



Planning

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Paper No 2

# Fire Safety Study Guidelines



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# 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

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# Executive Summary

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.

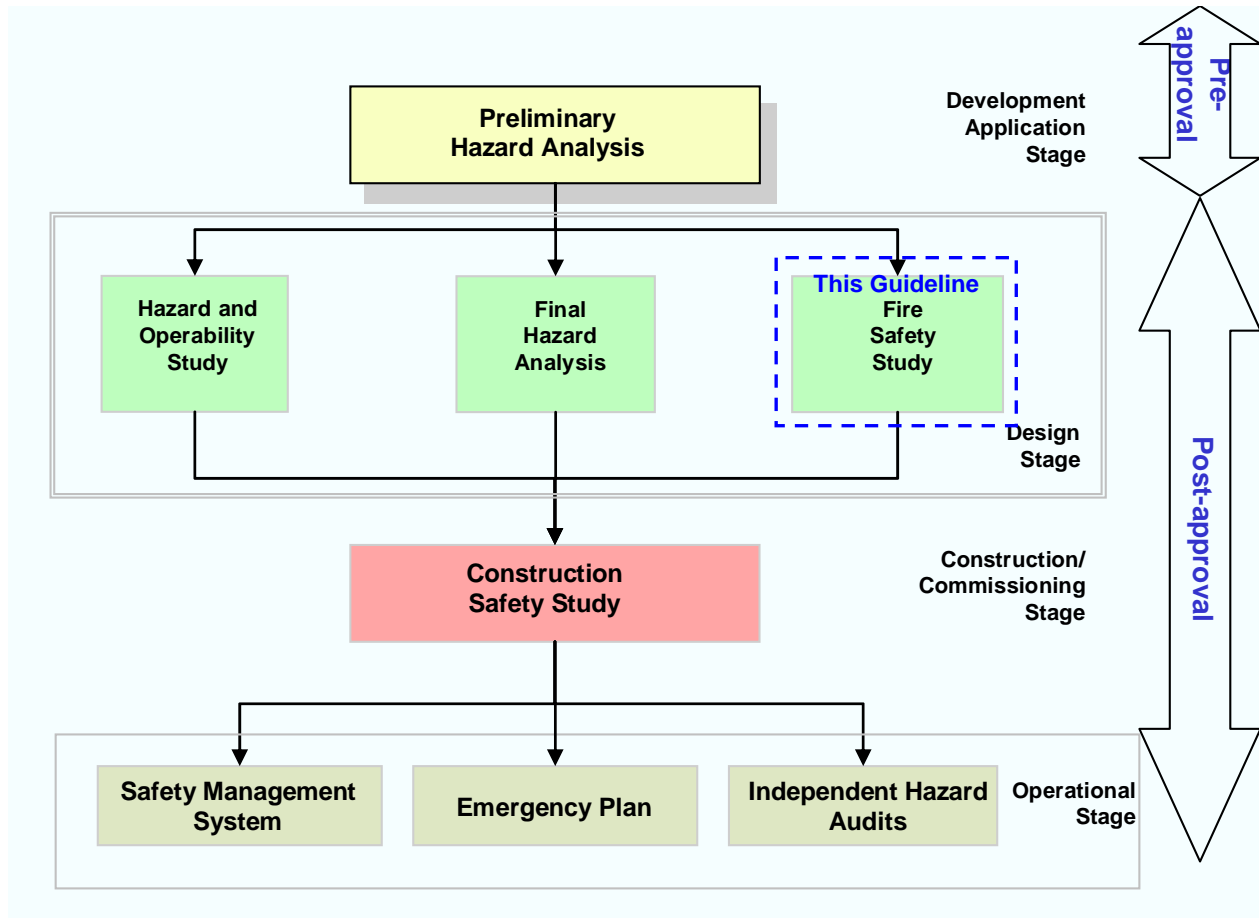
The process is shown diagrammatically in Figure 1.

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 Fire Safety Study

A fire safety study's objective is to ensure that the existing or 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 subject development.

These guidelines have been jointly prepared and issued by the NSW Department of Planning and Fire and Rescue NSW<sup>1</sup>. For development involving substantial quantities of hazardous materials, the Department and Fire and Rescue NSW have a common involvement and collaborate closely.

The fire safety study is one element in the safety assurance process. Emergency planning is also an important element and its relationship to fire safety arrangements should be clearly dealt with in the study and the report.

Fire and Rescue NSW also has a wider role and responsibilities which cover other types of development, particularly under the provisions of the Building Code of Australia (BCA) and the EP&A Act. These guidelines should help developers required to prepare reports for Fire and Rescue NSW under those provisions.

A fire safety study has two elements: the study and the report. When the study is prepared at the design stage, its results should be incorporated into the design. The report should justify design decisions.

<sup>1</sup> Formerly the NSW Fire Brigades

When it is prepared for an existing facility, the report should contain specific recommendations or measures to bring fire safety up to an acceptable level

Where development involves the extension or substantial modification of an existing facility, the study should be set in the context of the fire hazard and systems for the entire site.

Section 2 of these guidelines outlines the content of the study and section 3 sets out the recommended form and content of the report. The appendices provide relevant supporting material.

# 1 Introduction

**KEY MESSAGE**

- Fire safety studies should be carried out as early as possible in the detailed design stage of a facility, with modifications incorporated into the design as necessary.

The purpose of these guidelines is to assist developers, industry and consultants to carry out fire safety studies. Such studies are required as part of the overall safety assessment of development and building proposals and also used in the fire safety assessment of existing installations.

Basic fire safety issues should be considered early in the planning and design of a development. Fire and Rescue NSW should be consulted at this time. However, if final conclusions on fire safety matters are reached before detailed design is complete, it is likely that important factors will be missed. On the other hand, if left until construction has commenced, necessary modifications are likely to be difficult and costly. Therefore, fire safety studies should be carried out as early as possible in the detailed design stage with modifications incorporated into the design as necessary.

The studies involve case-specific hazard analyses and design of fire safety arrangements to meet those hazards. The approach is particularly important where significant quantities of hazardous materials are involved. It is, however, also applicable to other types of development. The level of detail warranted for each element of a fire safety study will vary with the nature and scale of the development. The case-specific approach offers the benefit that fire safety measures can be tailor-made and cost effective.



## 2 The Study

### SECTION SUMMARY

The fire safety study should be seen as complementary to the other hazard related studies shown in Figure 1. This ensures that the fire safety system is specifically designed to address the needs of the facility. The elements of the study include:

- identification of fire hazards and the consequences of possible fire incidents;
- fire prevention strategies and measures;
- analysis of the requirements for fire detection and protection and identification of the specific measures to be implemented;
- calculation of fire fighting water supply and demand;
- containment of contaminated fire fighting water; and
- first aid fire protection requirements.

### KEY MESSAGE

- While generalised codes and standards are useful, the fire safety system should be designed in the light of a specific analysis of site fire hazards and incident consequences.

This section outlines the elements of the fire safety study. The format and content of the report are dealt with in section 3.

### 2.1 The Objectives and Principles of Fire Safety Studies

There are two components to a fire 'system': the physical or hardware components (for example, smoke detectors, alarms and fire sprinklers) and the operational arrangements or software (for example, maintenance, testing, training and emergency planning).

The principle of a fire safety study is that the fire safety 'system' should be based on specific analysis of hazards and consequences and that the elements of the proposed or existing system should be tested against that analysis. This should always produce a better outcome than the application of generalised codes and standards alone.

Defining the hazard potential of a plant and/or operations involves the process of hazard identification and estimation of the potential consequences of credible incidents.

In addition to the hazard potential a number of other factors must be taken into account in the selection of the system. These include:

- (i) land use safety considerations: the impact of incidents on the surrounding land uses, and the sensitivity of these land uses;
- (ii) infrastructure available such as water mains supply, area emergency planning, Fire and Rescue NSW response times and access;
- (iii) external factors: effects from surrounding and use (for example, other hazardous industries, bush fires, weather, etc); and
- (iv) regulations: requirements of statutory bodies.

Too often fire safety systems are seen merely as an adjunct to a facility and are not integrated into design and management. The importance of prevention in the overall system cannot be emphasised enough. The hazard potential and the risk of death or injury, property loss, or damage to the biophysical environment are at least as dependent on the design and layout and the management of a facility as on the nature of the activities involved and the nature and quantity of hazardous materials.

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 toxic combustion products in the event of fire and the potential for the release of contaminated fire fighting water.

The fire protection requirement should be based on the worst case scenario(s).

While the basis of these studies is specific analysis, codes and standards are an important resource in carrying them out; they are, however, generally the minimum requirement. Only after a complete assessment of the fire study can the adequacy of the standards to meet the needs of the particular case be determined.

Examples of codes and standards that may be useful in a fire study are set out in Appendix 10,

## 2.2 Identification of Fire Hazards

The first step in the study involves the identification of all possibly hazardous materials, processes and incidents; in particular, those associated with flammables and combustibles. The possible internal and external causes of incidents should also be identified. The Preliminary Hazard Analysis/Final Hazard Analysis and HAZOP (see Figure 1) should be used for guidance in the hazard identification process.

For example, if a storage terminal has tanks containing flammable liquids, such as petrol, then the possibility of tank fires, bund fires, fires due to pipe and pump failure, fires in loading or drum filling operations and so on must be considered. Similarly, if a plant processes and stores large quantities of liquefied flammable gases then the possibility of jet fires, vapour cloud explosions, flash fires and boiling liquid expanding vapour explosions (BLEVEs) must be addressed. In the case of storage of materials with potential for generating toxic combustion products and/or contaminated water run off, these hazards must be addressed.

The analysis should cover the nature of the materials and quantities involved, the nature of hazardous events (such as the loss of containment), potential initiating events, ignition sources and so on.

It is important that the possibility of the site being exposed to hazards external to the site is dealt with.

Word diagrams may be useful in the hazard identification. Table 1 is a sample word diagram

**Table 1: Sample Hazard Identification Word Diagram**

Facility/Event	Cause/Comments	Possible Results/Consequences	Prevention/Detection/Protection Required
Petroleum tank fire	<ul style="list-style-type: none"> <li>Static electricity build-up and spark due to fast filling</li> <li>Pressure vent valve fails, tank roof fails and ignition.</li> </ul>	<ul style="list-style-type: none"> <li>Tank roof may fail, fire of entire roof area. if not controlled or extinguished may involve other tanks in same compound</li> </ul>	<ul style="list-style-type: none"> <li>Pressure vent valves checked prior to fill/discharge</li> <li>Foam Injection system in all class 3(a) tanks</li> <li>Water cooling system on each tank</li> </ul>
Petroleum bund fire	<ul style="list-style-type: none"> <li>Corrosion tank base/floor</li> <li>Pipeline/pump leakage/rupture</li> <li>Tank overfilled</li> </ul>	<ul style="list-style-type: none"> <li>Leakage of tank contents into bund, If ignited may result in pool or bund fire</li> </ul>	<ul style="list-style-type: none"> <li>Tanks cleaned, inspected, integrity tested annually</li> <li>Adequate foam stocks on site</li> <li>High level alarms to be provided on all storage tanks</li> <li>Foam/monitors to be</li> </ul>

Facility/Event	Cause/Comments	Possible Results/Consequences	Prevention/Detection/Protection Required
			<ul style="list-style-type: none"> <li>provided In and around bund compound</li> <li>Locate fire fighting equipment (to be accessed by Fire and Rescue NSW) outside are likely to be affected by radiant heat</li> </ul>
Petrochemical tank(s) (cool fire)	<ul style="list-style-type: none"> <li>Adjacent tank fire or bund fire heating tank contents to decomposition</li> </ul>	<ul style="list-style-type: none"> <li>Emission of toxic products or vapours. Downwind effects depend on toxicant released and wind/stability conditions</li> </ul>	<ul style="list-style-type: none"> <li>Tanks placed in separate bund</li> <li>Cooling system on all tanks</li> </ul>
<b>LPG Road Tanker Facility</b>			
<ul style="list-style-type: none"> <li>Flexible hose failure</li> </ul>	<ul style="list-style-type: none"> <li>Road tanker drives away while still connected</li> <li>Third party damage or excessive wear</li> </ul>	<ul style="list-style-type: none"> <li>Gas disperses. If ignited may result in flash fire. Impact local</li> </ul>	<ul style="list-style-type: none"> <li>Fixed deluge system at road tanker bay</li> <li>Scully system on tanker loading</li> </ul>
Pipe failure	<ul style="list-style-type: none"> <li>Mechanical impact</li> <li>Corrosion</li> </ul>		<ul style="list-style-type: none"> <li>Area drained</li> <li>Gas detectors around perimeter of LPG area</li> </ul>
Pump seal failure	<ul style="list-style-type: none"> <li>Pump not maintained</li> <li>Pump run dry</li> </ul>		<ul style="list-style-type: none"> <li>Pump shut off at two locations, local and remote</li> <li>Isolation systems on main liquid lines</li> </ul>
<b>Warehouse Dangerous Goods Store</b>			
Warehouse fire	<ul style="list-style-type: none"> <li>Wiring not flameproof</li> <li>Handling equipment not intrinsically safe</li> <li>Shrink wrapping fired by LPG, undertaken on site</li> <li>Arson</li> <li>Lighting not intrinsically safe</li> <li>Unsafe storage of drums</li> </ul>	<ul style="list-style-type: none"> <li>Fire involving warehouse contents. Exploding drums/packets depending on material stored</li> <li>Toxic combustion products evolved</li> </ul>	<ul style="list-style-type: none"> <li>All products segregated by class</li> <li>Thermal/smoke detectors provided, linked to alarm and local fire station</li> <li>Warehouse sprinkler system provided</li> <li>Area bunded</li> <li>Flameproof wiring used in dangerous goods store</li> <li>Diesel fork lifts only</li> <li>Security firm employed after hours</li> <li>All lighting Intrinsically safe</li> <li>Drum storage racked or drum</li> </ul>

Facility/Event	Cause/Comments	Possible Results/Consequences	Prevention/Detection/Protection Required
height restricted			
LPG Storage			
Catastrophic vessel failure	<ul style="list-style-type: none"> <li>• Direct flame impingement on tank, from pipes, tank fittings or pump failure ignition</li> </ul>	<ul style="list-style-type: none"> <li>• Pressure Inside tank rises. If fire not extinguished vessel may weaken and fail, resulting in a BLEVE/fireball, Damage widespread</li> </ul>	<ul style="list-style-type: none"> <li>• Vessel fitted with pressure relief valves, discharge vertical to atmosphere</li> <li>• Deluge system</li> <li>• Isolation valves on all main liquid lines</li> <li>• Pump shut offs at two locations</li> </ul>
Large leak	<ul style="list-style-type: none"> <li>• Mechanical impact</li> <li>• Corrosion</li> <li>• Failure of tank or associated fittings, pump or pipework and ignition</li> </ul>	<ul style="list-style-type: none"> <li>• On dispersion vapour may form a gas cloud, If ignited may result in UVCE or flash fire</li> </ul>	<ul style="list-style-type: none"> <li>• Isolation valves on all main liquid lines</li> <li>• Pump shut off at two locations, local and remote</li> <li>• Gas detection on perimeter of LPG area</li> <li>• Fog nozzles provided</li> <li>• Crash barriers provided around tank</li> </ul>

## 2.3 Analysis of Consequences of Incidents

Once the hazards have been identified, the consequences of incidents can be estimated. The consequence analysis should address both the direct impacts of incidents and the potential for propagation and secondary incidents.

The analysis should relate selected targets such as people, equipment or buildings to specific time related exposures (heat flux, explosion overpressure, toxic concentrations and so on).

Justification must be given for the selection of targets, exposures and models used in the consequence calculation.

There are various models available for estimating the consequences of events. Generally, each model has a range of applicability outside of which its use is inappropriate.

All models and assumptions used to estimate consequences should be justified.

Note: If a hazard analysis study has been carried out for the site, the hazard identification and consequence analysis components of the fire safety study should be able to be largely drawn from that study. Reference to other studies such as HAZOPs could also be useful in the hazard identification.

## 2.4 Fire Prevention Strategies/Measures

The most basic element of fire safety is prevention. Appropriate design and layout of the facility and operating procedures and arrangements are essential to fire prevention. The study should move from the hazard identification and consequence analysis to identifying measures which minimise the likelihood of fires and/or reduce their severity or extent.

Examples of matters which should be considered as part of fire prevention include:

- building design and compliance with building regulations;
- elimination/minimisation of hazardous materials in storage or in process;
- elimination of ignition sources;
- bund design, construction and capacity;
- type of medium suitable for the hazard (for example, minimising use of fire fighting water);
- Division of large quantities of certain materials e.g. rubber tyres;
- separation of incompatible materials;
- Training; and
- housekeeping.

Site security has implications for fire safety, as fire preconditions and fires themselves are often caused by intruders. The provision of physical barriers such as fencing and intruder detection systems (alarms) should be considered together with the staffing and operational arrangements.

The location of gatehouses, patrolling of the site, who responds to alarms and so on should be considered. Arrangements to restrict access to critical areas or plant components should also be considered in order to reduce the possibility of employee or visitor actions which could lead to fire or fire pre-conditions (for example, locking of valves).

Site upkeep (housekeeping) can be particularly important. Issues include removal of trade wastes; regular maintenance of installed facilities and equipment; as well as clearance and checking of drains and collection pits.

Safe work practices, including observance of standards, codes and regulations, provision of material data including safety data sheets and company policies and procedures, all have important bearing on fire safety and should be explicitly addressed.

Procedures and practices covering contract work should be carefully considered, especially hot work controls and permits and gas/vapour checks.

Appropriate emergency plans and procedures are an important part of fire prevention. Appropriate and early action can prevent small incidents developing into serious situations and can limit the scale and extent of the impact of incidents. The development or analysis of fire prevention strategies and measures should therefore be integrated with emergency planning.

## 2.5 Analysis of Requirements for Fire Detection and Protection

From the consideration of prevention measures, the analysis should move to the requirements for fire detection and protection. This should include detection of pre-

conditions for fire, such as flammable atmosphere detection, and physical protection measures such as purging with inert gases of vapour spaces.

Issues to consider include:

- prevention of fire pre-conditions, for example, inert vapour spaces;
- detection of fire pre-conditions, for example, leaks and spills of flammables, flammable or explosive atmospheres and overheating in process vessels;
- explosion suppression;
- detection of combustion, smoke, flame, early warning systems, thermal alarm systems;
- fire suppression, for example, automatic sprinkler systems, foam systems (type of foam), gas flooding, hydrant systems, hose reel systems, monitors (water and foam);
- provide adequate facilities for Fire and Rescue NSW intervention – ensure fire fighting equipment is located outside the area likely to be affected by radiant heat ;
- prevention of propagation, for example, cooling, deluge systems, drencher systems; and
- isolation of fuel supply especially means of control of gas or liquid flows from storage vessels, including pump control, valves, switch or control actuators (local or remote).

Road and rail vehicle and ship loading and discharge facilities should be fully covered in the study.

In some cases it may be better to contain rather than extinguish a fire. For example, it is generally best to let LPG jet fires burn rather than extinguish the fire and allow the possibility of a vapour cloud explosion.

The type of extinguishing or control medium needs to be carefully considered as not all fires can be

extinguished or controlled with water. Some require foam, dry powder, CO<sub>2</sub>, even water in various forms.

Another consideration is that water may be used for cooling of exposures but a different medium used for extinguishing or control. Where this is the case, compatibility between the two mediums is essential. If, say, water breaks down the foam applied, the design foam application rates need to allow for foam breakdown, or alternatives to cooling water used (for example, insulation of vessels to be protected).

The need to control spillage and drainage from the area in the event of fire, should be built into the analysis, including the need to contain or limit run-off of contaminated fire-fighting water.

Ventilation can be a factor in confined places. Control of smoke or toxic releases also needs to be addressed.

Design features identified through the fire prevention measures analysis (such as mounding of pressure vessels, increased separation distances and in-built safety features) can reduce the need for fire protection. For example, reducing the number of tanks in any one bunded area may reduce the requirement for foam and/or water.

The emphasis on hardware in this part of the study process should not obscure the fact that the hardware is only as good as its maintenance and operation allows. The analysis of requirements must take this into account.

## 2.6 Detection and Protection Measures to be Implemented

The above analysis should identify the detection and protection systems required. There will usually be a range of design or equipment options which could meet the requirements.

From this point, the detailed selection of detection and protection measures to be implemented can be made, or the adequacy of existing measures assessed.

## 2.7 Fire Fighting Water Demand and Supply

A crucial part of the study is ensuring that the hydraulic design is sufficiently satisfactory to cope with the hazards and consequences. There are three elements: fire fighting water demand, fire fighting water supply and contaminated water containment and disposal. The demand calculation is based on the worst case scenario. If the supply cannot be made sufficient to meet the demand, or the contaminated water systems cannot cope with water applied, the choices of protection systems will need to be reviewed.

Once the protection systems have been selected, the fire fighting water demand can be calculated. This calculation should be based on the worst case fire scenario(s) and its/their foam/cooling water requirements. The demand will depend on the duration and intensity of potential fire(s), the prevention measures including facility design and the protection systems selected. Demand will be particularly influenced by choice of fire fighting media and facility layout (especially in relation to cooling water). Other features of particular significance include fire rated construction, vapour barriers, and compartmentalising of storage (including separate bunding).

Analysis of supply should cover details of the fire water pumps. This would include the number of pumps and their configuration; power supply; pump details including capacity, type, pump curves, backup and so on,

The calculations justifying the fire protection should show pressure and flows on operation of any and all of fire fighting facilities in the area under review.

Where appropriate, the facility should be divided into fire areas and the water requirements calculated for each area.

The design of the water supply system must be assessed against the calculated water demand.

The adequacy of the water supply available from town mains should be assessed based on written advice from the local water authority.

Where the mains water supply is not adequate in terms of quantity or reliability, the need for static water supplies should be considered as well as the size and type of storage identified with drawings showing location of mains, size and street hydrants.

On-site water storage should be calculated to meet worst case demand. The minimum requirement is generally 90 minutes supply. Justification must be provided for the storage quantity adopted. Demand scenarios should include bund fires and cooling needs for adjacent tanks equipment and buildings.

The analysis needs to include careful consideration of the effect of potentially competing demands for reticulated and static water supply.

An example sample calculation is given in Appendix 6.

## 2.8 Containment of Contaminated Fire Fighting Water

The importance of the containment of contaminated water will depend on the nature of the materials held on site and where the site drains to. For example, if substantial quantities of biocides are involved and/or the site drains to a sensitive environmental area then special attention would be warranted.

Factors that need to be taken into account in the design of the retention system include control, drainage, storage and disposal.

The design of the contaminated water containment and disposal system should be based, where appropriate, on a probabilistic analysis. The analysis should account for not only the total containment of the calculated run-off of potentially significantly contaminated water from the worst case scenario fire but also the availability of the

retention capacity as affected by rain events, testing, treatment and disposal arrangements. The possibility of soil and groundwater contamination should be considered in the analysis.

Further information is provided in the New South Wales Government's *Best Practice Guidelines for Contaminated Water Retention and Treatment Systems*, available from the Department.

## 2.9 First Aid Fire Protection Arrangements and Equipment

In addition to fixed fire protection systems, provision for first aid fire protection equipment and operational arrangements must be considered.

Relevant matters to be covered would include:

- provision of portable fire extinguishers - size, type, medium, number, location, testing and maintenance;
- provision of hose reels - number, location, type, testing and maintenance. Installed hose reels can remove the need for water type extinguishers;
- provision of warning signs (including exit signs, placarding and first aid fire fighting equipment use instruction signs), location, type, size;
- site fire crews - formation, training, responsibilities and drills;
- training of operators/staff - knowledge of plant, materials, emergency action/shut down procedures; and
- road vehicles measures - extinguishers, driver/operator instruction, placarding, vehicle maintenance.

The interaction of these matters with emergency planning should be carefully considered.



# 3 The Report

## SECTION SUMMARY

This section suggests a general format for a fire safety study and its content. While the amount of detail required may vary considerably depending on the scope of the study, there are a number of features that need to be present in all fire safety study reports:

- formal document control procedures;
- a clear summary of findings and recommendations;
- a description of the facility, including its processes, layout and location drawings;
- identification of flammable materials, fire scenarios that can arise and their consequences;
- a description of the fire prevention and mitigation strategies;
- details of the fire system and demonstration of its adequacy to cope with the identified fire scenarios; and
- arrangements for containing contaminated fire fighting water.

A number of supporting appendices are also suggested.

## KEY MESSAGE

- The report must clearly demonstrate the fire fighting arrangements are sufficient to deal with identified fire scenarios.

The report should provide sufficient information on each element so that, either read alone or together with available and clearly cross-referenced documents, an assessment of the adequacy of fire prevention, detection, protection and fighting measures can be made. This section outlines the recommended format and content of the report.

A new page should be started for each section of the report.

### 3.1 Study Title Page

The study title should be clearly shown on both the cover and on a separate title sheet. The title should clearly and unambiguously identify the facility covered by the study: the type of operation, whether it is a proposed operation or an existing facility and its location. The title sheet should also show who prepared the study, on whose authority and the date.

### 3.2 Table of Contents

An easy to read table of contents with page numbers should be included at the beginning of the study. It should also include a list of figures and appendices.

### 3.3 Summary of Main Findings and Recommendations

The summary should briefly outline the nature of the proposed or existing facility, the scope of the report and the matters addressed. It should present in point form the main findings and, where appropriate, recommendations for action.

An implementation program agreed to by the proponent company or the owner or operator should be included. If any recommendations are not to be proceeded with reasons should be given.

### 3.4 Glossary and Abbreviations

To ensure that the study can be understood, a glossary of any special terms, titles of personnel, names of parts of the plant and a list of abbreviations used should be included.

For example:

#### Glossary and abbreviations

ACI	Acme Company Pty. Ltd.
AFFF	Aqueous Film Forming Foam
BLEVE	Boiling Liquid Expanding Vapour Explosion
DCP	Dry Chemical Powder
DGC	Dangerous Goods Classification
DSA	Drum Storage Area
FB	Fire and Rescue NSW
FH	Fire Hydrant
FHR	Fire Hose Reel
FMO	Fire Maintenance Officer
FPW	Finished Products Warehouse
FS	Foam Store
IUPA	International Union of Pure and Applied Chemistry
NSWFB	Fire and Rescue NSW
SWP	Stored Water Pressure
TFA	Tank Farm Area
UVCE	Unconfined Vapour Cloud Explosion

### 3.5 Scope of Report

This section should give a brief description of the aims and purpose of the study and the reason for its preparation. For example, is the study being prepared to satisfy conditions of development consent or BCA requirements, or at the company's initiative as part of safety upgrading? Is it for an entirely new development, the modification of or extension to an existing development, or the establishment of adequacy of fire safety for an existing development? Is part or all of the site addressed?

Reference should be made to any other relevant safety related studies previously carried out or under preparation.

### 3.6 Description of the Facility

This section should give an overview of the site, plant, buildings and substances used/stored. Design and construction standards must be addressed. Where this information is already available through an environmental impact statement (EIS), hazard analysis or other document, clear cross-reference to these documents and/or supply of copies as necessary would suffice.

The description should include:

- (a) details of the facility (general description) including brief process description where applicable;
- (b) site locational sketch (see Appendix 2);
- (c) site layout diagram (see Appendix 3);

- (d) building description including floor area limitations, fire resistance, means of egress, fire fighting services and appliances, type of construction, and special provisions;
- (e) a generalised outline of the materials and quantities which are, or will be, stored or in process on site;
- (f) a brief description of adjacent/surrounding land uses; and
- (g) number of people typically on the site and hours of operation.

### **3.7 Hazards Identified**

A comprehensive list of materials which are or will be present on site should be provided. Information should include:

- (a) name of material — common, trade and IUPAC names. If mixtures, the relative proportions of each component should be given;
- (b) class of material and type of hazard (for example, flammable, explosive, toxic, flammable toxic or produces toxic combustion products). HAZCHEM UN number;
- (c) average and maximum quantities in storage and process;
- (d) physical state of substances (for example, pressurised, atmospheric, refrigerated, gas, liquid, temperature); and
- (e) reference to process or storage area on site plan.

Where it is not possible or practicable to adequately describe a material within a tabular format, specification sheets and/or material safety data sheets should be provided. Reference to this additional information should be included in the table.

A suggested format for the presentation of this information is shown in Table 2.

Hazardous incident scenarios identified in the study should be detailed. Where applicable, word diagrams such as shown in Table 1, which relate specifically to the site, should be included in the report. In addition, an additional column containing comments relating to safeguards for each specific hazard identified should be included.

**Table 2: Example Materials/Quantities List**

<b>Chemical Name and/or Common Name and/or Trade Name</b>	<b>Class</b>	<b>UN No.</b>	<b>HAZCHEM Code</b>	<b>Inventory Average/Maximum</b>	<b>Storage Type</b>	<b>Location Reference</b>
Kerosene	3PG2	1223	3[Y]E	12,000/20,000 L	Aboveground tank	Tank 1
Acetone	3PG1	1090	2[Y]E	24,000/40,000 L	Aboveground tank	Tanks 2, 3
Acmesol (60% Toluene/ 40% Xylene)	3PG1	—	3[Y]E	36,000/160,000 L	Aboveground tank	Tanks 4, 5, 6
Turpentine	3.2	1299	3[Y]E	5000/10,000 L	200L drums	Raw materials area
Various pigments	—	—	2[Z]	900kg/1500kg	200L drums	Raw materials area
Butyl alcohol	3.2	1120	3[Y]	1000/3000 L	200L drums	Raw materials area
Acetone	3.1	1090	2[Y]E	2500/5000 L	200L drums	Raw materials area

### 3.8 Consequences of Incidents

The estimated consequences of potential hazardous incidents, as developed in the study, should be detailed.

Where applicable, diagrams showing worst case scenario heat flux distances, explosion overpressures and toxicity effects must be included. Such information should be time related where applicable. Consequence and risk contours used in the PHA/FHA (see Figure 1) must be included.

The potential for fire propagation without fire protection measures should be detailed.

### 3.9 Fire Prevention Strategies/Measures

The full range of prevention strategies and measures identified in the study, as outlined in section 2.4, should be described.

Compliance with, or departures from, regulations and standards should be detailed. The justification for departures should be clearly set out.

Reference to an emergency plan should be given if one has been prepared for the facility/site or is being written in conjunction with the fire safety study.

### 3.10 Details of Detection and Protection

The detection and protection systems selected should be detailed and justified in this section.

The full array of systems covering detection of flammable atmospheres, fire, smoke and heat, etc. together with the automatic and manually actuated suppression and protection systems should be covered where appropriate.

The analysis in the study, as outlined in sections 2.5 and 2.6, forms the basis of this section of the report.

Where applicable the detailing of detection and protection systems should be supported with drawings. Such drawings should be bound in to the report or enclosed in a securely attached pocket or pouch.

### **3.11 Detailed Drawings of Fire Services Layout**

Detailed drawings showing the location and layout of various fire service components should be included to enable an assessment to be made of the compatibility of the system with the fire service. The drawings should cover access for emergency services and layout of all fire service pipework. Drawings of adequate scale to clearly indicate relevant details should show:

- pipe sizes;
- valves;
- fitting;
- materials;
- pumps;
- boosters;
- controls;
- water storage tanks;
- containment controls for used fire fighting water;
- emergency vehicle access;
- connections to town mains; and
- hydrants.

A clear key should be provided.

Australian Standard symbols should be used where possible. All other symbols should be shown in the key. (Refer Appendix 5).

Drawings should be bound into the report document or enclosed in a securely attached pocket or pouch.

### **3.12 Detailed Hydraulic Calculations for Fire-Fighting Water**

The report should present a clear justification of the fire water system and decisions on static water storage supported by calculations and statements of assumptions. See Appendix 6 and Appendix 11.

Both the demand for fire fighting water and its supply need to be clearly addressed.

### **3.13 Arrangements for Containing Contaminated Fire Fighting Water**

The arrangements for containing water which becomes contaminated during fire fighting operations should be detailed. As outlined in section 2.8, the retention, treatment, testing and disposal arrangements chosen should be based on the nature and quantity of materials involved, the hydraulic calculations and the effect of rain events. The section should present both the assumptions and calculations on which arrangements are based and also a justification of design and operational arrangements.

### **3.14 First Aid Fire Protection**

The equipment and arrangements for first aid fire protection should be detailed on the basis of the analysis outlined in section 2.9 .

The location of fire extinguishers, hose reels and so on should be clearly shown on the site plan or other drawings included in the report as applicable. (See appendix 4 ).

### **3.15 Codes and References**

The various codes and references used in the design and operation of the facility should be listed and any exceptions or departures from the standards detailed and justified.

Where codes and standards are not generally available, copies should be attached to the study (for example, specific company standards or insurance requirements).

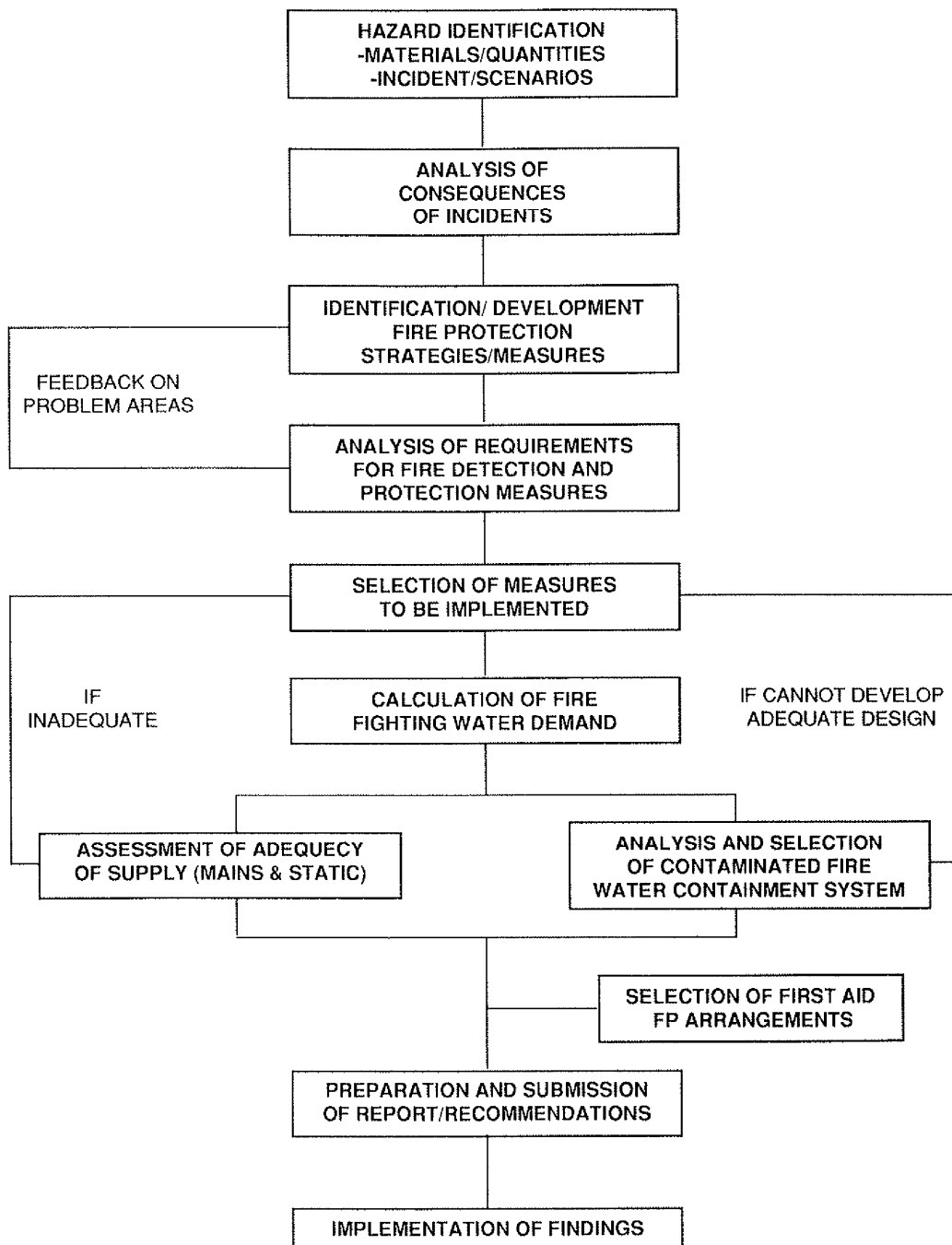
### **3.16 Appendices**

To support the content of the document the following should be included as appendices:

- local water authority/Water Board water pressure form — original (see Appendix 11)
- water authority approvals for pumps;
- water authority services site plan
- subdivision plan;
- development plan; (see Appendices 3&4)
- building plans; (indicate fire rated walls, doors and escape routes)
- drainage systems drawings;
- existing and/or proposed fire fighting equipment list and drawings;
- sprinkler/drencher system layouts;
- CO2, flood systems layouts;
- proposed fire protection layouts;
- hydraulic calculations; (see Appendix 6)
- fire protection/fighting equipment. type, design and specifications;
- drawings referred to in text; and
- reference list

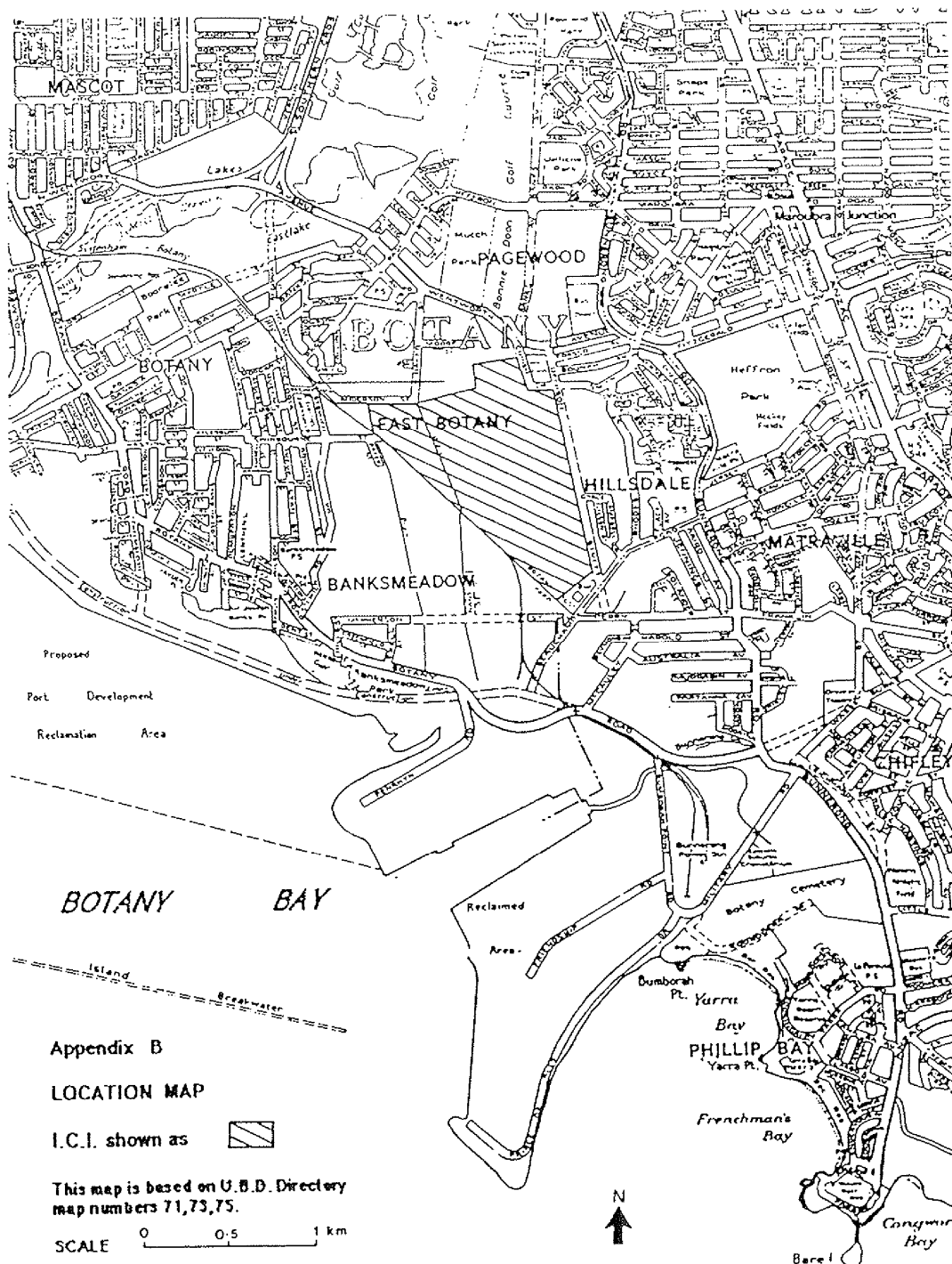
# Appendix 1

## Flow Diagram for a Fire Safety Study



# Appendix 2

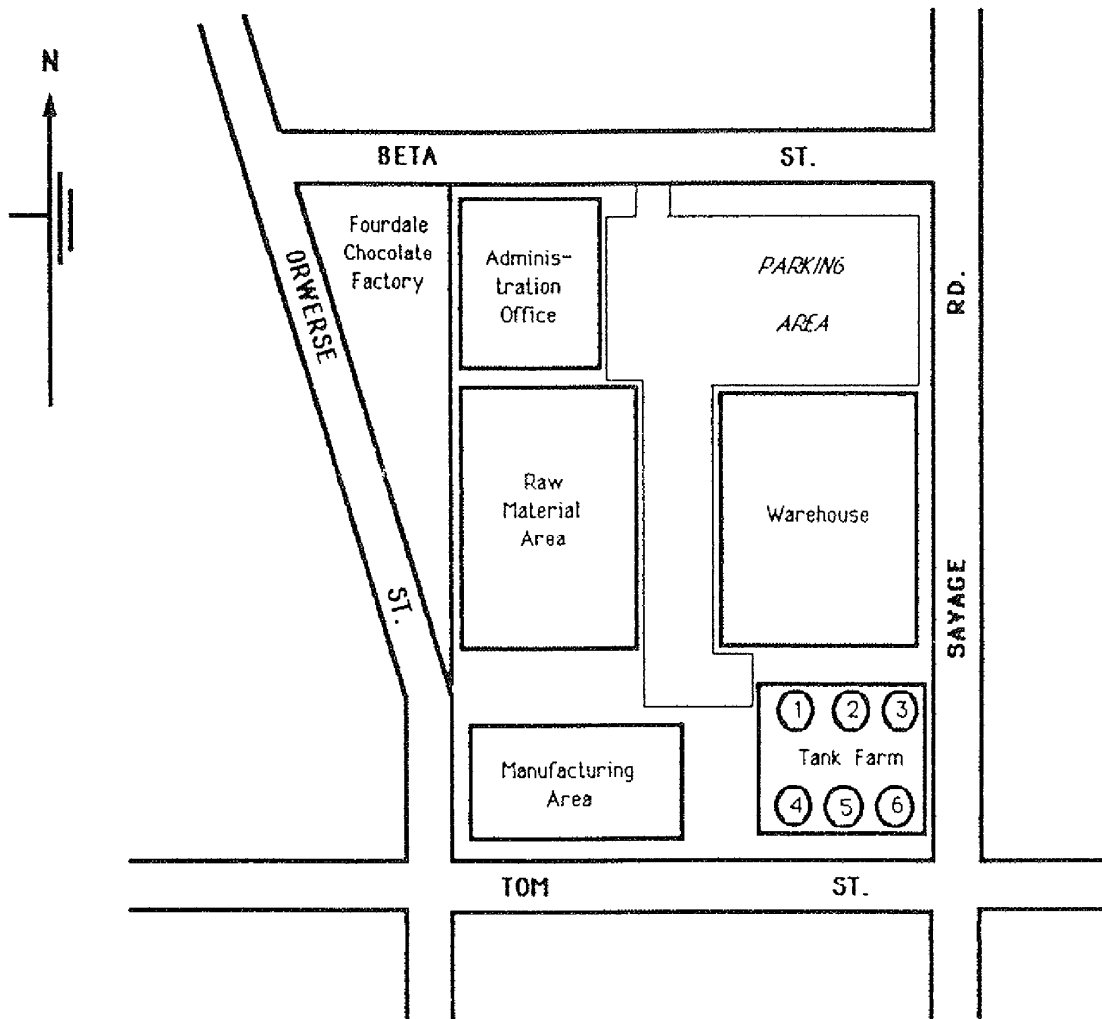
## Sample Site Location Sketch





# Appendix 3

## Sample Site Layout Diagram

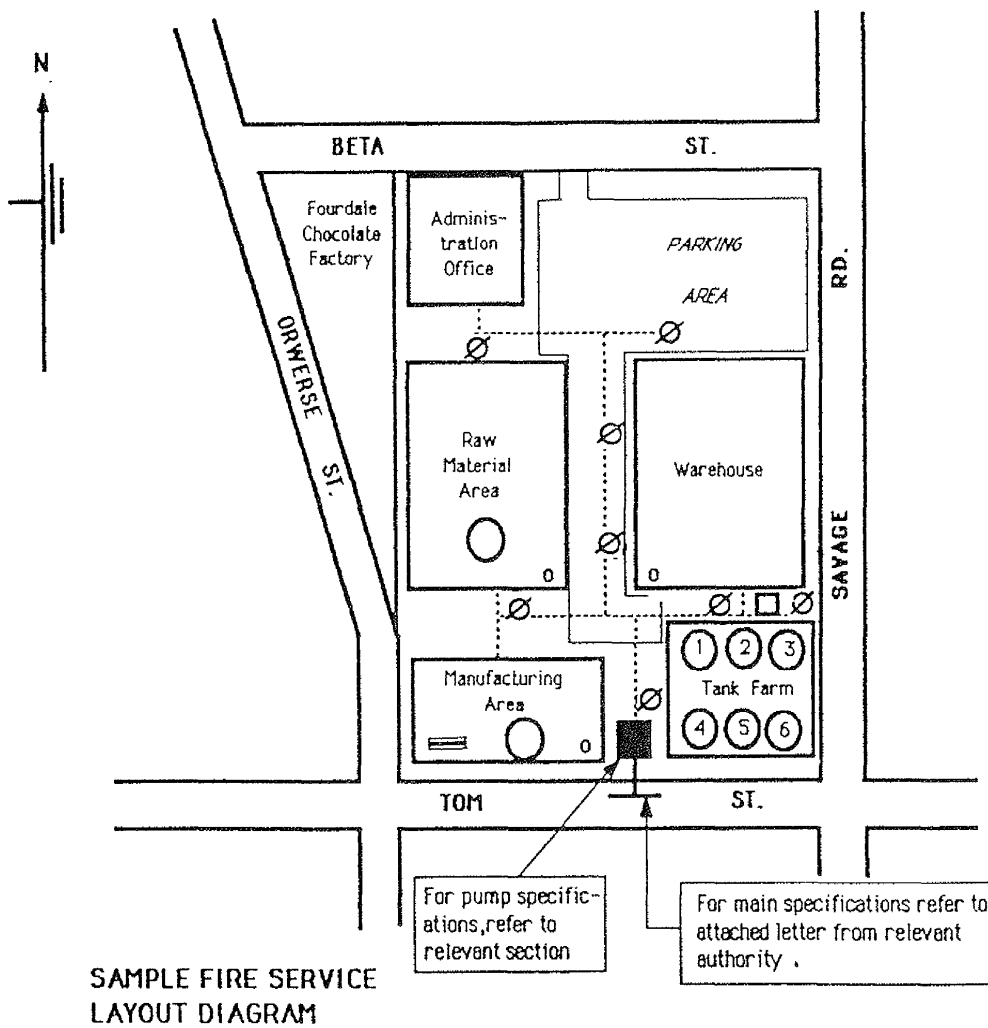


SAMPLE SITE  
LAYOUT DIAGRAM

ACME PTY., LTD.  
Site Layout  
1cm = 10m

# Appendix 4

## Sample Fire Service Layout Diagram



**SAMPLE FIRE SERVICE LAYOUT DIAGRAM**

**ACME PTY., LTD.**  
**Site Layout**  
 1 cm = 10m

**KEY**

- Foam container
- Hydrant system
- Automatic sprinkler
- Hand held extinguishers
- ⊗ Hydrants
- ≡ Fire hose reel
- Pump house

# Appendix 5

## Standard Symbols

	CONTROL VALVE OR STOP COCK
	GATE VALVE
	BALL VALVE
	SOLENOID VALVE
	CHECK VALVE OR REFLUX VALVE
	VALVE AND CAST IRON SURFACE BOX
	'STAD'/'STAF' BALANCING VALVE
	GLOBE VALVE
	REGULATOR
	CLEAROUT
	FIRE HOSE REEL
	FIRE HYDRANT
	PRESSURE LIMITING VALVE
	FILTER
	STRAINER
	FLEXIBLE CONNECTION
	DIESEL EXHAUST
	GAS SERVICE
	COLD WATER SERVICE
	FIRE HYDRANT SERVICE
	FIRE HOSE REEL SERVICE
	DROPPER
	RISER
	TEE DROPPER
	TEE RISER
	EXISTING SERVICE
	EXISTING SERVICE TO BE REMOVED
	GREASE WASTE
	HIGH PRESSURE GAS SERVICE
	CHECK VALVE
	DIAPHRAGM VALVE
	PRESSURE RELIEF VALVE
	FOAM PROPORTIONER
	STRAINER
	PRESSURE GAUGE
	ANNUBAR TEST POINT
	REDUCER

# Appendix 6

## Sample calculations

The following sample calculation for Acme Pty Ltd is intended as a guide only (see Appendix 3 and Appendix 4). The level of detail required in a fire safety study would usually be much greater. It would include a detailed analysis of a fire system, pipe head losses, and many other details not addressed in this simplified calculation. Depending on the complexity of the installation, a hydraulic consultant may be required.

It is important that the assessment of the worst case demand be under all conditions of fire and winds. Items to be considered in assessing water demands include:

- sprinklers;
- monitors;
- deluge systems;
- cooling water;
- hand-held fire hoses; and
- foam production.

For the Acme site, a worst case demand may involve a warehouse with a sprinkler system design discharge rate of 32 litres/second; a need for two hand held lines for fire fighting at 15 litres/second each and two monitors for cooling, say, at 50 litres/second each. Therefore, total demand is:

Sprinklers	32 litres/second
hand lines	30 litres/second
monitor	100 litres/second
<b>TOTAL</b>	<b>162 litres/second (9,720 litres/minute)</b>

For 90 minutes' demand, total required volume is 874.8 kilolitres (90 x 9720).

For the tank farm, the relevant Australian standard, AS1940-1988, requires a minimum four litres at 400 kPa and 12.5 litres of foam solution per square metre of net area of tank compound. If a deluge system was proposed for tank cooling the requirement is for the worst case. This would be either tank 2 or 5. The worst case tank will see half of the other tanks, so the system will require enough cooling water for 5 x 0.5 tank surface areas. The possibility of a bund fire impinging on the warehouse also needs to be addressed and consideration should be given to bund size and its distance from the warehouse.

The level of detail required for the hydraulic calculations is shown in Table 3.

**Table 3: Typical Output Required for the Hydraulic Calculations**

Pipe No.	Pipe Nodes	Flow (l/min)	Pipe Nom (mm)	Pipe Diameter Actual (mm)	Pipe/ Fitting Code #	Fitting Length (m)	Total Length (m)	Head Loss per m (kPa)	Head Loss Over Pipe (kPa)	Static Head Loss (kPa)	Total Head Loss (kPa)	Roughness Coeff	Water Velocity (m/Sec)	Veloc. Press, (kPa)
20	100 101	1029.60	80	81	AVM	15.6	26.6B	1.679	44.702	59.751	104.454	120	3.355	5.622
			103	105	1GV	0.2								
			100	105	IAY	1.9								
			80	81	3SE									
21	101 102	766.00	65	69	ASAM	3.0	6.0	2.125	12.750	0.000	12.750	120	3.443	5.921
			65	69	1TT	3.0								
22	102 103	508.47	65	69	ASAM	3.0	6.0	0.995	5.970	0.000	5.970	120	2.285	2.609
			65	69	1TT	3.0								
23	103 104	253.47	65	69	WM	3.0	6.0	0.275	1.649	0.000	1.649	120	1.141	0.650
			65	69	1TT	3.0								
24	101 105	263.60	40	42	ASAM	3.0	7.0	3.274	22.915	0.000	22.915	120	3.184	5.066
			40	42	1TT	4.0								
25	105 106	171.73	32	36	ASAM	4.0	7.0	3.107	21.751	0.000	21.751	120	2.813	3.962
			32	36	1TT	3.0								
26	106 107	83.78	25	27	ASAM	4.0	7.0	3.158	22.104	0.000	22.104	120	2.384	2.839
			25	27	1SE	3.0								
27	102 108	257.53	40	42	AVM	4.0	7.0	3.135	21.947	0.000	21.947	120	3.111	4.834
			40	42	1TT	3.0								
28	108 109	167.76	32	36	ASAM	4.0	7.0	2.975	20.629	0.000	20.629	120	2.748	3.771
			32	36	1TT	3.0								
29	109 110	81.83	25	27	ASAM	4.0	7.0	3.023	21.163	0.000	21.163	120	2.329	2.709
			25	27	1SE	3.0								
30	103 111	254.64	40	42	ASAM	4.0	7.0	3.070	21.492	0.000	21.492	120	3.076	4.726
			40	42	1TT	3.0								

Pipe No.	Pipe Nodes	Flow (l/min)	Pipe Nom (mm)	Diameter Actual (mm)	Pipe/ Fitting Code #	Fitting Length (m)	Total Length (m)	Head Loss per m (kPa)	Head Loss Over Pipe (kPa)	Static Head Loss (kPa)	Total Head Loss (kPa)	Roughness Coeff	Water Velocity (m/Sec)	Veloc. Press, (kPa)
31	111 112	165.87	32	36	ASIM	4.0	7.0	2.914	23.306	0.030	20.396	120	2.717	3.687
			32	36	1TT	3.0								
32	112 113	80.91	25	27	ASAM	4.0	7.0	2.960	20.722	0.000	20,722	120	2.303	2.648
			25	27	1TT	3.0								
33	104 114	253.83	40	42	ASAM	4.0	7.0	3.052	21.337	0.000	21.367	120	3.066	4.696
			40	42	1TT	3.0								
34	114 115	165.34	32	36	ASAM	4.0	7.0	2.897	20.276	0.000	21.276	120	2.708	3.663
			32	36	1TT	3.0								
35	115 116	80.66	25	27	PSW	4.0	7.0	2.943	20.600	0.000	20.600	120	2.296	2.631
			25	27	1SE	3.0								
510	105 300	91.88	25	27	ASAM	0.10	7.0	3.746	0.375	0.000	0.375	120	2.615	3.415
511	106 301	87.95	25	27	ASAM	0.10	0.10	3.456	0.346	0.000	0.346	120	2.503	3.129
512	107 302	83.78	25	27	ASAM	0.10	0.10	3.158	0.316	0.000	0.316	120	2.384	2.839
513	108 303	89.77	25	27	ASAM	0.10	0,10	3.500	0.354	0.000	0.350	120	2.5E6	3.260
514	109 304	85.93	25	27	ASAM	0.10	0.10	3.309	0.331	0.000	0.331	120	2.445	2.987
515	110 306	81.83	25	27	ASAM	0.10	0.10	3.033	0.302	0.000	0.302	120	2.329	2.709
516	111 306	88.77	25	27	ASAM	0.10	0.10	3.515	0.351	0.000	0.351	120	2.525	3.188
517	112 307	84.96	25	27	ASAM	0.10	0.10	3.241	0.324	0.000	0.324	120	2.418	2.920
518	113 306	80.91	25	27	ASAM	0.10	0.10	2.960	0.296	0.000	0.296	120	2.303	2.648
519	114 309	86.44	25	27	ASAM	0.10	0.10	3.495	0.349	0.000	0.349	120	2.518	3.168
520	115 310	64.69	25	27	ASAM	0.10	0.10	3.222	0.322	0.000	0.322	120	2.410	2.902
521	116 311	80.65	25	27	ASAM	0.10	0.10	2.943	0294	0.000	0.294	120	2.296	2.631

# Appendix 7

## Extinguisher Types and Fire Fighting Media

**Table 4: Fire Extinguishing Agents - Forms and Ranges of Application**

Extinguishing Agent	Extinguishing Device	Extinguishing Effect	Typical Application
Water	Water extinguishers	Cooling effect	Small fires
	Hose streams	Cooling effect	Small to large fires
	Water curtains	Cooling effect	Preventing the spread of openings and cooling exposed surfaces
	Sprinkler systems	Cooling effect	Controlling fires at an early stage
	Deluge systems	Cooling effect	Where very rapid development and spread of fire is to be expected
Aqueous film forming agent	Fixed and mobile extinguishing systems	Smothering effect, cooling effect	Flammable liquid fires covering large areas
Foam — high density foam	Portable extinguishers, fixed extinguishing systems	Cooling effect, smothering effect	Flammable liquid fires
Foam — medium density foam	Portable extinguishers, fixed extinguishing systems	Cooling effect, smothering effect	Flammable liquid fires
High expansion foam	Fixed extinguishing systems	Smothering effect, minor cooling effect	Fires in storage areas
Dry chemical	Portable extinguishers, fixed and mobile extinguishing systems	Anti-catalytic effect, i.e. oxidation reaction stopped smothering effect	Small to large fires
Gaseous agents, including CO <sub>2</sub> and vapourising liquid	Portable extinguishers, fixed and mobile extinguishing systems	Displacement of air, oxygen, smothering effect	Fires involving electrical and electronic equipment, flammable liquid fires
Wet chemical agent	Portable/fixed/mobile extinguishers	Cooling and smothering	Small to large fires

# Appendix 8

## Consequences of Heat Radiation

Heat Radiation (kW/m <sup>2</sup> )	Effect
1.2	Received from the sun at noon in summer
2.1	Minimum to cause pain after 1 minute
4.7	Will cause pain in 1 5-20 seconds and injury after 30 seconds' exposure (at least second degree burns will occur)
12.6	<ul style="list-style-type: none"> <li>• Significant chance of fatality for extended exposure. High chance of injury</li> <li>• Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure</li> <li>• Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure</li> </ul>
23	<ul style="list-style-type: none"> <li>• Likely fatality for extended exposure and chance of fatality for instantaneous exposure</li> <li>• Spontaneous ignition of wood after long exposure</li> <li>• Unprotected steel will reach thermal stress temperatures which can cause failure</li> <li>• Pressure vessel needs to be relieved or failure would occur</li> </ul>
35	<ul style="list-style-type: none"> <li>• Cellulosic material will pilot ignite within one minute's exposure</li> <li>• Significant chance of fatality for people exposed instantaneously</li> </ul>



# Appendix 9

## Consequences of Explosion Overpressure

Explosion Overpressure	Effect
3.5 kPa (0.5 psi)	<ul style="list-style-type: none"> <li>• 90% glass breakage</li> <li>• No fatality and very low probability of injury</li> </ul>
7 kPa (1 psi)	<ul style="list-style-type: none"> <li>• Damage to internal partitions and joinery but can be repaired</li> <li>• Probability of injury is 10%. No fatality</li> </ul>
14 kPa (2 psi)	<ul style="list-style-type: none"> <li>• House uninhabitable and badly cracked</li> </ul>
21 kPa (3 psi)	<ul style="list-style-type: none"> <li>• Reinforced structures distort</li> <li>• Storage tanks fail</li> <li>• 20% chance of fatality to a person in a building</li> </ul>
35 kPa (5 psi)	<ul style="list-style-type: none"> <li>• House uninhabitable</li> <li>• Wagons and plants items overturned</li> <li>• Threshold of eardrum damage</li> <li>• 50% chance of fatality for a person in a building and 1 5% chance of fatality for a person in the open</li> </ul>
70 kPa (10 psi)	<ul style="list-style-type: none"> <li>• Threshold of lung damage</li> <li>• 100% chance of fatality for a person in a building or in the open</li> <li>• Complete demolition of houses</li> </ul>

# Appendix 10

## List of Codes and Standards

### Standards Australia

AS 1020	SAA Static Electricity Code
AS 1216	Class labels for dangerous goods
AS 1221	Fire hose reels
AS 1596	SAA LP gas code
AS 1768	Lightning protection
AS 1850	Portable extinguishers classification, rating and performance testing
AS 1851	Maintenance of fire protection systems and equipment (set)
AS 1940	The storage and handling of flammable and combustible liquids
AS 2118	Automatic fire sprinkler systems
AS 2419	Fire hydrant installations
AS 2441	Installation of fire hose reels
AS 2444	Portable fire extinguishers and fire blankets – Selection and location

### Other

In addition to Australian Standards, publications of the British Standards Institution, the American Petroleum Institute and the FPA may be useful.

The Australian Code for the Transport of Dangerous Goods by Road and Rail is an important reference, particularly for transportation related aspects.

The Building Code of Australia (BCA) is also an important source.

**NOTE: This list is intended to serve as a guide and is not exhaustive.**

# Appendix 11

## Typical Information Supplied from Water Authorities

The Manager,  
Acme Pty. Limited, 4 Beta Street,  
Bradstow NSW

**RE: Mains Pressure Inquiry: 26 Tom Street, 15m west of the corner of Tom Street and Savage Road, Bradstow**

Dear Sir

I refer to your inquiry of 24 November 2007 and advise that the expected maximum and minimum pressure heads that could occur in our 150mm water main at the above location, relative to an approximate ground level of 54 metres (AHD), are 113 and 48 metres respectively. During fire fighting the minimum pressure head is expected to be:

- 47 metres with a fire demand of 4.5 litres/second
- 47 metres with a fire demand of 9 litres/second
- 46 metres with a fire demand of 13.5 litres/second
- 45 metres with a fire demand of 18 litres/second
- 44 metres with a fire demand of 22.5 litres/second

We endeavour to maintain a minimum pressure of at least 15 metres in our water mains except during fire fighting. Although the minimum pressure heads quoted above may be higher than 15 metres, these higher pressure heads may not always be available.

If you intend to install a pump which draws water directly from the main, our prior approval will be required for both the pump and its installation.

Yours faithfully

R. Tyne  
Regional Manager Bradstow

# Additional Information

## Relevant DoP Publications

### **Hazardous Industry Planning Advisory Papers (HIPAPs):**

- No. 1 - Industry Emergency Planning Guidelines
- No. 2 - Fire Safety Study Guidelines
- No. 3 - Environmental Risk Impact Assessment Guidelines
- No. 4 - Risk Criteria for Land Use Planning
- No. 5 - Hazard Audit Guidelines
- No. 6 - Guidelines for Hazard Analysis
- No. 7 - Construction Safety Studies
- No. 8 - HAZOP Guidelines
- No. 9 - Safety Management System Guidelines
- 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](http://www.planning.nsw.gov.au)