b) is effectively in place and that at least one emergency exercise has been conducted; and
- (c) the Safety Management System required under condition 2(c) has been fully implemented and that records required by the system are being kept.

Ongoing**5. INCIDENT REPORT**

Within 24 hours of any incident or potential incident with actual or potential significant off-site impacts on people or the biophysical environment, a report shall be supplied to the Department outlining the basic facts. A further detailed report shall be prepared and submitted following investigations of the causes and identification of necessary additional preventive measures. That report must be submitted to Council no later than 14 days after the incident or potential incident.

The Applicant shall maintain a register of accidents, incidents and potential incidents. The register shall be made available for inspection at any time by the independent Hazard Auditor and Council.

6. HAZARD AUDIT

Twelve months after the commencement of operations of the proposed development or within such further period as Council may agree, the Applicant shall carry out a comprehensive Hazard Audit of the proposed development and within one month of the audit submit a report to Council.

The audit shall be carried out at the Applicant's expense by a duly qualified independent person or team approved by Council prior to commencement of the audit. Further audits shall be carried out every three years or as determined by Council and a report of each audit shall within a month of the audit be submitted to Council. Hazard Audits shall be carried out in accordance with the Department of Planning's Hazardous Industry Planning Advisory Paper No. 5, 'Hazard Audit Guidelines'.

The audit shall include a review of the site Safety Management System and a review of all entries made in the incident register since the previous audit.

The audit report must be accompanied by a program for the implementation of all recommendations made in the audit report. If the Applicant intends to defer the implementation of a recommendation, justification must be included.

7. FURTHER REQUIREMENTS

The Applicant shall comply with all reasonable requirements of Council in respect of the implementation of any measures arising from the reports submitted in respect of conditions 1 to 6 inclusive, within such time as Council may agree.

Additional Information

Relevant DoP Publications

Hazardous Industry Planning Advisory Papers (HIPAPs):

- No. 1 - Emergency Planning
- No. 2 - Fire Safety Study Guidelines
- No. 3 - Risk Assessment
- No. 4 - Risk Criteria for Land Use Safety Planning
- No. 5 - Hazard Audit Guidelines
- No. 6 - Hazard Analysis
- No. 7 - Construction Safety
- No. 8 - HAZOP Guidelines
- No. 9 - Safety Management
- No. 10 - Land Use Safety Planning
- No. 11 - Route Selection
- No. 12 - Hazards-Related Conditions of Consent

Other Publications:

Applying SEPP 33: Hazardous and Offensive Development Application Guidelines

Multi-level Risk Assessment

Locational Guideline: Liquefied Petroleum Gas Automotive Retail Outlets

Locational Guideline: Development in the Vicinity of Operating Coal Seam Methane Wells

Electronic copies of some of these publications are available at:

www.planning.nsw.gov.au