Queensland Government
Department of Employment and Industrial Relations

Hazardous materials

In order to understand the workplace health and safety requirements for hazardous materials, and your obligations under the law you must consider and understand relevant legislation and codes of practice.

What law applies
Regulations and codes of practice governing hazardous materials in the workplace

What are hazardous materials
Definition, material safety data sheets (MSDS), health effects, risk assessments, controlling the risk of exposure

Type of hazardous substance - chemicals and pesticides
Use, storage, disposal, transport chemicals, pesticides, transporting dangerous goods, record keeping

Type of hazardous substance - lead
What is lead, exposure methods, health effects, controlling the risks, lead-based paint, lead audit checklists

Dangerous practices with hazardous materials
Dangerous practices include extending diesel fuel and using flammable refrigerant gas in car air conditioners

Hazardous substances and laboratories
What to consider when using hazardous substances in laboratories

Dangerous goods
Definition, classes of dangerous goods, key stakeholder agencies, managing the risks, transport and storage

Type of dangerous goods - ammonium nitrate
Hazards, storage and handling, risk management

Type of dangerous goods - gas cylinders
Hazards, class diamonds for gases, storage, handling, housekeeping, safety signs, emergency planning

Managing incompatible goods
Storage, segregation tool, segregation methods, other issues including fire fighting, cleanup equipment, non-dangerous goods and situations involving small quantities

What law applies

In order to understand the workplace health and safety requirements for hazardous materials, and your obligations under the law you must consider and understand relevant legislation and codes of practice.

General health and safety obligations

To understand your obligations and safety requirements you must be familiar with the:
Workplace Health and Safety Act 1995 which imposes obligations on people at workplaces to ensure workplace health and safety. The *Workplace Health and Safety Act 1995* also helps you to meet your workplace health and safety obligations through:

- The *Workplace Health and Safety Regulation 2008* which describes what must be done to prevent or control certain hazards which cause injury, illness or death
- codes of practice, which are designed to give practical advice about ways to manage exposure to common risks. In particular, the *Risk Management Code of Practice 2007* should be read in conjunction with information on PPE.

Every Queensland employer must have **workers' compensation** insurance. Most employers insure with WorkCover Queensland, while a small number of large organisations have their own insurance. This insurance coverage ensures that employees injured at work receive financial support.

What you must do

It is a requirement of the *Workplace Health and Safety Act 1995* that risks must be assessed and control measures then implemented and reviewed to prevent or minimise exposure to the risks.

If the *Workplace Health and Safety Regulation 2008* describes how to prevent or minimise a risk at your workplace you **must** do what the regulation says. If there is a code of practice that describes how to prevent or minimise a risk at your workplace you **must** do what the code says or adopt and follow another way that gives the same level of protection against the risk.

If there is no regulation or code of practice about a risk at your workplace you **must** choose an appropriate way to manage exposure to the risk. People must, where there is no regulation or code of practice about a risk, take reasonable precautions and exercise proper diligence against the risk.

See the *Risk Management Code of Practice 2007* for further information.

Specific legislation for hazardous materials

Hazardous substances

Part 13 - Hazardous substances, of the *Workplace Health and Safety Regulation 2008* clearly sets out the way workplace health and safety risks from certain hazards must be managed.

Part 17 of the *Workplace Health and Safety Regulation 2008* clearly sets out the way workplace health and safety risks from certain hazards must be managed at construction workplaces.

Lead

Part 14 - Lead, of the *Workplace Health and Safety Regulation 2008* describes how to prevent or minimise the risk to health from exposure to lead at a workplace.

Dangerous goods

The *Dangerous Goods Safety Management Act 2001* and *Dangerous Goods Safety Management Regulation 2001* clearly sets out obligations for dealing with dangerous goods including storage and handling, transport of goods too dangerous to be transported under the Australian Dangerous Goods Code, combustible liquids, major hazard facilities, dangerous goods locations, and minor storage workplaces.

The Queensland Department of Emergency services *Guide to the Dangerous Goods Safety Management Act 2001* (PDF, 88 KB) outlines these obligations, and provides definitions and information to help explain requirements under the Act.

Specific codes of practice for hazardous materials

Please note, from 18 November 2004 the *Workplace Health and Safety Act 1995* was amended so that:

- all advisory standards that were in force on that day were continued as codes of practice and now expire 10 years after their commencement; and
- all existing industry codes of practice that were in force on that day now expire 10 years after their commencement.
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The *Hazardous Substances Advisory Standard 2003* (now known as a Code of Practice) has been developed for people working with hazardous substances. It gives practical advice on ways to manage specific risks that arise when hazardous substances are used at workplaces.

The *Rural Chemicals Industry Code of Practice 2000* states ways to manage risks to health and safety arising from the storage and use of chemicals at rural workplaces.

What are hazardous materials?

Understanding hazardous materials
What they are, what they are not, hazardous substances, dangerous goods, examples

Material Safety Data Sheets (MSDS)
What is an MSDS, what should be included on container labels

Health effects from hazardous substances
What are the health effects and how do hazardous substances get into the body

Assessing the risk of exposure
Who is responsible for managing exposure and how to conduct a risk assessment

Controlling the risk of exposure
Methods of control including monitoring, health surveillance, training and emergency procedures

Understanding hazardous materials

Hazardous substances, lead hazardous substances, stated dangerous goods and combustible liquids are examples of **hazardous materials** classified according to their relevance to workplace health and safety.

Materials are classified as hazardous substances if they meet the National Occupational Health and Safety Commission's Approved Criteria for Classifying Hazardous Substances. Materials are also classified as hazardous substances if their name appears in the NOHSC publication titled "List of Hazardous Substances" and are found above the stated cut-off concentrations in that publication.

Hazardous materials, if not stored or handled correctly, can cause harm to workers, members of the public, property and the environment due to their physical, chemical, and biological properties.

Hazardous materials include many commonly found industrial, commercial, pharmaceutical, agricultural and domestic chemicals.

Examples of some hazardous materials include:

- paints
- drugs
- cosmetics
- cleaning chemicals

- degreasers
- detergents
- gas cylinders
- refrigerant gases
- pesticides
- herbicides
- diesel fuel
- petrol
- liquefied petroleum gas
- welding fume.

Hazardous substances are chemicals and other substances including most dangerous goods for which a **manufacturer** or **importer** must prepare, amend, provide and review a Material Safety Data Sheet (MSDS).

Hazardous materials can cause adverse health effects such as asthma, skin rashes, allergic reactions, allergic sensitisation, cancer, and other long term diseases from exposure to substances.

Material Safety Data Sheets (MSDS)

What is an MSDS?

An MSDS is a document containing important information about a hazardous substance and must state:

- a hazardous substance's product name
- the chemical and generic name of certain ingredients
- the chemical and physical properties of the hazardous substance
- health hazard information
- precautions for safe use and handling
- the manufacturer's or importer's name, Australian address and telephone number.

The MSDS provides employers, self-employed persons, workers and other health and safety representatives with the necessary information to safely manage the risk from hazardous substance exposure.

It is important that everyone in the workplace knows how to read and interpret a MSDS.

Access to MSDS

Access to a MSDS can be provided in several ways including:

- paper and microfiche copy collections of MSDS with microfiche readers open to use by all workers
- computerised and internet MSDS databases.

The register of MSDS should be used as an information tool to make sure everyone is involved in managing hazardous substances exposure at the workplace.

A MSDS should be reviewed whenever there is:

- a change in formulation which:
    - affects the hazardous properties of the substance
    - alters the form, appearance or mode of application of the substance
- a change to the hazardous substance which alters its health and/or safety hazard or risk
- new health and/or safety information on the hazardous substance such as exposure standard changes or a substance previously considered not harmful is now established to be harmful (e.g. carcinogenic)
- at least every five years.

In respect of MSDS and labels, **employers** and **self-employed persons** must:

- Obtain an MSDS of a hazardous substance from the supplier.
- Keep a register containing a list of all hazardous substances used at the workplace and put a copy of any MSDS obtained in the register.
- Take reasonable steps to ensure the MSDS is not changed other than by the manufacturer or importer.
- Keep the MSDS close to where the substance is being used.
- Ensure a label is fixed to a hazardous substance container.
- Ensure warnings are given about enclosed systems containing hazardous substances.

Retailers are not required to distribute MSDSs. However, if a hazardous substance is purchased from a retailer, and the substance is for use at a workplace, an MSDS can be requested from another supplier of the hazardous substance such as the manufacturer or importer.

In certain circumstances a **supplier** must provide copies of the MSDS to the workplace and fix a label to the containers of all classified hazardous substances because the substances:

- are on the National Occupational Health and Safety Commission (NOHSC) List of Designated Hazardous Substances
- on the designated list and are contained in a substance above a certain concentration
- meet the Approved Criteria (because of health effects).

More information about MSDS is provided in Section 1 of the *Hazardous Substances Advisory Standard 2003* (now known as a Code of Practice).

The format and content for a MSDS used in Australia is set out in the 'National Code of Practice for the Labelling of Workplace Substances'.

Employers can also ask the supplier of a hazardous substance for a 'National Industrial Chemicals Notification and Assessment Scheme (NICNAS) summary report' which provides more detailed advice about health hazards and control measures.

Labelling and decanting

Suppliers, employers and self-employed persons have specific labelling obligations for all hazardous substances containers in the workplace.

What is on the label?

The label must be in English and contain the following:

- name of the product
- risk and safety phrases – as stated in NOHSC's document entitled 'National Code of Practice for the Labelling of Workplace Substances' that gives information about the substance's or lead's hazards
- chemical names of particularly hazardous ingredients
- chemical or generic names of certain other ingredients.

If the manufacturer has amended a MSDS, the label should be changed to ensure that it is consistent with the information in the amended MSDS.

Containers of decanted hazardous substances at the workplace must be labelled with the product name and basic health and safety information (risk and safety phrases) from the supplier's label.

More information about labelling and decanting is available in Section 2 of the *Hazardous Substances Advisory Standard 2003* (now known as a Code of Practice).

Health effects from hazardous substances in workplaces

It is important when using **hazardous materials** in the workplace they are properly controlled if they are:

- toxic
- harmful
- corrosive
- irritant
- sensitising
- carcinogenic (causing cancer)
- mutagenic (causing genetic damage)
- teratogenic (causing abnormalities of the foetus).

Some of the **health effects of exposure** to hazardous materials include:

- skin irritation
- occupational asthma
- systemic chemical poisoning
- chemical burns from corrosives
- cancer.

Factors that determine whether illness or disease occurs include:

- amount and route of exposure
- simultaneous exposure to other hazardous substances
- sensitivity to the substance's effects.

Some of the **ways** hazardous materials can enter the body include:

- breathing in (inhalation)
- skin contact (where skin is the target organ)
- absorbed through the skin and mucous membranes of the eye
- accidentally swallowed by eating or smoking with contaminated hands
- accidental injection through the skin.

These health effects can be acute, resulting from short-term (usually high) exposure, or chronic, resulting from long term (often low level) exposure over a period of time. Chronic effects may not occur for many years and the cause is often hard to identify.

Assessing the risk of exposure from Hazardous Substances

Who is responsible?

Employers and self-employed persons must manage the risk from worker exposure to hazardous substances in the workplace to prevent serious illness or disease.

The following issues need to be considered to manage the risk when people are exposed to hazardous materials in the workplace:

- assessing the risk
- controlling the exposure
- reviewing health and exposure
- recording risks
- training workers.

Workers must:

- use personal protective equipment (PPE) where it has been supplied by the employer and in the correct manner
- follow instructions given to ensure health and safety
- not wilfully misuse anything provided by the employer to ensure health and safety.

If the workplace has a **Workplace Health and Safety Committee**, the committee can assist the employer to plan, implement and monitor measures to reduce the exposure to hazardous materials in the workplace. When a hazardous material is to be introduced into the workplace or any changes to the way work is done with a hazardous material, the employer must consult with the committee representative (WHSR).

If an employee is concerned about the way a hazardous material is used in the workplace, they can raise the matter with the committee or the WHSR.

Conducting a risk assessment and keeping a record for hazardous substances

To carry out a risk assessment associated with the use of hazardous materials, **employers and self-employed persons** need to consider the following:

- the identity of hazardous materials used at the workplace
- a review of the hazardous substance's health effects from the MSDS and label

- how hazardous materials are used
- how people are exposed to hazardous materials
- how exposure to hazardous materials should be controlled
- whether the risk from the hazardous material is significant
- are monitoring or health surveillance required
- a written record of the risk assessment.

Employers can use a generic assessment prepared by an industry body rather than develop one. If an employer does use a generic risk assessment, it must be from a similar type of workplace e.g. a service station should use a generic risk assessment developed for service stations.

Controlling the risk of exposure

Managing the risk

Managing risks from hazardous materials should be applied in the work locations under certain working conditions.

Exposure to hazardous materials can be managed according to the outcome of the risk assessment by following the 10 step process outlined in Section 5 of the *Hazardous Substances Advisory Standard 2003* (now known as a Code of Practice).

Other ways to reduce exposure to hazardous substances include:

- removing a non-essential hazardous materials
- using a less hazardous materials or the same substance in a less hazardous form or process
- separating a process from people by distance or by barriers like separating the area for mixing and preparing chemicals with limited access
- using machinery, equipment or processes that minimise workplace contamination by containing or removing hazardous materials
- changing the way that people do the job or having procedures about how to do the job safely like limiting the period of exposure for a worker
- providing personal protective equipment or clothing like respirators, gloves or eye protection that is suitable for the material, the task of the operator, fitted to the worker and complies with relevant Australian Standards.

Specific controls used including personal protection must be regularly maintained to ensure exposure to the hazardous material is prevented or minimised.

Where this not possible, the level of the hazardous material in workplace air should be controlled so that a worker's exposure does not exceed any relevant exposure standard listed in the NOHSC Exposure Standards for Atmospheric Contaminants in the Occupational Environment.

Exposure can be estimated and compared with the Hazardous Substances Information System.

Monitoring

Monitoring is the periodic and/or continuous sampling of the air a worker breathes at a workplace to check exposure to a hazardous substance.

If monitoring is required, employers and self-employed persons must:

- Make sure monitoring is done as soon as possible and record the results.
- Make sure the exposed person is given a copy of the record and can inspect the record at any time.

Monitoring should cover:

- all environmental and process variables
- the collection of enough data needed to estimate any Time Weighted Average (TWA), Short Term Exposure Limit (STEL) Peak Limitation
- the correct selection of workers from groups doing the same or different tasks
- whether monitoring is for simple legislative compliance or for health surveillance.

Monitoring can be conducted in the workplace using direct reading indicating devices or by collecting a sample for later laboratory analysis or a combination of both.

More information about monitoring is provided in Section 7 of the *Hazardous Substances Advisory Standard 2003* (now known as a Code of Practice).

Health surveillance

Health surveillance is the monitoring (including biological monitoring) of the health of workers to identify any changes caused by exposure to a hazardous substance. Any requirement for health surveillance will be determined by the risk assessment. Monitoring can be done through the testing of body fluids such as blood and urine or body function.

If health surveillance is required, employers and self-employed persons must:

- Arrange and pay for the health surveillance to be done by or under supervision of a designated doctor.
- Ask the designated doctor for a health surveillance report and explain the report to the worker.
- Keep the report as a record at the workplace.
- Obtain a worker's medical record only with the worker's written consent.
- Disclose the contents of the worker's medical record only with the worker's written consent.

The designated doctor should be:

- Willing to visit the workplace to gain an understanding of the hazards and work processes.
- Able to communicate well with the workers.

The designated doctor should be provided with:

- access to a list of the hazardous substances, names of the workers requiring health surveillance and a copy of the MSDS and exposure standard for the substances
- any monitoring results and access to any relevant assessment reports.

More information about health surveillance is provided in Section 8 of the *Hazardous Substances Advisory Standard 2003* (now known as a Code of Practice).

A list of hazardous substances that require health surveillance is provided in Schedule 6 of the *Workplace Health and Safety Regulation 1997*.

Consultation

Consultation is an important part of managing workers' exposure to hazardous substances.

Employers have a responsibility to their workers to:

- Consult with a worker over the choice of a designated doctor.
- Provide a copy of a monitoring record result to a worker who may be exposed.
- Allow a worker to inspect the monitoring and risk assessment records at any reasonable time.
- Allow a worker to inspect the MSDS register at any reasonable time.

More information about consultation is provided in Section 3 of the Hazardous Substances Advisory Standard 2003 (now known as a Code of Practice).

Training

Training ensures that workers have the knowledge and skills to use a hazardous substance without risking their health and the health of others.

Employers and self-employed persons have a responsibility to their workers to:

- Provide induction and ongoing training about exposure to hazardous substances.
- Keep a record of the induction and training for five years stating date of the session, the topics dealt with, the name of the person who conducted the session and the names of the attendees.

More information about training is provided in Section 4 of the *Hazardous Substances Advisory Standard 2003* (now known as a Code of Practice).

Emergency procedures

In the event of a leak, spill or uncontrolled release of a hazardous material, emergency procedures should be established to enable the source of a release to be safely identified and repairs to be made. Everyone not directly affected by the emergency should be excluded from the area of contamination.

Emergency procedures may include special treatment in the workplace of affected workers where this is indicated in the Material Safety Data Sheet (MSDS). Where medical treatment is subsequently sought, the MSDS should also be made available to the medical practitioner.

More information about emergency procedures is provided in Section 6 of the *Hazardous Substances Advisory Standard 2003* (now known as a Code of Practice) and Section 2.5 of the *First Aid Advisory Standard 2004* (now known as a Code of Practice).

Type of hazardous substance – Rural chemicals and pesticides

Information on chemicals and pesticides used within the rural industry is available through the Safe use, storage and disposal of rural chemicals section of this site.

Type of hazardous substance - lead

What is lead and how can I be exposed?
Definition of lead and the types of work that can expose you to lead

How to avoid lead exposure
Use of personal protective equipment (PPE), dealing with contaminated clothing, good hygiene practices

Health effects from lead absorption
Symptoms of lead absorption, who is at risk, what to do if you suspect lead poisoning

How to control lead risks
Who is responsible for controlling the risks, what to do

Working with lead-based paint
Testing for lead, safe removal methods, general site housekeeping

Lead audit checklist
A checklist for employers and self-employed persons to ensure compliance with the Regulation

Lead paint removal/residential buildings audit checklist
A checklist for employers and self-employed persons dealing with lead paint to ensure compliance with the Regulation

What is lead and how can I be exposed?

Lead is a metal obtained from mining lead ore, which is used in a number of forms including pure metal, alloys (mixtures of metals) and as lead compounds. It has many uses including vehicle batteries, solder, paint pigments and as a stabiliser to protect plastic from sun damage.

The definition of lead is provided in Schedule 9 of the *Workplace Health and Safety Regulation 1997*.

Some of the workplace activities exposing people to lead include:

- dry machine grinding, discing, buffing or cutting of lead
- manufacturing or recycling lead-acid batteries
- repairs to radiators or vehicle exhaust systems
- melting or casting of lead or alloys containing lead e.g. lead dampcourse, trophies, yacht keels, leaded brass
- removal of lead paint from surfaces by dry sanding, heat or grit blasting
- demolition involving oxy-cutting of structural steel primed with lead paint

- fire assay involving lead
- handling of lead compounds causing lead dust e.g. from dry lead pigments, lead UV stabilisers
- spray painting with lead paint (> 1% lead by dry weight).

A list of lead process activities is provided in Schedule 9 of the Workplace *Workplace Health and Safety Regulation 1997*.

How to avoid lead exposure

- Wear protective clothing like overalls, disposable overshoes, hat and gloves.
- Do not use practices that produce dust clouds containing lead (e.g. dry sweeping, using compressed air to clean areas contaminated with lead, use of ordinary vacuum cleaners without HEPA filters).
- Wear a respirator designed in accordance with Section 8.4.3 of AS 1716 - *Respiratory protective devices* for the method used.
- Do not use inexpensive disposable dust masks with a single elastic strap, as they do not provide adequate respiratory protection against lead dust or lead fume hazards.
- Make sure the respirator fits and seals the face. To seal properly the face must be cleanly shaven. If you have a beard, you should wear a powered air-purifying respirator fitted with P2 or P3 filters.
- Store the respirator face down, in a sealed container away from the hazard source when not in use. Do not hang it by the straps.
- Check that the respirator is free of dust inside, all valves are in good condition and correct filters are fitted and in good condition before use.
- Leave the respirator on until the protective clothing has been removed.
- Change coveralls and overshoes before leaving the work area to avoid contaminating other areas.
- Use nailbrushes to wash hands and face thoroughly before smoking, eating or drinking near the work area.
- Do not take lead contaminated clothing home for laundering. Employers are responsible to ensure that lead contaminated clothing is laundered.
- Shower and wash hair as soon as possible after finishing work.
- Have your blood levels checked by a designated doctor if you are working with lead-based paint.

Health effects from lead absorption

Lead particles can be inhaled through dust or fumes or swallowed through eating contaminated food or smoking with contaminated fingers. Untreated

lead poisoning in adults, children and pets can be fatal. Often pets are the first to show signs of lead poisoning.

Lead poisoning symptoms

Common symptoms of lead poisoning are:

- loss of appetite
- constipation
- diarrhoea
- loss of weight
- severe abdominal pains
- muscle weakness
- limb paralysis
- headaches
- tiredness
- irritability.

Continued exposure or high levels of exposure can cause:

- anaemia
- kidney damage
- nerve and brain damage.

What to do if you suspect lead poisoning

Consult a doctor immediately if lead poisoning is suspected.
The doctor should order a blood test to determine if lead has been absorbed.

Who is at risk?

- anyone visiting the workplace (workers, employers, customers, maintenance workers)
- anyone removing lead-based paint
- people in premises neighbouring the workplace
- family members exposed to lead carried home on the clothing of a worker, employer or self-employed person
- children, pregnant and breastfeeding women.

Lead exposure during pregnancy is of particular concern because it can cross the placenta and at low levels has been shown to be harmful to the foetus, affecting the baby's nervous system. Children are also at risk because even the low amounts of lead that are absorbed by a child can result in a reduction of the child’s intellectual development.

How to control lead risks

Who is responsible?

Lead is a highly toxic cumulative poison for which:

- **manufacturers and importers** must prepare, review, amend and provide Material Safety Data Sheets; and
- **suppliers** must provide the Material Safety Data Sheets and label lead containers.

Employers and self-employed persons must:

- Conduct a risk assessment, control and review control measures.
- Provide health surveillance by a designated doctor for workers in lead-risk jobs.
- Conduct atmospheric monitoring for lead-risk jobs.
- Temporarily remove anyone with high blood lead levels and exclude workers who are pregnant or breastfeeding or have a specific medical condition.
- Consult with workers on choosing a doctor.
- Maintain confidentiality of workers' medical records.
- Provide induction and training.
- Record information about lead exposure and training provided.
- Provide workers and workplace health and safety representatives with access to records.
- Notify Workplace Health and Safety Queensland in the approved form:
    - notification of a lead-risk job
    - health surveillance report
    - summary of health surveillance reports.

Workers must:

- Participate in health surveillance.
- Tell the employer about a medical condition that may be adversely affected by exposure to lead.
- Tell the employer if pregnant and/or breastfeeding.

The lead audit checklist and the lead paint removal/residential buildings audit checklist will help identify the risks of working with lead.

More information about health effects of lead is available from:

- The Canadian Centre for Occupational Health and Safety

- Queensland Health 2002 *Public Health Guidance Note: Excessive Lead Exposure.*

Working with lead-based paint

How do I know if there's lead based paint?
Testing methods include do-it-yourself test kits, or laboratory testing

Alternatives to removal
Painting over lead paint, covering it with other materials

Safe lead paint removal methods
Methods include wet scraping, chemical strippers or dry sanding with HEPA filters

Site housekeeping
Setup, cleaning up and waste disposal

How do I know if there's lead based paint?

Lead based paint is most likely to be found on window frames, doors, skirting boards, kitchen and bathroom cupboards, exterior walls, gutters, metal surfaces and fascias on homes or structures built before 1970, or even interior walls.

Sometimes lead-based paint may be covered by more recently applied paint and becomes a workplace health and safety issue when the paint deteriorates and becomes powdery or flaky, or during paint removal.

- Test all surfaces and layers of paint to be removed to determine if the paint contains lead as lead-based paint cannot be identified by its appearance.
- A simple test kit available from some paint manufacturers and distributors can determine the presence of lead-based paint. Carefully read the manufacturer's instructions before using the test kit.
- Test kits can give false results, so if the swab gives a negative reading, but the age of the house indicates that lead-based paint could have been used, assume that lead-based paint is present or have the paint tested by a laboratory. Some analytical laboratories can provide a precise analysis of lead presence and its concentration.
- A list of accredited laboratories is available from the National Association of Testing Authorities of Australia (NATA) for environmental lead testing.

Alternatives to removal

If paint is in good condition there may be no need to remove it unless major renovation and comprehensive removal is planned. However, lead-based paint should be removed from areas that are likely to be chewed or licked by children, knocked or subject to friction.

Alternatives to paint removal include:

- painting over lead-based paint
- covering lead-based paint with other materials.

Painting over lead-based paint

- Only paint over lead-based paint if surfaces are in good condition. If the paint is flaking or chalking, prepare the surface by a light wet sanding with wet-and-dry sandpaper to help the paint stick to the surface. Take care not to generate lead dust or contaminate the area with water from the wet-sanding process.
- Painting over the paint is a temporary solution limited by the life of the paint.

Covering lead-based paint with other materials

- Cover lead-based paint on exterior surfaces with durable materials, such as aluminium cladding or weatherboard and thoroughly seal all gaps.
- Cover internal surfaces with durable materials that will not tear, chip or peel. These include plasterboard, vinyl wall coverings, wood panelling and floor coverings such as carpet, tiles or vinyl.

Safe lead paint removal methods

If you have decided to remove the paint, choose a safe removal method. Different ways of removing lead paint create different risks to health, which need to be properly controlled.

Safe methods include:

- Wet scraping
- Chemical strippers
- Wet hand sanding
- Low-temperature heat processes
- Dry power sanding with HEPA vacuum attachment sanding.

Wet scraping

Risk

- Dust may be produced during the scraping process if paint is not wet properly, spreading flakes of paint around the worksite.

Control

- Wear a half face respirator with P2 particulate filter during removal and clean up.
- Use plastic drop sheet that has the edges raised with wooden studs to collect water.
- Collect paint debris properly.

Chemical strippers

Risk

Some strippers contain flammable solvents which can burn the skin or produce vapours that are highly toxic. Even after chemical stripping has been done, sanding after this method may still produce lead dust.

Control

- Wear a half face respirator for organic vapours, safety glasses, overalls and chemically resistant gloves. If further sanding is required after applying a chemical stripper, wear a combined particulate and organic vapour filtration cartridge respirator.
- Consult the MSDS for further information.
- Ensure windows and doors are open.

Wet hand sanding

Risk

Dust may be produced if paint is not wet properly before sanding. Fine lead residue is left after water dries.

Control

- Wear a half face respirator with P2 particulate filter during removal and clean up.
- Use plastic drop sheet that has the edges raised with wooden studs to collect water.
- Wash down surfaces carefully.

Low-temperature heat processes

Risk

This method is unlikely to produce lead fume unless the paint smokes from too much heat being applied. Dust may also be produced during the scraping process if the paint has started to reharden.

Control

- Wear a half face respirator with P2 particulate filter if smoke is present. Toxic fumes can be generated at temperatures as low as 200ºC and heat guns should be controlled to ensure that this temperature is not exceeded.
- Scrape softened paint directly into a disposable container before it rehardens to avoid having to sand or scrape to clean it up.

Dry power sanding with HEPA vacuum attachment sanding

Risk

Lead dust may be generated if the shroud of the sander extends beyond the surface being sanded or if the sander is not kept flat on the surface.

Control

- Training and experience.

Site housekeeping

How to set up the site

When working on the exterior of the building:

- Complete exterior work before doing the interior. Remove any lead dust in the house generated by exterior work during the interior clean up.
- Cover the ground and vegetation with plastic sheeting extended two metres from the base of the house and an additional metre for each storey to catch dust and debris.
- Use impervious materials such as tarpaulin or plastic sheeting to prevent dust from travelling to neighbouring properties. Attach the tarpaulin to house guttering at the top and to the plastic ground sheet at the bottom.
- Use bricks or rocks to hold the edges of the plastic sheeting in place and place wooden studs under the edges of the sheeting to contain liquid.

- Close windows and doors to prevent dust from entering the building.
- Avoid working in windy conditions, as the lead dust and paint might be blown off the plastic sheeting as it dries.
- Move play equipment and personal belongings away from the work area and cover sandpits.
- Advise the neighbours to close windows and doors while exterior work is being done, move play equipment away from the boundary fence and cover their own sandpits.
- Exclude all others from the work area, especially pregnant women, children and pets.

When working on the interior

- Remove furniture, rugs, curtains, food, clothing and other household items.
- Cover the floor with disposable double plastic sheeting and tape the sheeting to the skirting boards. Dispose of the top sheet with the debris.
- Keep the bottom sheet in place during the wash down.
- Cover or temporarily remove carpet to prevent it becoming contaminated with lead dust. Lead dust is difficult to remove from carpet, even with a HEPA vacuum cleaner. Carpet exposed to chalking or flaking paint, may need to be replaced.
- Cover openings, such as gaps around pipes and between floorboards, immovable surfaces such as counter-tops and shelves with plastic sheeting and heavy-duty tape to prevent dust from entering.
- Tape around the door seals of refrigerators.
- Turn off forced-air heating and air conditioning. Cover and seal doors and air ducts for heating and cooling systems.
- Cover entrances to the work area with two lengths of plastic sheeting which overlap each other in the middle. Tape the outside edges at the top and sides to the door jambs.
- Close the windows unless using a torch or open flame or chemical strippers.
- Use exhaust fans when using chemical strippers indoors.
- Repair or replace torn sheets immediately.
- Exclude all others from the work area, especially pregnant women, children and pets.

How to clean the site

- Remain in protective clothing, including gloves and respirator when cleaning the site.
- Place large disposable items including the plastic sheet and other debris into tough plastic bags.
- Vacuum all surfaces including the tarpaulin used for exterior work with a suitable commercial vacuum cleaner fitted with a HEPA filter.

- Wet-clean hard surfaces using a carpet steam cleaner or by wet mopping several times. Put dust into tough sealable plastic bags. Alternatively, some contract cleaning services offer an effective chemical method of removing lead dust.
- Do not use a broom, compressed air or a vacuum cleaner without a HEPA filter as it will spread lead dust.
- Use a spray bottle to wet down all dust and debris lying on the plastic sheeting before taking them up.
- Wipe down all surfaces in the work areas with a damp cloth.
- Wash the area with 25 grams of 5% trisodium phosphate (TSP) in 5 litres of hot water or sugar soap. Renew the solution frequently to prevent it becoming contaminated.
- Dispose of cloths and mops to avoid spreading lead dust during cleaning.
- Vacuum dry surfaces such as skirting boards, architraves, window sills, casings, shelves and counter-tops until no dust or residue remains.
- Dampen dusty outside areas with spray from a garden hose and sweep and collect debris. Avoid dry sweeping since it spreads lead dust.
- Shovel paint debris into heavy-duty plastic bags.
- Remove the top layer of contaminated soil and put into tough sealable plastic bags.
- Clean tools with TSP solution or sugar soap.
- Clean respirators after use and store them in a container away from the lead source.
- Remove contaminated clothing before leaving the work area and place clothes in a plastic bag until washed.
- Clean up the site frequently throughout the day and vacuum at the end of each day.

How to dispose of lead contaminated waste

- Place lead-containing debris into deflated heavy-duty plastic bags and seal them.
- Pour lead-contaminated water generated as a result of wet scraping or sanding, or during clean-up, into a strong, securely sealed container.
- Provide short-term secure storage.
- Transport debris and solid waste materials containing lead to waste systems.
- Check with the waste management section of the local council about proper waste disposal.
- Ensure that all bulky items are covered during transportation.

The lead paint removal/residential buildings audit checklist and the lead audit checklist will help you identify and control the risks of working with lead.

More information for homeowners when removing lead-based paint is available from:

- *AS 4361.2 - Guide to lead paint management - Residential and commercial buildings*
- Department of Environment and Heritage, Six-Step Guide To Painting Your Home.

More information about health effects of lead is available from:

- Department of Environment and Heritage, Lead alert facts: Lead and Your Health
- The Canadian Centre for Occupational Health and Safety
- Queensland Health 2002 *Public Health Guidance Note: Excessive Lead Exposure.*

Lead audit checklist

This checklist will help employers and self-employed persons at a workplace where a lead process is carried out to comply with all sections of Division 4, Part 14 Lead of the *Workplace Health and Safety Regulation 1997*.

Date: _____ Workplace: _____

Auditor: _____

A=Audited NC=No Compliance N/A=Not Applicable Yes/No answers go in remarks column

		A	NC	N/A	Remarks
1	Is a lead process being carried out at this workplace? (See definition of a lead process in Schedule 9 of the Regulation)				
Material Safety Data Sheet (MSDS)					
2	Has the MSDS been obtained?				
3	Is a copy of the MSDS close to where the lead is being used?				
Register					
4	Is there a lead register?				
5	Is a copy of the lead MSDS placed in the register?				
6	Are exposed workers allowed to inspect the register?				
Labelling					
7	Are containers correctly labelled, including where it is transferred to a second container?				
Risk assessment					
8	Has a risk assessment been conducted?				
	Does it include:				
9	An identification of the lead used at the workplace?				
10	A review of the MSDS or if the MSDS is not available, a review of equivalent information?				
11	If the substance is in a consumer package, a review of the package's label?				
12	A decision about whether a job in a lead-risk process is a lead-risk job?				
13	A decision on atmospheric monitoring and control measures?				

		A	NC	N/A	Remarks
14	Is the risk assessment done annually if, in the last assessment, the process was assessed to include a lead-risk job?				
15	Has the employer notified the Workplace Health and safety Queensland, in the approved form within 28 days of the assessment, that the process includes a lead-risk job?				
16	Is the risk assessment done every five years if, in the last assessment, the process was assessed not to include a lead-risk job?				
17	If the process can be changed to a process that does not include a lead-risk job, has a plan been developed to do that?				
18	If the process cannot be changed to a non lead-risk job, has a plan been developed to minimise the risk to health from lead?				
19	Is the plan as above been developed in consultation with workers and workplace representatives?				
20	Does the plan contain specific aims and ways of deciding whether aims are being achieved?				
Controlling exposure					
21	Has exposure been controlled and how?				
22	Is exposure less than the national exposure standard for lead?				
23	Is exposure controlled, as far as is practicable, by ways other than by the use of PPE?				
24	Are control measures, including engineering controls, safe work practices effectively maintained?				
	Does the employer ensure the following:				
25	Lead used in the lead process area does not, as far as is practicable, contaminate other areas of the workplace?				
26	Workers are not exposed to the risk of lead in an area provided by the				

		A	NC	N/A	Remarks
	employer for eating and drinking?				
27	Workers wash their forearms, hands and face at the washing facility before eating and drinking?				
28	No one eats, chews gum, smokes or carries anything used for smoking in a lead process area?				
29	No one in a lead process area drinks from anything other than a drinking facility that is made free from lead contamination?				
30	That the workplace is cleaned of lead?				
31	The lead process area is not cleaned by compressed air or other compressed gas or dry sweeping?				
32	A shower facility is provided?				
33	A worker does not take lead contaminated clothing home for laundering?				
34	Lead contaminated clothing is laundered?				
Personal protective equipment (PPE)					
35	If exposure cannot be controlled other than by PPE, is appropriate PPE provided?				
36	Are workers properly instructed in the use of PPE?				
37	Are systems in place to ensure that workers use PPE when being exposed to lead?				
38	Have warning signs been erected showing the need to wear the PPE in the lead process area?				
39	Is PPE maintained?				
Atmospheric monitoring					
40	Has monitoring been conducted?				
41	Have monitoring results been recorded?				
Health surveillance					
42	Is health surveillance conducted?				
45	Is health surveillance conducted for workers:				
44	Before they start work in a lead-risk job?				
45	One month, three months and then six months after the worker starts work?				

		A	NC	N/A	Remarks
46	Is health surveillance conducted by a designated doctor?				
47	Has the employer asked the designated doctor to give the employer and the worker the health surveillance report as soon as possible after it is done?				
48	Does the designated doctor give the worker the results of biological monitoring?				
49	Has the employer notified Workplace Health and Safety Queensland, in the approved form, of the results of the health surveillance within 6 months of receiving the report?				
50	Does the employer pay for the health surveillance of workers?				
Reviewing control measures					
	If the worker is required to be removed from a lead-risk job because of elevated blood lead levels, does the employer:				
51	Identify how the worker was exposed to the lead?				
52	Review the control measures?				
53	Control the exposure?				
Removal from a lead-risk job					
	Is a worker removed from a lead-risk job when the designated doctor recommends removal because of the following:				
54	Elevated blood lead levels?				
55	Medical condition that may be adversely affected by exposure to lead; or				
56	Is pregnant or breast-feeding?				
57	Has a worker, in the opinion of the employer or worker ever been exposed to an excessive level of lead?				
58	Did the employer remove the worker from a lead-risk job?				
59	Was health surveillance conducted within 7 days of exposure?				
Return to a lead-risk job					
60	Does the employer ensure that the worker is not returned to a lead-risk job				

		A	NC	N/A	Remarks
	until the designated doctor advises the worker may return?				
Confidentiality of worker's medical record					
61	Does the employer disclose the contents of a worker's medical record to anyone other than the worker, without the worker's written consent?				
Induction and training about lead					
62	Is induction and ongoing training provided?				
Records					
	Are records kept of:				
64	Workers who work in a lead-risk job – 30 years?				
65	The risk assessment record of a job that has been assessed as a lead-risk job – 30 years?				
66	Monitoring results – 30 years?				
67	Health surveillance report – 30 years?				
68	A record of the date when a person was removed from, or returned to, the lead-risk job – 30 years?				
69	The risk assessment record of a process that does not include a lead-risk job – 5 years?				
70	Induction and training – 5 years?				
Do the risk assessment record state the following:					
71	The date when the assessment was done?				
72	The results of the atmospheric monitoring?				
73	Whether the process was assessed to include a lead-risk job?				
74	The lead's product name or other identification?				
75	The control measures that were in place when the assessment was done?				
Do the training records include the following:					
76	The date of the session?				
77	The topics dealt with at the session?				
78	The name of the person who conducted the session?				
79	The names of the workers who attended the session?				

Lead paint removal/residential buildings audit checklist

This checklist will help employers and self-employed persons to comply with all sections of Division 4, Part 14 Lead of the *Workplace Health and Safety Regulation 1997*.

Date: _____ Workplace: _____

Auditor: _____

A=Audited NC=No Compliance N/A=Not Applicable Yes/No answers go in remarks column

		A	NC	N/A	Remarks
	Lead process				
1	Has a test to determine the lead in paint been conducted?				
2	What method of testing was used?				
3	Will any of the following methods be used to remove lead based paint?				
4	Wet scraping and wet sanding?				
5	On site chemical strippers?				
6	Removal by heat gun and scraper?				
7	Sander with HEPA dust extraction facility attached?				
8	Other methods not listed?				
9	Is a lead process being carried out?				
	Risk assessment				
10	Has a risk assessment been conducted?				
11	Is this a lead-risk job?				
12	Has a record of assessment been kept?				
13	Has Workplace Health and Safety Queensland been notified, in the approved form, of the lead-risk job?				
	Controlling exposure				
14	Is exposure less than the National Exposure Standard for lead?				
15	Is exposure controlled, as far as is practicable, by ways other than the use of PPE?				
16	Has the employer ensured that lead used in the lead process area does not, as far as is practicable, contaminate other areas of the workplace?				
	Has the employer ensured that the				

		A	NC	N/A	Remarks
	following provisions are made:				
17	Workers are not exposed to the risk of lead in an area provided by the employer for eating and drinking;				
18	Before moving from the lead process area to an area used for eating and drinking, workers wash their forearms, hands and face at the washing facilities provided at the workplace;				
19	No one eats, chews gum, smokes or carries anything used for smoking in a lead process area;				
20	No one in a lead process area drinks from anything other than a drinking facility that is made free from lead contamination;				
21	The lead process area is not cleaned by compressed air or other compressed gas or dry sweeping;				
22	A worker does not take lead contaminated clothing home for laundering; and				
23	Lead contaminated clothing is laundered.				
	Have containment control measures as listed been implemented:				
24	Physical barriers to restrict access?				
25	Exclusion of persons from the work area?				
26	Security of the work area?				
27	Regular clean up and disposal of debris?				
28	Physical barriers to contain lead dust?				
29	Has a disposable polyethylene ground sheet been placed below the work area?				
30	Does the sheeting extend to two metres from the base of the building and an additional metre for each storey?				
31	Are there provisions made to hold the sheeting in place?				
32	Are systems in place to ensure the maintenance of the ground sheet? (tear)				
33	Is there a tarpaulin or plastic sheeting enclosure to prevent dust from travelling to neighbouring properties?				

		A	NC	N/A	Remarks
34	Is a vacuum cleaner fitted with a HEPA filter available for particulate removal?				
35	What other systems are in place to prevent lead dust and debris from spreading to the immediate area?				
	Have the following preparation precautions been taken:				
36	Have windows, doors, ventilators and other openings including eaves been adequately sealed?				
	Are the following systems in place to ensure workplace health and safety of workers:				
37	Project surveillance by a responsible person?				
38	Are there documented policies and procedures regarding implemented control measures and safe systems of work?				
39	Is water from wet processing collected and not disposed of to the sewer or stormwater outlet?				
40	Is all process water handled as hazardous waste?				
	Decontamination systems				
	Are the following decontamination systems in place:				
41	Frequent removal of accumulated debris to prevent spreading from the immediate work area?				
42	Provision of a HEPA vacuum cleaner for removing the remaining dust and particles from the surrounding area; or				
43	Systems to wet wash the surrounding area with sugar soap solution and rinsing with clean water?				
44	Disposal of the polyethylene sheeting or covers, or washing them down, and collecting the residue for safe disposal?				
45	Removal of paint dust from ledges, windows and walls with a damp cloth, and disposing of the cloth along with the paint debris?				
46	Is equipment cleaned thoroughly of dust and paint fragments before it leaves the work area?				

		A	NC	N/A	Remarks
	Personal protective equipment (PPE)				
47	What PPE is provided? Eg disposable overshoes, overalls and head covering for workers working within the work area? Wet sanding – Half face respirator with P2 particulate filter. Chemical stripping – Half face respirator with filter for organic vapours. Wet hand sanding - Half face respirator with P2 particulate filter. Low temperature heat processes – Half face respirator with P2 particulate filter. Dry power sanding with HEPA vacuum attachment sanding - Half face respirator with P2 particulate filter.				
48	Is appropriate PPE provided?				
49	Are contaminated overalls contained in a clean polyethylene bag before being removed from the work area?				
50	Are boots and gloves cleaned with a HEPA vacuum cleaner and then washed or wet wiped at the end of each working day?				
51	Are systems in place to ensure workers use PPE when exposed to lead?				
52	Is there a PPE maintenance program in place?				
	Atmospheric monitoring				
53	Has atmospheric monitoring been conducted?				
54	Have monitoring results been recorded?				
55	Is lead exposure less than the National Exposure for lead?				
	Health surveillance				
56	Is health surveillance conducted?				
57	Does a designated doctor conduct health surveillance?				
58	Is health surveillance conducted as per Section 133 (1) to (11) of the Regulation?				
59	Has Workplace Health and Safety Queensland been notified, in the approved form of the summary of health surveillance reports?				
	Induction and training about lead				

		A	NC	N/A	Remarks
60	Has the employer provided information and training about lead to workers who may be exposed to lead?				
61	Are training records kept?				
	Clean up				
62	Are procedures in place for the final clean up of lead dust paint?				
	Is equipment as listed provided for clean-up procedures:				
63	(a) plastic work gloves				
64	(b) spray bottle with water				
65	(c) Sugar soap cleaning solutions (tri-sodium phosphate), mixed in the ratio of at least 25g of 5% tri-sodium phosphate to each 5L of hot water.				
66	(d) disposal of cleaning items, such as lint-free towels, rags, sponges and mops.				
67	(e) HEPA filter vacuum cleaner				
68	Will there be any clearance testing done to determine if there has been a significant impact on the property and surrounding areas from the work and if the building is safe for normal use?				
	Waste management				
69	Has the local council been contacted to find out how to dispose of lead waste?				

Dangerous practices with hazardous substances

Extending diesel fuel

Diesel users need to be aware of the practice of extending diesel fuel.

When diesel is mixed with a blending agent such as kerosene or light crude oil the flashpoint of the fuel is altered and can increase the risk of fire or explosion. The practice may be an offence under the *Trade Measurement Act 1990* administered by the Queensland Office of Fair Trading.

Use of flammable refrigerant gas in car air conditioners

Motor vehicle personnel, emergency service workers and the public need to be aware of the practice that some car air-conditioning systems are being “regassed” with a flammable hydrocarbon refrigerant without labels specifying the flammable nature of the gas.

Even small quantities of gas in the system can result in a severe explosion and/or fire within the vehicle if there is a leak and an ignition source.

This matter is regulated by the Department of Natural Resources and Mines.

Hazardous substances and laboratories

The following should be considered when using hazardous substances in laboratories:

- The manufacturer or supplier of the material to be stored should be able to provide information in relation to any specific requirements about its storage. Seek this information at the time of acquisition of the material.
- Storage arrangements for each substance, usually outlined on the material safety data sheet (MSDS), should be in accordance with the manufacturer's specifications.
- MSDS's must be available for all hazardous substances stored.
- Unless there is a specific requirement for controlled temperature and humidity, good natural ventilation should provide storage conditions and a suitable work environment in case of leakage or minor spills.
- Spill control measures should be in place where any liquid is stored. A bund, designed as part of the building, is generally the most convenient form of spill control.
- Where corrosive or reactive materials are stored, the store should be constructed of materials of an inert nature, or where this is not practicable, the building should be designed so component replacement is possible.
- Buildings are required to be built of non-flammable material where flammable liquids are stored. All stores containing substances that will burn but are outside of Class 3 (primary or subsidiary risk within the Australian Dangerous Goods Code) should also be constructed of non-flammable material. For stores where amounts of particular substances are in excess of prescribed limits, appropriate Dangerous Goods licences must be held.
- Electrical work should be in accordance with AS/NZS 3000 *Electrical installations*. This may necessitate the installation of such devices as flameproof switches.
- All materials in the store should be properly labelled.

Operators of laboratories should also be familiar with dangerous goods.

Dangerous goods

What are dangerous goods?
The properties that define dangerous goods

Responsibilities for dangerous goods
Obligations for manufacturers, importers, suppliers, and occupiers

Classes of dangerous goods
Explanation of the different classes and examples

Key stakeholder agencies
Who is responsible in Queensland for the management of dangerous goods

Managing the risk from dangerous goods
Managing dangerous goods, avoiding explosions and emissions

Transport and storage of dangerous goods
Conditions of transport, hazards associated with storage, management of incompatible goods in the workplace

What are dangerous goods

Dangerous goods are defined under Schedule 1 of the *Dangerous Goods Safety Management Regulation 2001*. They have the potential to cause immediate harm to people, property and the environment due to the possibility of a fire, explosion, release of toxic, flammable, or corrosive materials during a storage or handling incident.

These materials may be dangerous because of one or more of the following properties:

- an ability to cause or accelerate combustion
- acute toxic effects
- an ability to cause corrosion of skin and other materials
- capacity to harm the environment
- potential to cause asphyxiation by displacement of oxygen
- temperature or pressure hazards
- ability to react with other materials adversely.

They are divided into nine classes, some of which are divided into sub-classes according to the nature of the hazard.

Responsibilities for dangerous goods

Under Division 2 of the *Dangerous Goods Safety Management Act 2001* and Part 2 of the *Dangerous Goods Safety Management Regulation 2001* everyone involved with dangerous goods at workplaces has obligations for workplace health and safety.

Manufacturers, importers and suppliers

Under Part 2 of the *Dangerous Goods Safety Management Regulation 2001* **manufacturers**, **importers** and **suppliers** of dangerous goods must:

- ensure that all such goods are safe for storage and handling;
- provide information regarding safe storage and handling with the dangerous goods, as well as Material Safety Data Sheets for each type of goods supplied;
- provide a label on all containers containing information on the UN number (a unique substance identifier), class subsidiary risk and packing group to which the goods belong.

Occupiers

Under Part 3 of the *Dangerous Goods Safety Management Regulation 2001* **occupiers** (employers, or other persons, who have overall management of the facility or workplace) have requirements for the prevention or control certain hazards at workplaces including:

- Dangerous goods locations and large dangerous goods locations
- Major hazard facilities
- Minor storage workplaces.

Ways to prevent or control hazards include:

- Identification of hazards, use of placards
- Maintaining manifests and registers
- Conducting risk assessments
- Training
- Personal protective equipment
- Protecting visitors
- Workplace security
- Planning for emergencies.

Employees (and other persons)

Under Division 2 of the *Dangerous Goods Safety Management Act 2001* employees or other persons must:

- comply with safety procedures
- comply with safety instructions
- report to supervisors any safety issues
- act to ensure no-one is exposed to an unacceptable level of risk.

Key stakeholder agencies

There are also key stakeholder agencies that have responsibilities to help regulate the storage, handling and transportation of dangerous goods, licence certain activities, and deal with emergencies.

Classes of dangerous goods

There are nine classes of dangerous goods. Workplace Health and Safety Queensland enforces the storage and handling of a subset of those nine classes, known as “stated dangerous goods and combustible liquids”.

These include:

- Class 2, 3, 4, 5, 6.1, 8, and 9;
- goods too dangerous to be transported and combustible liquids.

Identifying classes of dangerous goods

Schedule 3 of the *Dangerous Goods Safety Management Regulation 2001* outlines the requirements for the display of information about dangerous goods.

There are requirements for:

- HAZCHEM outer warning placards.
- Information placard for dangerous goods of Class 2, 3, 4, 5, 6.1, 8 or 9 stored in tanks.
- Information placard for tanks containing goods too dangerous to be transported.
- Information placard for stated dangerous goods stored in packages.
- Information placard for stated combustible liquids in tanks or packages.

The Department of Emergency Services CHEM unit list the diamonds or warning signs associated with each class.

Class 2.1 - Flammable gases

Flammable gases can be ignited in air. They may be lighter or heavier than air. Heavier than air gases can collect in low lying areas such as pits, depressions, and drains causing a fire and explosion hazard.

Examples include:

- liquefied petroleum gas (LPG)
- liquefied natural gas (LNG)
- hydrogen
- acetylene.

Class 2.2 - Non-flammable, non-toxic gases

Non-flammable, non-toxic gases are neither flammable or toxic.

Examples include:

- nitrogen
- carbon dioxide
- compressed air
- helium.

Some of these may cause an asphyxiation hazard (e.g. nitrogen, carbon dioxide). When asphyxiating gases are heavier than air they can collect in low lying areas and cause suffocation by the dilution or displacement of oxygen in air.

Class 2.2 - Non-flammable, non-toxic gases sub-risk 5.1 (Oxidising gases)

Oxidising gases are non-flammable, non-toxic gases with a sub-risk of Cass 5.1. These gases, although not flammable, can accelerate combustion and increase the risk of fire in the presence of combustible or flammable materials.

Examples include:

- nitrous oxide
- entonox
- nitrous oxide.

Class 2.2 - Toxic gases

On inhalation these may cause death or injury. Many of these also have other properties (e.g. may be flammable, oxidising or corrosive). Class 2.3 is never used as a subsidiary risk. If a material meets the criteria it will be classified as a toxic gas.

Examples of toxic gases include:

- anhydrous ammonia
- methyl bromide
- sulphur dioxide
- carbon monoxide.

Class 3 - Flammable liquids

Flammable liquids produce vapour that can be ignited in air on contact with a suitable ignition source. By definition these must have a flash point of less than or equal to 60.5 degrees Celsius.

Examples include:

- unleaded petrol (ULP)
- xylene
- kerosene
- acetone.

The flash point is the temperature at which a liquid can produce enough vapour to ignite in the presence of an appropriate ignition source.

Combustible liquids

Combustible liquids are not classified as dangerous goods but are designated as either C1 or C2 combustible liquids.

A C1 combustible liquid has a flashpoint between 60.5°C to 150 °C.

A C2 combustible liquid has flashpoint exceeding 150°C.

This information can be obtained by reviewing the chemical and physical properties of a material safety data sheet (MSDS).

An example of a C1 combustible liquid is diesel fuel. Many lubricating oils and cooking oils are examples of C2 combustible liquids.

Class 4.1 - Flammable solids

These materials are easily ignited and may cause fire through friction heat or other ignition sources.

Examples include: red phosphorous, hexamine, naphthalene, and camphor.

Class 4.2 - Substances liable to spontaneous combustion

These materials are flammable solids that a capable of spontaneous combustion being heated up in contact with air or moisture in air. Examples include:

- white phosphorous
- fish meal
- cotton waste.

Class 4.3 - Substances that in contact with water emit flammable gases

On contact with water these materials can become spontaneously combustible or liberate flammable or toxic gases.

Examples include:

- aluminium phosphide (liberates phosphine gas)
- calcium carbide (liberates acetylene on contact with water)
- sodium.

Class 5.1 - Oxidising agents

These substances can contribute/accelerate the combustion of other combustible or flammable materials.

Examples include:

- ammonium nitrate
- hydrogen peroxide
- potassium permanganate
- calcium hypochlorite.

Class 5.2 - Organic peroxides

Organic peroxides are organic materials containing the peroxide reactive group (-O-O-). These chemicals may have the following properties:

- liable to explosive decomposition
- burning rapidly
- sensitive to heat, shock or friction
- react violently with other materials.

Examples include:

- benzoyl peroxide
- methyl ethyl ketone peroxide.

Class 6.1 - Toxic substances

These materials comprise substances liable to cause death or serious injury or harm from inhalation, ingestion or absorption through the skin. Some toxic materials may have other sub-risks (e.g. flammable or corrosive).

Examples include:

- paraquat;
- endosulfan
- arsenic compounds
- cyanide
- toluene di-isocyanate (TDI)
- many pesticides.

Class 8 - Corrosive substances

Corrosive materials are capable of causing the degradation and destruction of living tissue, steel and other materials on contact. Some may give off irritating vapours affecting the eyes, airways and skin.

Corrosive material may possess other properties (e.g. flammability or oxidation). Corrosive materials are either acids or bases/alkalis.

Examples of acids include:

- nitric acid
- sulphuric acid
- hydrochloric acid
- lead acid batteries.

Examples of alkalis include:

- sodium hydroxide (caustic soda)
- calcium hydroxide.

Class 9 - Miscellaneous dangerous goods

This class comprises substances and articles that present a danger not offered by other classes. Some of the materials may be assigned to this class based on temperature properties (e.g. elevated temperature products).

Examples of class 9 goods include:

- dry ice
- asbestos
- molten bitumen.

Key stakeholder agencies

Agency	Role	Relevant legislation
CHEM Services, Department of Emergency Services	Lead agency role for all hazardous materials	• *Dangerous Goods Safety Management Act 2001* • *Dangerous Goods Safety Management Regulation 2001*
	Regulate safety of major hazard facilities	
	Advice during hazardous materials emergencies	
Workplace Health and Safety Queensland, Department of Industrial Relations	Regulation of the holistic management of the storage and handling of Class 2, 3, 4, 5, 6.1, 8, 9, goods too dangerous to be transported and combustible liquids.	• *Dangerous Goods Safety Management Act 2001* • *Dangerous goods Safety Management Regulation 2001* • *Workplace Health and Safety Act 1995*
Local Government Authorities	Licensing of the storage of flammable and combustible liquids above quantities in Table 2.1 of AS 1940: *The storage and handling of flammable and combustible liquids*.	• *Dangerous Goods Safety Management Act 2001* • Part 4 of the *Dangerous Goods Safety Management Regulation 2001*
Petroleum and Gas Operations, Department of Natural Resources and Mines	Regulate storage and handling of flammable gases (Class 2.1), installations of gas appliances, pipe-work, use of gas as fuel, and licensing of gas fitters.	• *Gas Act 1965* • *Gas Regulation 1989* • *Dangerous Goods Safety Management Act 2001* • *Dangerous Goods Safety Management Regulation 2001*
Explosives Inspectorate,	Regulation of materials that have explosive	• *Explosives Act 1999* • *Explosives Regulation*

Department of Natural Resources and Mines	properties. Usually Class 1 but also some other classes.	*2003* • *Dangerous Goods Safety Management Act 2001* • *Dangerous Goods Safety Management Regulation 2001*
Queensland Health	The licensing of possession, supply and transport of radioactive materials (Class 7).	• *Radiation Safety Act 1999* • *Radiation Safety Regulation 1999*

Managing the risks from dangerous goods

Managing dangerous goods involves:

- identifying dangerous goods and site classification
- providing information, training and supervision in evacuation and fire fighting procedures
- controlling ignition sources such as naked lights, sparks and mobile phones where flammable atmospheres may exist
- segregating incompatible goods
- separating dangerous goods from 'protected places'
- spills management
- selection, provision and maintenance of safety equipment and personal protective equipment
- placarding of sites with dangerous goods in packages stored or handled above the prescribed quantities
- displaying a clearly visible information placard on tanks holding more than 500L of LPG or 450L of other classes of stated dangerous goods and combustible liquids
- using documented safety management systems
- keeping unused storage or handling systems clean and safe.

To avoid the possibility of an explosion or the emission of toxic flammable or corrosive gases:

- Store two incompatible goods at least 3m apart.
- Where the goods could react violently, store them at least 5m apart.
- Consider storing some goods (especially highly pyrophoric or unstable goods e.g. Class 4.2 or 5.2) in separate fire rated enclosures or separate buildings with appropriate fire suppression equipment. Separate enclosures or buildings may also be required for those goods with special fire suppression requirements (e.g. Class 4.3 goods react adversely with water).
-

Transport and storage of dangerous goods

Transporting dangerous goods

Certain conditions apply when the quantity of transported dangerous goods is above the exemption limits set out in the Australian Dangerous Goods Code. The conditions include:

- separating foodstuffs from chemicals
- signs and equipment for the vehicle
- licensing for the driver and training in emergency procedures.

The federal Department of Transport and Regional Services provides information on the transport of dangerous goods.

Storing dangerous goods in workplaces

Requirements for the storage of dangerous goods in workplaces vary with the classes of dangerous goods and the volumes or amounts stored.

For example, under Division 3 of the *Dangerous Goods Safety Management Regulation 2001* there are licence requirements to store flammable or combustible liquids.

When storing dangerous goods in workplaces:

- Conduct a risk assessment and address the risks identified.
- Ensure labels are intact and legible.
- Use information about storage and compatibility information provided on the MSDS or label.
- Separate incompatible goods.
- Employ spill containment measures.
- Have appropriate personal protective equipment on hand like chemical gloves, boots, aprons and respirators.
- Have appropriate materials on hand to help with spills like fire fighting equipment, soil, water, absorbent pillows, lime or sand.
- Have emergency procedures in place.

The Department of Emergency Services has published *Safe Storage and Handling of Dangerous Goods: Guidelines for Industry*.

Type of dangerous goods - ammonium nitrate

What is ammonium nitrate?
What it is, why it is dangerous

Hazards of ammonium nitrate
Properties, health effects, hazards including fire and explosion, accidents

Storage and handling
Good storage practices and material safety data sheets (MSDS)

Hazard identification and risk management
Including storage structures, handling precautions, housekeeping, safety signs, emergency planning and disposal methods

Security checklist
Controlling access, alarms, barriers, inventory management, local law enforcement, lighting and visibility, locks, signage, surveillance, customer transactions

What is ammonium nitrate?

Ammonium nitrate can be classified as a class 5.1 “oxidising agent” under the dangerous goods classification system and is used as an explosive in mining operations and as a fertiliser. It is a strong oxidizer and can react violently with other incompatible materials so it is very important to store and handle it correctly. The information in this document is concerned primarily with storage and handling of ammonium nitrate of class 5.1 under the *Dangerous Goods Safety Management Act 2001*.

The information provided here is suitable for materials including goods with the following UN numbers: UN 1942, UN 2072, UN 2069, UN 2067, UN 2068, and UN 2070.

The storage of liquid ammonium nitrate (UN 2426) or materials classified as Class 1 “Explosives” is not addressed here. Expert advice should be obtained for dealing with these materials.

Ammonium nitrate fertilizer as Class 9 (UN 2071) is not an oxidizing agent but may present a hazard in a fire.

Similar names for ammonium nitrate include:

- nitric acid ammonium salt
- detapril
- nitropil.

In Queensland approximately 99% of ammonium nitrate is used as an explosive in mining operations. The remainder is used as a fertiliser.

Ammonium nitrate is an odourless material, which is usually a granulated (if a fertiliser) and white in appearance. Crystalline ammonium nitrate is unusual outside a laboratory.

In Queensland, new requirements relating to security concerns came into effect on 1 July 2005, regarding security sensitive ammonium nitrate (SSAN). SSAN is now covered by the *Explosives Act 1999* and the *Dangerous Goods Safety Management Act 2001*.

Security sensitive ammonium nitrate includes ammonium nitrate, ammonium nitrate emulsions, and ammonium nitrate mixtures containing greater than 45% ammonium nitrate, excluding solutions and ammonium nitrate products that are classified as class 1 explosives. SSAN may also include non dangerous goods.

For additional information on ammonium nitrate including siting and security requirements for security sensitive ammonium nitrate please refer to the Department of Natural Resources and Mines for information.

Hazards of ammonium nitrate

Stability and explosion hazards

Ammonium nitrate is stable in solid, molten or in solution. However, it can become less resistant to detonation/initiation due to the presence of contaminants or on exposure to high temperatures (e.g. fire or radiant heat).

The following can cause ammonium nitrate to become less stable and at greater risk of detonation:

- Exposure to contaminants including:
  - chlorides
  - metals such as chromium, copper, cobalt, and nickel
- A decrease in pH (increased acidity)
- If bubbles are permitted to form in molten ammonium nitrate or solutions of ammonium nitrate.

Once ammonium nitrate becomes molten (particularly if confined) the risk of an explosion increases and increases dramatically if pH of molten ammonium nitrate falls or if it comes into contact with oxidisable material e.g. organics eg oil, diesel, paper, rag, or straw.

Ammonium nitrate may explode due to the following factors:

- Exposure to strong shocks (e.g. from shock waves of nearby explosions.
- Exposure to high temperatures under confinement (e.g. in a closed pipe).
- A smaller detonation can trigger an explosion in larger quantities stored nearby.

Heat, fire and combustion hazards

Ammonium nitrate does not burn. However, it will support and increase the rate of combustion in the presence of flammable or combustible materials even in the absence of oxygen.

When heated it will melt, decompose and release toxic gases including nitrogen oxides (NOx) and ammonia gas (NH_3). When heated excessively (e.g. as in a fire) it can cause an explosion in an enclosed space and closed containers or vessels may rupture violently.

Accidents

Ammonium nitrate explosion in Toulouse - France

On 21 September 2001 an explosion occurred at the AZF Fertiliser factory in Toulouse, France where approximately 200-300 tonnes of ammonium nitrate exploded.

The explosion was caused by unknown causes related to handling practices. Twenty workers were killed at the site. The blast caused damage 3 km away, causing disruption of telephone lines up to 100 km away. Over 500 homes were left uninhabitable and 85 schools were damaged.

A secondary explosion was also triggered in a neighbouring munitions factory.

Physical properties

- Melting point: 170 °C.
- Decomposition temperature: < 210 °C.

Chemical properties

- Strong oxidizer that can react violently with other incompatible materials.
- Acidic: pH of 5.4.

Health effects

- Harmful if swallowed.
- Irritating to eyes, skin and respiratory tract.

Storage and handling

The safe storage of ammonium nitrate relies on the following principles:

- avoidance of contamination of foreign materials, especially if that material is combustible or incompatible
- good house keeping
- storing the material away from heat sources and naked flames;
- avoiding serious confinement
- storage away from explosives
- avoiding exposure to shock
- avoiding uptake of moisture, (not a safety concern if ammonium nitrate is bagged)
- preventing unauthorised access
- being prepared for an emergency.

Material Safety Data Sheets (MSDS)

- Material safety data sheets (MSDS) must be obtained for ammonium nitrate from your supplier for dangerous goods including ammonium nitrate. The MSDS must be kept in a register.
- A register includes the name of each dangerous goods on site and a copy of the MSDS for each of those.
- Each MSDS must be located close to where people who may be exposed can refer to the MSDS easily. This will ensure that each MSDS can be referred to easily by workers and allow emergency responders access to information about the hazards.
- The MSDS must be read to identify:

    (a) The chemical and physical hazards.
    (b) Appropriate safe storage and handling practices.
    (c) The need for additional control measures.
    (d) First aid measures.
    (e) Fire fighting and emergency information.

Hazard identification and risk management

<u>Assessment</u>

Hazard identification, control of hazards including training and implementation of appropriate systems and procedures

Storage structures
What to consider when designing storage structures, including electrical equipment, stacking of ammonium nitrate, ventilation and the location of the storage structures

Minimum distance from protected places
Who to contract about “siting of ammonium nitrate storage facilities”

Handling precautions
Personal protective equipment (PPE), handling equipment and forklift trucks and vehicles

Housekeeping
General housekeeping information as well as heat and ignition sources, security and dealing with incompatible materials

Safety signs
When are safety signs required and what are the specifications of these signs

Emergency planning
Manifests, fire fighting measures and when to notify the Department of Emergency Services

Disposal of containers
What to consider when disposing of empty ammonium nitrate containers and how to reduce the risk of damage to the environment

Assessment

Assessment and risk management

After reviewing the product’s MSDS and container label, the hazards from ammonium nitrate need to be identified in the context of how the material is being stored and handled.

Following from this, a risk assessment needs to be undertaken to determine the nature, likelihood and severity of any incidents that may result in harm to persons, property of the environment (e.g. fire, explosion or spillage).

Appropriate control measures need to be considered and implemented to ensure that the risk to people, property and the environment is minimised as far as practicable.

Training, information and supervision

The occupier of the premises must ensure person employed at the premises are provided with training in:

- Safe work methods for handling ammonium nitrate
- Hazardous properties of ammonium nitrate
- Location and use of safety and personal protective equipment
- Action to take in an emergency (e.g. spills, fire or explosion).

Additionally, workers need to be given effective supervision to ensure systems and procedures are adhered to.

Systems and procedures

Procedures should be documented to inform workers about how to store and handle ammonium nitrate safely. The systems should ensure that the risks identified in your risk assessment are effectively managed.

The following are some examples of procedures that are appropriate:

- how to clean up a spill
- segregation of incompatible goods
- operating machinery
- lock up and security procedures
- inventory management and stock control
- what to do in a theft, fire or other emergency.

Storage structures

Design considerations

In designing ammonium nitrate storage facilities the following points should be considered:

- Buildings over one storey should not be used to store ammonium nitrate;
- Stores must be constructed out of non-combustible materials and be compatible with the ammonium nitrate;
- Buildings must be protected against lightning damage. AS/NZS 1768 - *Lightning protection* can provide guidance on lightning protection;
- Flooring is best made of concrete, should be open and without traps, pits, tunnels, or pockets where molten ammonium nitrate could flow and be confined in the event of a fire;

- If the floor is made of other materials the floor should be protected against impregnation by ammonium nitrate;
- Flooring should have a fall to an open drainage system that will not allow molten ammonium nitrate to become trapped or confined;
- Silos should not be used for ammonium nitrate storage if the material is stored for longer than one week as this material tends to form hard cakes of material which may be difficult to remove safely – this can lead to silo turnover during emptying if there is a hang up on one side of hopper;
- Shelving systems need to be constructed to prevent the build up of the ammonium nitrate or other contaminants on ledges or in corners. The design should allow for easy visual inspection for spillage;
- Liquid also should not be able to accumulate on the shelving;
- Shelving/ storage racks must allow for free passage of personnel;
- Buildings and structures should allow for dry storage of ammonium nitrate by being free of water leakage or seepage through walls, floors or roof.

Electrical equipment

- Electrical wiring and lighting in the store needs to be able to withstand corrosion that may occur in regular fittings. It should have a rating of at least IP65 as per AS 1939 - *Degrees of protection provided by enclosures for electrical equipment (IP Code)*.
- Electrical equipment should be kept where it cannot come into contact with ammonium nitrate.
- Electrical lamps shall be located or guarded so as to prevent hot surfaces coming into contact with bags of ammonium nitrate.

Piles or stacks of ammonium nitrate

- Except where pallet racking systems are used, stacks of ammonium nitrate bags should be limited to 3m in height.
- IBCs (bulk bags) of ammonium nitrate must be stored in stable stacks, preferably less than 3m in height.
- At least 1.2 m free air space must be maintained in between stacks of ammonium nitrate as well as between each stack and the walls of the building.
- You should consult the manufacturer for information on the maximum allowable stack height.
- Other products must not be stored in the same stack with ammonium nitrate.
- Containers of ammonium nitrate must be securely stacked or suitably restrained from falling.

Ventilation and atmospheric controls

- Stores need to be adequately ventilated. This may be provided using either natural or mechanical ventilations systems.
- Inhalation must be kept below any national exposure standard.
- Humidity control may be required as recommended by the manufacturer of the ammonium nitrate.
- The temperature of ammonium nitrate storage should never be permitted to exceed 55°C.

Location of storage areas

The location of ammonium nitrate storage areas needs to be given careful consideration as follows:

- Storage areas need to be kept apart by suitable distance from “protected places” where members of the public may be placed at risk (e.g. property boundaries, schools, places of worship, colleges, theatres, hospitals, age care facilities). Suitable separation distances are recommended in the table below in (from Table 4.2 of AS 4326 - *The storage and handling of oxidizing agents*). Under no circumstances must a store of ammonium nitrate be located inside a protected place.
- Storage areas should be located on a floor with immediate access from outside the building.
- All vegetation, combustible materials and non-associated equipment must be kept at least 10m away from ammonium nitrate stores.

Minimum distance from protected places

Please contact the Queensland Department of Natural Resources and Mines for more information about “siting of ammonium nitrate storage facilities”.

Explosives Information Bulletin No. 55 should be observed regarding siting of ammonium nitrate stores.

Your local government authority planning area also should be contacted to ensure you meet their requirements.

Handling precautions

Safety equipment and personal protective equipment (PPE)

- Appropriate personal protective equipment must be provided.

- The eyes, skin, and airways of personnel must be protected from exposure to dusts of ammonium nitrate.
- Appropriate PPE may include:
    - Chemical goggles or face shield
    - PVC or rubber gloves
    - PVC/rubber aprons and boots
    - Disposable P1 respirators.

PPE should be provided for the purposes of handling the ammonium nitrate, or cleaning up spills. Advice should be sought from the MSDS on what is appropriate.

Safety showers and eye wash stations should also be provided where a risk of exposure to eyes or skin exists.

Handling equipment

- Intermediate bulk containers (IBCs) should be protected from puncturing from sharp objects (e.g. forklift tynes, protruding nails on pallets).
- Any hollow spaces in ammonium nitrate handling equipment where the material may collect and be confined under pressure should be avoided. In the event of a fire an explosion could result.
- Any mechanical handling device (e.g. conveyors) should be cleaned to prevent build up of debris or ammonium nitrate on the surfaces.
- Bins and bunkers must be free of materials that may contaminate ammonium nitrate.
- Aluminium bins are suitable. Wooden bins, even if coated to prevent impregnation are not recommended.
- Due to corrosive and reactive properties of ammonium nitrate, and to avoid contamination, galvanised iron, copper, lead, and zinc must not be used in bins, or other handling devices (e.g. shovels or mechanical shovels) that may come into contact with the material.
- Ammonium nitrate corrodes copper and copper alloys - relevant to electrical switches, cables, motors and also electronic equipment that may form part of a protection system e.g. fire detection, control gear on conveyors, rotary valves.

Forklift trucks and vehicles

- Forklift trucks, tractors, platform lift trucks, and other vehicles must be kept clean and maintained so that fuels (e.g. diesel) or hydraulic fluid is not contaminated by the ammonium nitrate and vice versa – equipment (mobile and static should be routinely checked for oil leaks. If found, the leaking equipment should be removed from the ammonium nitrate area and oil spillage cleaned up immediately.
- Internal combustion engine vehicles, lift trucks, or cargo conveyors should be:

    - Garaged at least 10m from any ammonium nitrate storage area
    - Not left running whilst unattended inside a building where ammonium nitrate is stored
    - Kept outside when not in use
    - Provided with a dry powder extinguisher.
- Only electricity, LPG or diesel fuelled vehicles should be used.
- LPG or diesel forklift trucks should be started up, outside of the store.
- Vehicles powered by LPG or diesel should be fitted with spark arrestors (exhaust water scrubbers).
- Battery terminals need to be fitted with an insulated cover and clearly marked batter isolation switch.

Housekeeping

Housekeeping precautions

Housekeeping with ammonium nitrate is an important part of managing the risk from ammonium nitrate. The following precautions are strongly recommended:

- Prior to placing ammonium nitrate in a storage area, the area should be cleaned first;
- Walls, floors, access ways and surrounding areas and equipment must be kept clear and free of build up of combustible debris, including ammonium nitrate;
- Regular inspections should occur to ensure leaks are detected promptly and cleaned up;
- Ammonium nitrate storage areas need to be kept clean and apart from any unnecessary objects by at least 3m in all directions, (e.g. unused wooden pallets);
- All dry vegetation should be cleared away from the store by a distance of at least 5m;
- Filled bags and intermediate bulk containers (IBCs) should be stored in stable stacks;
- Spillage of ammonium nitrate and other materials stored nearby should be cleaned up immediately;
- Damaged bags should be kept in overpacks or slip-over bags to prevent additional spillage;
- Contaminated products must be safely disposed of or made free of ammonium nitrate; and
- Pallets, ropes, slings, covers, machinery, or combustible items must not be allowed to become contaminated with a build up of ammonium nitrate.

Hot work and ignition sources

- Sources of ignition (e.g. naked flames, smoking) are not permitted in ammonium nitrate storage areas.
- All potential sources of heat and fire (e.g. matches, naked flames, incandescent materia, and welding sparks) must be excluded from any opening to a store by at least 3m.
- Other sources of ignition, such as hot work (e.g. welding or cutting) should only be conducted with a hot work permit under AS 1674.1 *Safety in welding and allied processes - Fire precautions*.
- Before carrying out maintenance or hot work the ammonium nitrate bags must be removed from the area by a safe distance or use of barriers.
- Surfaces contaminated by ammonium nitrate must be cleaned free of the material before welding or hot work is carried out. Otherwise a risk of fire or explosion or release of toxic vapours may result.

Security, access and control of visitors

- Unauthorised persons must be prevented from accessing storage or handling areas.
- Visitors and contractors must also be controlled and made aware of relevant safety precautions.
- A security checklist provides detailed guidance on what precautions are appropriate. You should also consult the Queensland Department of Natural Resources Mines and Energy for advice.

Segregate incompatible materials

Ammonium nitrate is incompatible with the following materials including (but is not limited to):

- All flammable and combustible liquids;
- All flammable solids;
- Organic chemicals, acids, alkalis, and other corrosive materials;
- Compressed flammable gases;
- Other contaminating materials including:
    - Animal fats, baled cotton, baled rags, scrap paper, bleaching powder, cotton bags, caustic soda, coal, charcoal, coke, cork, camphor, fish oils, fish meal, foam rubber, hay, lubricating oils, linseed oil, or an other oxidisable or drying oils, naphthalene, oiled clothing, oiled textiles, straw, sawdust, timber shavings, vegetable oils and cement.
- Ammonium nitrate must be segregated from all other incompatible goods by 3m or more.
- Ammonium nitrate fertilizers of Class 9 UN 2071 should not be stored with ammonium nitrate of class 5.1.
- If one of the goods present is a liquid or if the goods may react violently with the ammonium nitrate, they should be stored in separate compounds or stored at least by 5 m or more apart.

- An appropriate, inert, fire rated physical barrier (FRL 120/120/120) may be used to achieve segregation if the distances are measured around the barrier.
- However, incompatible goods **must never** be permitted to come into contact with the ammonium nitrate.
- In order to achieve this, it may be necessary to provide bunds, kerbing or sloping floors to ensure that molten or liquid incompatible products cannot mix.
- Ammonium nitrate should **not** be bunded.
- It is best **not** to assume that all class 5.1 oxidising agents are compatible as many are **not** (e.g. ammonium nitrate is also incompatible with sodium nitrate, another oxidising agent). Unless proven otherwise, assume the materials are incompatible. Please refer to the product MSDS for guidance.
- Blasting agents, explosives, sulphur and finely divided combustible solids must not be stored in the same store as ammonium nitrate except where approved by the Department of Natural Resources Mines and Energy, Explosives Branch.

Safety signs

- Stores should be sign posted with appropriate safety signs to prohibit smoking, e.g. “Danger: no smoking”
- Signs to restrict unauthorised entry are also appropriate.

Placarding storage areas

Placarding is required where ammonium nitrate is stored in excess of the quantities shown in the table below (an extract of Schedule 1 of the *Dangerous Goods Safety Management Regulation 2001*).

Quantities requiring placards

Packing group	**Quantity of ammonium nitrate (kg)**
I (great danger)	50
II (medium danger)	250
III (minor danger)	1,000
Mixed packing groups	1,000

Where the placarding quantities have been exceeded an outer warning placard stating “HAZCHEM” as shown below, must be visible from every entrance to the premises.

Information placards are required to be placed at the following locations where goods are stored in excess of the placarding quantity:

- the main point of entry into a building
- at either the main point of entry to a room or enclosure or other area
- adjacent to the where the ammonium nitrate is being stored.

Information placards may take two forms:

- For package stores, the placard consists of the Oxidising Agent (class 5.1) label for each building, room or area where material is present in excess of the placarding quantity. The class diamonds must be at least 100 mm in diameter and not confused or obstructed by other signs or objects
- Those for “tanks” (i.e. containers that have a capacity of 400 kg or more, e.g. bulker bags.) need to be in the format shown in Figure 3 below, displaying the UN number, Proper shipping name, Class label and HAZCHEM code.

Tank information placard

Packages are those containers with a capacity of less than 400 kg net mass. Any container larger than 400 kg that is regarded as a “tank”.

Emergency planning

Emergency services manifests

An emergency services manifest and site plan is required to be kept up to date at all premises where gas cylinders are stored above the manifest quantities stated in the table below.

Packing group	Quantity of ammonium nitrate (kg)
I (great danger)	500
II (medium danger)	2,500
III (minor danger)	10,000

Mixed packing groups	10,000

The manifest must contain an up to date inventory of each class of dangerous goods present on site, the quantity and location of each storage area. Class 2.3 gases require the proper shipping name of the gas to be entered. For additional advice, please consult Schedule 4 of the *Dangerous Goods Safety Management Regulation 2001*. The manifest and site plan are required to be kept in a red weatherproof container at the main entrance to your site.

Fire fighting measures

Although ammonium nitrate is not combustible it may present a hazard in a fire due to its strong oxidation properties, or through the evolution of toxic and irritating gases from the heat in a fire.

Fire fighting facilities should be compatible with local Queensland Fire and Rescue Service equipment. Fire fighting measures must be provided to ensure the following:

- Access to adequate supplies of water.
- A small fire involving ammonium nitrate is able to be extinguished immediately using a hose.
- If a major fire occurs nearby to the store, water spray can be accessed to cool the adjacent store.
- For large storages of ammonium nitrate, water spray should be able to be directed from a safe distance.
- Fixed fire detection systems should be provided to allow for early detection.
- Fire hose reels are required to be installed where stores exceed 200 m^2.

Fire fighting measures should be provided in accordance with Section 10 of AS 4326 *Safety in welding and allied processes - Fire precautions*. In the event of a fire, call the Queensland fire and Rescue Service and consider evacuation to a safe place where people are not exposed to the fumes or risk from explosion. Please consult the Queensland Fire and Rescue Service for additional advice regarding fire protection measures.

Emergency planning

Emergency plans are not required to be documented at all workplaces where ammonium nitrate is stored or handled, however it should be regarded as good practice and is recommended even for small quantities.

Emergency plans are required at all places where the quantity of dangerous goods exceeds that shown the table for manifest quantity.

Emergency plans should identify the types of emergency situations likely to be encountered (e.g. fires, gas leaks for each type of gas, explosion) what resources are required and how people are to respond. You may need to consider adequacy of fire fighting systems, access and egress from the site, deciding a safe evacuation assembly area, the need to notify neighbouring places during an emergency, provision and testing of alarms, and carrying out regular emergency drills.

Notification to Emergency Services

If you store ammonium nitrate in excess of the manifest quantity, you will also be required to provide notification to the Queensland Department of Emergency Services on the approved form.

Disposal of containers

In disposing of ammonium nitrate, caution should be taken considering the following:

- It is highly soluble in water and at low concentration can be fatal to livestock if it contaminates water courses.
- Burial of ammonium nitrate residues with hot earth, and organic material can result in a violent underground reaction and is not recommended.

Empty containers should be rendered safe by washing out with water (triple rinsed) before their disposal. Unless the containers are refilled with the same materials, the containers should be removed or fully destroyed.

You should consult the manufacturer about the disposal of unwanted ammonium nitrate.

Security checklist

The following security measures are appropriate as part of appropriate safe storage and handling measures for ammonium nitrate storage areas:

Control access

- All customers and visitors are escorted and in storage areas and loading docks.
- An identification badge and uniform system is in place to distinguish employees from visitors more readily at large premises.
- Ammonium nitrate is not stored outside or in public access areas overnight.

- If supplying ammonium nitrate, ensure material is not sold to people who you suspect may not be using it for lawful use.

Alarms

- Audible and visible strobe alarms present.
- Considered an alarm monitoring service.
- Phone lines protected or a service interruption alarm installed.

Barriers

- Fencing is present to prevent site access.
- Bars present to protect windows.
- Install bollards and chains across driveways after hours.
- Storage wherever possible is in locked building.

Inventory management

- Up to date inventory maintained to assess quantities present.
- Systematic inventory control present to monitor outgoing and incoming quantities.
- Inspect storage areas each morning.
- Retain shipping/receiving paperwork in a secure place.

Local law enforcement

- Establish contact with local police and fire and rescue services so they are familiar with your site.
- Keep your emergency services manifest and site plans up to date with relevant emergency after hours contact numbers.
- Report thefts immediately.
- Report suspicious behaviour immediately to local police officers or if warranted call the 24 Hour National Security Hotline: 1800 123 400.

Lighting and visibility

- Exterior lighting is provided around the storage areas are adequate.
- Site visibility not obstructed by shrubs.

Locks

- A system exists to ensure premises are locked up at the close of business and that someone is accountable.
- High security locks are provided for silos and buildings where ammonium nitrate is stored.
- Deadlocks are used on doors.
- Fencing complies with AS 1725.
- Keys used to access the site or items such as machinery, hoppers, or storage areas are controlled.

Signage

The following security signage is installed:

- ”No vehicles beyond this point”.
- “All visitors must be escorted”.
- “All visitors report to front office”.
- “This premises under video surveillance”.

Surveillance

- Security cameras installed where appropriate (low visibility areas).
- Regular security patrols provided.

Customer transaction

For businesses supplying ammonium nitrate, you should:

- Know your customer.
- Record customer’s name, address, and telephone number (ask for driver’s license if in doubt).
- Only make deliveries if customer can take receipt.
- Be alert to suspicious behaviours:
    - insistence on paying in cash
    - will not take delivery
    - refusal to offer identification when requested
    - insists on ammonium nitrate instead of other products
    - asks unusual questions about the product.

Type of dangerous goods - gas cylinders

Hazards
Including fire, explosion, asphyxiation and valve damage

Gas cylinder markings
Images of the class diamonds relevant to the different gases in gas cylinders

Provision of information
Material safety data sheets (MSDS), risk assessments, training

Storage
Securing cylinders, location of gas stores, ventilation, personal protective equipment (PPE)

Safe handling practices
Moving cylinders safety, use of personal protective equipment (PPE) in handling

Housekeeping
General housekeeping information including heat and ignition sources, segregation of incompatible goods

Safety signs
When is signage required, what should be included on the signs

Emergency planning
Manifests, emergency plans, fire fighting measures, notification to Department of Emergency Services

Hazards

Hazards due to the chemical properties of gas cylinders include:

- fire or explosion from the release of flammable gases near ignition sources (e.g. acetylene or liquid petroleum gas);
- spontaneous combustion from oxidising gases (e.g. oxygen or nitrous oxide);
- exposure to toxic or corrosive gases (e.g. anhydrous ammonia); or
- asphyxiation from **some** non-toxic, non-flammable gases by displacement of oxygen (e.g. nitrogen, carbon dioxide or argon).

Compressed gas cylinders contain gas stored under hundreds of atmospheres of pressure. A valve seals the gas in the cylinder.

The pressure related hazards include:

- damage to a valve or regulator, causing failure and leakage of the gas;
- low boiling point, cryogenic or liquefied gases may cause frostbite on release;
- heating of the cylinder (eg. from fire) or impact to the pressure vessel, resulting in explosion and shrapnel.

Some gases are also denser than air (e.g. LPG, carbon dioxide). On release, these gases will tend to collect in low lying areas such as pits, depressions and basements. Depending on the chemical properties of the heavier than air gas, people working in low lying areas may be exposed to the risk of fire or explosion, asphyxiation, or exposure to toxic or corrosive gases.

When gases are released and expand a drop in temperature occurs. In some cases e.g. carbon dioxide) the rapid release and expansion of gas can cause a cold hazard (e.g. frostbite) to exposed persons.

Large gas cylinders (e.g. G or F sized cylinders) can also be bulky, heavy, awkward objects that could cause severe strain and sprain injuries from inappropriate handling practices.

Gas cylinder markings

Gas cylinders and their hazardous properties can be recognised readily identifiable by recognition of gas cylinder markings as follows:

Class 2.1 Flammable gas

Examples: LPG, hydrogen, acetylene

Class 2.2 Non-flammable, non-toxic gases

Examples: compressed air, nitrogen, argon, carbon dioxide, helium.

Class 2.2, Sub-risk 5.1

“Oxidising gas”

Examples: oxygen, nitrous oxide, Entonox (50% oxygen, 50% nitrous oxide).

Class 2.3 Toxic gas

Examples: methyl bromide, anhydrous ammonia, chlorine.

Under the *Dangerous Goods Safety Management Legislation* gas cylinders are required to be labelled with the following, as shown below:

- class label and any subsidiary risk labels
- the proper shipping name
- a four digit United Nations number
- manufacturer/importer's name.

Figure 1 Gas cylinder marking

Gas cylinder marking for oxygen

In addition, to the markings shown in Figure 1, a cylinder will also be required to have other markings which are stencilled onto the cylinder near the neck of the cylinder these will include:

- the tare weight
- serial number
- owner's name
- test pressure
- retest date
- manufacturer's stamp
- water capacity.

Water capacity is the equivalent water volume of the cylinder in litres.

Manufacturers paint gas cylinders using a colour coded system that is useful in identifying gas cylinders. You should consult the manufacturer's product catalogues for colour charts with this information.

Provision of information

- Material safety data sheets (MSDS) must be obtained from your supplier for each cylinder of gas. These must be kept in a register.
- Each MSDS must be located close to where people who may be exposed can refer to the MSDS easily. This will ensure that each MSDS can be referred to easily by workers and allow emergency responders access to information about the hazards.
- The MSDS must be read to identify:
    - chemical and physical hazards from each gas cylinder
    - appropriate safe storage and handling practices
    - the need for additional control measures
    - first aid measures
    - fire fighting and emergency information.
- A risk assessment must be carried and recorded out to identify hazards and the need for any additional control measures.
- Workers need to be given information, training and effective supervision, about the hazards from gas cylinders, safe storage and handling information and what to do in an emergency.
- Procedures should be documented to inform workers about how to store and handle gas cylinders safely.

Storage

Securing cylinders in the upright position

- Cylinders should always be stored in the upright position. Some gases (e.g. LPG and acetylene) contain a gaseous and liquid phase. Some flammable gas cylinders contain a pressure relief valve which must be in contact with the vapour phase if the cylinder is to function properly during an emergency.
- Ensure that cylinders are prevented from falling or being knocked over by securing cylinders using a racking system or using a non abrasive, coated chain that will not be abrasive to the cylinder markings and paint work.
- If cylinders have been lying on their side, place the cylinder in the upright position and wait 30 minutes before using.

Note: Some cylinders are designed to be stored on their side. Consult your MSDS or contact your supplier for additional information.

Location of gas stores

Gas stores should be located outdoors, preferably in a secure, cage protected from sunlight. Storage indoors is not recommended unless the building has been designed for that purpose with appropriate fire rated walls and ventilation. Where gases are stored indoors, additional safety considerations and control measures need to be given consideration.

Some general principles apply:

- Gas cylinders should not be stored in areas or structures constructed of combustible materials.
- Gas stored should be located on the ground floor away from other dangerous goods (e.g. Class 3, 4, 5, 6.1, 7, 8 or 9, etc) and combustible liquids (e.g. diesel fuel) stores by at least 5 m or more.
- Storage below ground level should be avoided especially if flammable, toxic or asphyxiant gases are present.
- Heavier than air gases need to be stored with caution to avoid storage where these gases can collect in low lying areas.
- Avoid storing gas cylinders in significant quantities near to or inside protected places where members of the public may assemble (e.g. places of worship, theatres, age care facilities, schools, hospitals, property boundaries).

For LPG or other workplaces where flammable gases are the dominant gas present, please contact the Department of Natural Resources and Mines.

It is recommended that if you store significant quantities of gas in cylinders that you consult AS 4332 *The storage and handling of gases in cylinders* for guidance, or consider the services of a consultant.

Ventilation

- Store gas cylinders in well ventilated areas to prevent build up of escaped gases.
- Where possible gases should be stored outside in a cage.
- Where gases are stored inside a building, a mechanical ventilation system may be required if the natural ventilation is inadequate. Expert advice should be obtained if you are unsure.
- The mechanical ventilation system must be designed so as to capture escaped gases, not ignite flammable gases, ensure workers are not placed at risk of asphyxiation, or exposed to gases above the relevant National Exposure Standard (NES). National Standards are those stated

in the NOHSC publication *Exposure Standards for Atmospheric Contaminants in the Occupational Environment*.
- AS 4332 *The storage and handling of gases in cylinders* is recommended for guidance.

Personal protective equipment

- Eye protection, safety shoes and gloves should be worn in gas cylinder storage and handling areas.

Safe handling practices

- Avoid knocking cylinders about. Prevent damage to cylinders from impact from other objects (e.g. crashing into other cylinders). Some cylinders (e.g. acetylene) may react violently after being excessively shaken, heated, or knocked about.
- Cylinders should **never** be used as rollers to move other objects.
- When moving cylinders avoid rolling them. Ensure that an appropriate mechanical handling device (e.g. cylinder trolley with a restraining strap). Workcover Victoria has advice on manual handling of gas cylinders can be found within the Victorian Government publication, *Delivering large gas cylinders - a guide to manual handling*.
- Eye protection, safety shoes and gloves should be worn in gas cylinder storage and handling areas.

Housekeeping

General housekeeping

- Objects should not be stored on top of gas cylinders.
- Full and empty cylinders should be stored separately in clearly marked areas.
- Rotate stock, ensuring “first in first out”.
- Ensure gas cylinders are stored at least 3m away from combustible materials and debris (e.g. timber, card board, packaging materials) to prevent flame impingement on gas cylinders in a fire.
- Gas cylinders should not be located where they may block stairs, exits, ladders or walk ways.
- Ensure an up to date and accurate inventory is kept.
- Keep inventory quantities as low as possible.

Heat and ignition sources

- Store cylinders in cool areas away from sources of radiant heat (e.g. boilers, hot surfaces, and internal combustion engines). Where possible, store cylinders in the shade to avoid exposing cylinders to direct sunlight.
- Flammable gas cylinders should not be stored near sources of ignition such as naked lights or cigarette smoking.
- Where flammable gas is used, appropriate signs stating “No smoking”, “No naked lights” should be erected to prevent ignition sources in these areas.

Segregate incompatible gases and dangerous goods

Corrosive liquids can damage gas cylinders on contact. Flammable liquids can spread a fire across a workplace floor and allow flames to come into contact with gas cylinders. Other dangerous goods may also be adversely affected by gas cylinders in an emergency.

For this reason, gas cylinders are kept separately from other dangerous goods and combustible liquids by at least 5m or by using appropriate fire rated barriers. Segregation of incompatible goods also allows fire fighters to safely use appropriate fire fighting media for each type of goods present.

Gas cylinders must also be segregated from other incompatible gases by at least 3m or more. The following is recommended:

- Class 2.3 “Toxic gas” and corrosive gases (those with a subsidiary risk of Class 8 “Corrosive”) are stored away from all other gas cylinders
- Class 2.1 “Flammable gas” must be segregated during storage from all oxidising gases.

Mutually compatible gases (e.g. Class 2.2, without subsidiary risk) may be used between incompatible gases.

Safety signs

Placarding storage areas

Where gases are stored in excess of the quantities shown in Table 1 (an extract of Schedule 1 of the *Dangerous Goods Safety Management Regulation 2001*), placarding is required to be erected.

Table 1 Gas Quantities requiring placards

Gas class	Quantity (water capacity in litres)
Class 2.1	500 (eg. 10 G size cylinders)
Class 2.2, sub-risk 5.1	2,000 (eg. 40 G size cylinders)
Class 2.2 (without sub-risk)	5,000 (eg. 100 G size cylinders)

Class 2.3	50 (eg. 1 G size cylinders)

Where the placarding quantities in Table 1 have been exceeded an Outer warning placard stating “HAZCHEM” as shown in Figure 2, must be visible from every entrance to the premises.

Figure 2 Outer warning placard

Information placards are required to be placed at the following locations where gases are stored in excess of the placarding quantity:

(Note: Placarding is not required where the only gas present is liquefied petroleum gas in cylinders outside a building, connected to appliances by piping.)

- the main point of entry into a building
- at either the main point of entry to a room or enclosure or other area
- adjacent to the where the gas cylinders are being stored.

Information placards may take two forms:

- Those for tanks (gas cylinders that have a water capacity of 500L or more) need to be in the format shown in Figure 3 displaying, the proper shipping name, UN number, class diamond label and HAZCHEM Code
- For package stores, the placard consists of the Class diamond for each class of gas stored in excess of the placarding quantity. The class diamonds must be at least 100 mm in diameter and not confused or obstructed by other signs or objects. (Note: Packages are those cylinders that are less than 500 litres water capacity.)

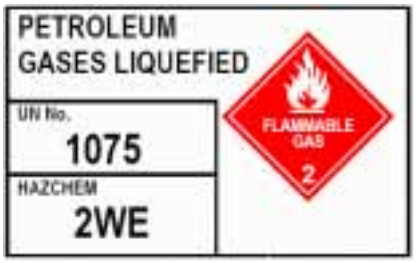

Figure 3 Tank information placard

Emergency planning

Emergency services manifests

An emergency services manifest and site plan is required to be kept up to date at all premises where gas cylinders are stored above the manifest quantities stated in the table below.

Manifest quantity

Gas class	**Quantity** (water capacity in litres)
Class 2.1	5,000
Class 2.2, sub-risk 5.1	20,000
Class 2.2 (without sub-risk)	50,000
Class 2.3	500

The manifest must contain an up to date inventory of each class of dangerous goods present on site, the quantity and location of each storage area. Class 2.3 gases require the proper shipping name of the gas to be entered. For additional advice, please consult Schedule 4 of the *Dangerous Goods Safety Management Regulation 2001*. The manifest and site plan are required to be kept in a red weatherproof container at the main entrance to your site.

Emergency plans

Emergency plans are not required at all workplaces where gas is stored or handled, however it should be regarded as good practice to so at all workplaces.

Emergency plans are required at all places where the quantity of gas exceeds that shown in the manifest quantity table.

Emergency plans should identify:

- the types of emergency situations likely to be encountered (e.g. fires, gas leaks for each type of gas, explosion)
- what resources are required
- how people are to respond.

You may need to consider:

- adequacy of fire fighting systems
- access and egress from the site
- deciding a safe evacuation assembly area

- the need to notify neighbouring places during an emergency
- provision and testing of alarms
- carrying out regular emergency drills.

Fire fighting measures

As a minimum, a single permanently connected hose capable of covering the entire store must be provided. However, where the total quantity of all the gas stored is greater than 1000L at least one fire hose real; or one 2 A 60B (E) fire extinguisher and a water hose connection should be provided.

Above these quantities, you should obtain advice or refer to AS 4332 *The storage and handling of gases in cylinders*.

Notification to Emergency Services

If you store gases in excess of the manifest quantity, you will also be required to provide notification to the Queensland Department of Emergency Services on the approved form.

Managing incompatible goods

Storage management
Factors to consider, use of the HAZCHEM code, keeping incompatible goods apart

Segregation tool for dangerous goods
Compatibility and segregation chart, how to use it, guidance notes

Segregation techniques
Using distance or inert materials, use of cut-off storage, using detached storage

Other issues
Fire fighting, spill cleanup equipment, foodstuffs, personal products, non-dangerous goods, situations involving small quantities

Storage management

The importance of storage management

When incompatible dangerous goods come into contact with one another during a spill or release, the goods can react together adversely to cause fire, explosion or release toxic, flammable or corrosive vapours.

Workplaces where dangerous goods or combustible liquids are stored or handled must have systems and procedures to prevent these goods or liquids coming into contact.

To manage the storage of incompatible goods you must:

- identify each of the dangerous goods you intend to store onsite
- recognise those goods or other materials that are incompatible.

The compatibility and segregation tool can be used to determine if each combination of dangerous goods and combustible liquids is likely to be compatible or not.

Note: this segregation tool is only a guide and not meant to replace a material safety data sheet (MSDS) or a risk assessment.

An important part of the process in identifying incompatible goods and materials includes a review of storage and handling information provided in the MSDS for each dangerous goods. After reviewing the MSDS information, you should list each incompatible dangerous goods or other material mentioned in the MSDS and take appropriate measures to keep them apart.

Factors to consider when determining incompatibility

The factors influencing compatibility are complex and should include consideration of the following:

- Whether a violent reaction (fire or explosion) between one or more highly reactive chemicals may occur.
- A reaction between two or more spilt goods may liberate flammable, toxic, or corrosive vapours or gases. Such reactions may occur rapidly or slowly over time until a build up of a hazardous material occurs which can then give rise to an emergency situation.
- Released or spilled goods may deteriorate, contaminate or destroy the packaging materials of another incompatible product to worsen a situation.
- Flammable goods stored next to other toxic or corrosive materials may catch fire causing rapid dispersal of the toxic or corrosive materials into the environment.
- Flammable materials may catch fire and cause flame impingement on products stored nearby (e.g. gas cylinders) resulting in rupturing of the gas cylinder.
- Fire suppression media suitable for one type of dangerous goods may be incompatible with another dangerous goods stored in the same area.
- How the materials used in the construction of spill catchment systems will react with dangerous goods spilt in the catchment (e.g. hydrochloric acid will rapidly corrode concrete walls used as a spill containment system).

Use of HAZCHEM Code

The HAZCHEM Code is a three digit, alphanumeric code providing initial emergency response information about:

- appropriate, compatible fire suppression media
- the likelihood of a violent reaction and other response advice
- spills containment or dilution
- personal protective equipment.

The product's MSDS can also be used to determine the HAZCHEM Code. Alternatively the ADG CODE may be used. This is *Australian Code for the Transport of Dangerous Goods by Road and Rail Transport* (Australian Dangerous Goods Code or ADG Code).

Where more than one dangerous goods are stored, a HAZCHEM Code for the mixture must be determined. Appendix 4 of the ADG Code provides more detail about the HAZCHEM Code.

Keeping incompatible dangerous goods apart

Once you have identified which goods are likely to be incompatible, you will then need to determine what will be the best approach to segregate (to keep apart) the incompatible goods. The control measures that you employ to segregate your incompatible materials will depend on the hazardous properties and the level of risk presented from each scenario.

Segregation tool for dangerous goods

Note: this segregation tool is only a guide and not meant to replace a material safety data sheet (MSDS) or a risk assessment.

Application

This tool is only intended for use in workplaces where dangerous goods are stored. It is not intended for transport situations where the Australian Dangerous Goods Code (Australian Code for the Transport of Dangerous Goods by Road and Rail) should apply. It is not intended for application against open (in use) packages kept on a shelf or bench top within a laboratory/workshop or similar situation.

The segregation chart is provided to assist occupiers of storage locations to better minimise the risk of storing incompatible goods. It recognises that transport guidelines are not suitable for workplace situations where larger quantities of goods may be kept together in circumstances enabling better control measures.

Radioactive materials (Class 7) and explosives (Class 1) should be deemed incompatible with all other dangerous goods.

Directions for use

- Identify if the material is a dangerous goods or combustible liquid. A combustible liquid has a flashpoint above 61 degrees Celsius) using the MSDS/label.
- Identify the class, subsidiary risk and packing group (where relevant) of each of the two dangerous goods you intend to store together.
- Where goods are also combustible liquids this should be regarded as a "subsidiary risk" for consideration.
- Use the chart below to ensure that the goods and or combustible liquids are compatible by aligning where the vertical and horizontal axis meet, (see key).

- Check and repeat this process for any subsidiary risks that either of the goods may have.
- It is recommended that an MSDS be consulted to ensure the materials are compatible. Goods with different UN numbers within the same class may be incompatible.
- Follow directions provided using the compatibility chart key, checking all guidance notes and supplementary notes.
- Where goods are incompatible consider greater separation if the packing group is PG I or II irrespective of the symbol used to account for the higher level of danger.

Compatible goods

Two or more goods are compatible provided that their interaction does not give rise to any of the following outcomes:

- Harm to persons, property or the environment.
- Fire, or explosion, generation of toxic, flammable or corrosive vapours/gases.
- Accelerate the combustion of other goods/liquids in the event of fire.
- Release of the contents results in the premature degradation/corrosion of other dangerous goods or combustible liquids' packaging/means of containment.
- During the event of a fire/spill/release, the interaction of dangerous goods/combustible liquids with incompatible fire fighting or dispersal media. Some materials are water reactive and should be stored away from other goods that are reliant on water or foam as a fire fighting/dispersal/suppression media).

Compatibility chart key

Symbol	Meaning
	May be compatible in many cases with exceptions. Follow the compatible goods guidance notes.
	Likely to be incompatible. Segregation strongly recommended, follow the segregation guidance notes for incompatible goods.

Compatibility and segregation chart

Class of goods	2.1	2.2	2.2 SR 5.1	2.3	3	4.1	4.2	4.3	5.1	5.2	6.1	8	9	Combustible liquids
2.1	✓ A	✓ B	✗ S1	✗ S1	✗ S2	✗ S2	✗ S4	✗ S5	✗ S1	✗ S4	✗ S1	✗ S1	✓ C	✗ S2
2.2	✓ B	✓ A	✓ B	✗ S1	✗ S2	✗ S2	✗ S4	✗ S5	✓ B	✗ S4	✓ B	✗ S1	✓ C	✗ S2
2.2 SR 5.1	✗ S1	✓ B	✓ B	✗ S1	✗ S2	✗ S2	✗ S4	✗ S5	✗ S2	✗ S4	✓ C	✗ S1	✓ C	✗ S2
2.3	✗ S1	✗ S1	✗ S1	✓ I	✗ S2	✗ S2	✗ S4	✗ S5	✗ S1	✗ S4	✓ C	✗ S1	✓ C	✗ S2
3	✗ S2	✗ S2	✗ S2	✗ S2	✓ A	✗ S3	✗ S4	✗ S5	✗ S3	✗ S5	✗ S3	✓ B	✓ B	✓ B
4.1	✗ S2	✗ S2	✗ S2	✗ S2	✗ S2	✓ A	✗ S4	✗ S5	✗ S3	✗ S5	✗ S3	✓ B	✓ B	✗ S3
4.2	✗ S4	✗ S4	✗ S4	✗ S4	✗ S4	✗ S4	✓ A	✗ S5	✗ S4	✗ S4	✗ S4	✓ B	✓ B	✗ S4
4.3	✗ S5	✗ S5	✗ S5	✗ S5	✗ S5	✗ S5	✗ S5	✓ A	✗ S5	✗ S5	✗ S5	✗ S5	✓ G	✗ S5
5.1	✗ S3	✓ B	✗ S2	✗ S2	✗ S2	✗ S2	✗ S4	✗ S5	✓ D	✗ S4	✓ C	✗ S3	✓ C	✗ S3
5.2	✗ S1	✗ S4	✗ S4	✗ S4	✗ S4	✗ S4	✗ S4	✗ S5	✗ S4	✓ E	✓ CE	✓ S4	✓ CE	✗ S4
6.1	✗ S1	✓ B	✓ C	✓ C	✗ S3	✗ S3	✗ S4	✗ S5	✓ CE	✓ C	✓ A	✓ H	✓ B	✗ S3
8	✗ S1	✗ S1	✗ S1	✗ S1	✓ B	✓ B	✓ B	✗ S5	✗ S3	✗ S4	✓ H	✓ F	✓ C	✗ S3
9	✓ C	✓ C	✓ C	✓ C	✓ B	✓ B	✓ B	✓ G	✓ C	✓ CE	✓ B	✓ C	✓ A	✓ B
Combustible liquids	✗ S2	✗ S2	✗ S2	✗ S2	✓ B	✗ S2	✗ S4	✗ S5	✗ S3	✗ S4	✗ S3	✗ S3	✓ B	✓ A

Segregation guidance notes for incompatible goods

S1 Segregate these goods by 3m or more in a well ventilated area. For liquid dangerous goods the distance is measured from the edge of the spill catchment area. See supplementary notes 6 and 7.
S2 Segregate by 5 m or more. If one of the dangerous goods is a liquid, measure the distance from the edge of the spill catchment area. Liquid dangerous goods should be located within a separate spill catchment area. See supplementary notes 6 and 7.
S3 Segregate by 3 m or more for PG III goods and 5m or more for PG II, PG I goods or where the goods may react dangerously. If both are solids then a minimum of 1m separation may be used. Where one of the goods is a liquid the distance is measured from the edge of the spill catchment area. See supplementary notes 6 and 7.
S4 Segregation preferred by the use of fire-rated partitioned areas. Consider use of separate detached building for organic peroxides and for highly pyrophoric class 4.2 goods.
S5 Segregation of class 4.3 preferred by use of a separate, detached building without water based fire suppression system.

Compatible goods guidance notes

A. In most cases materials of the same class will be compatible. However, not all materials with different *UN Numbers* will always be compatible. The MSDS should be checked.
B. In many cases the goods will be compatible. Must check for subsidiary risk compatibility. Please check the MSDS.
C. If one of the goods present is also a "fire risk substance" (one of class 2.1, 3, 4, 5, a combustible liquid or has a subsidiary risk of one of these) or elevated temperature goods, segregation is required by at least 3 m or more. Sub-risk MUST be considered. Other exceptions apply. Please check the MSDS.
D. Not all class 5.1 goods are compatible as follows:
    - Ammonium nitrate is not compatible with tetranitromethane, dichloroisocyanuric acid, any bromate, chlorate, chlorite, hypochlorites, or chloroisocyanurate, or any inorganic nitrate; and
    - Calcium hypochlorite (and its mixtures) are incompatible with dichloroisocyanuric acid, ammonium nitrate, or any chloroisocyanurate.
E. Organic peroxides are highly reactive materials. Please check the MSDS to ensure compatibility.
F. Where one of the goods to be stored together is a concentrated strong acid and the other a concentrated strong alkali, they should be deemed incompatible.
G. Class 4.3 goods must not be stored next to goods that are in a solution containing water, or where water or foam is the chosen fire fighting/spill/leak dispersal or suppression media for the storage area.
H. Except where the class 6.1 is cyanide and the class 8 an acid. Please check the MSDS.

I. Toxic gases ammonia and chlorine must be segregated due to risk of explosion. It is important to refer to the MSDS for incompatibilities within this class division. It is strongly recommended that each different toxic gas (Class 2.3) be segregated unless information in the MSDS says otherwise.

Supplementary notes for use with segregation tool:

1. Class 2 dangerous goods are generally not recommended to be stored with any *other* class of dangerous goods particularly flammable dangerous goods due to the risk of flame impingement. Corrosive goods can cause damage to the gas cylinder walls and thus should be kept away from class 2. In a fire gas cylinders need to have copious quantities of water applied to keep them cool. Toxic gases are stored away from other gases to minimise the release of toxic gases in a fire with other gases.
2. **Class 6.1 dangerous goods** are not recommended to be stored with fire risk goods or gas cylinders. In the event of a fire, the toxic material will be liberated and may be spread more effectively due to the heat of the fire or explosion of gas cylinders.
3. Two or more goods within the same class with incompatible subsidiary risk should be kept apart.
4. The packing group (PG) of dangerous goods denotes the magnitude of danger the material poses from its hazard. PGI is most dangerous. PG II these are more dangerous than PG III. If one of the incompatible materials is a PGI or II dangerous goods it is recommended that a greater segregation distance or other means of segregation is employed.
5. **If class 4.3 dangerous goods** are stored or handled care needs to be taken to segregate these away from all containers of aqueous (water containing) solutions even if the solutions are not dangerous goods. The areas these materials are stored in must not be serviced by a water based fire suppression system.
6. If one of the incompatible goods is a liquid OR a solid that is likely to melt from the heat of a fire, separate spill catchment systems or means of separating the incompatible goods must be considered. Solid dangerous goods should not be stored in direct contact with floor surface to avoid contact with liquids.
7. Fire rated walls constructed of appropriate impervious, chemically resistant materials may be used if provided with an FRL of 240/240/240. Timber structures are not appropriate barriers.
8. In the case of incompatible gases in cylinders intended for use in welding (such as acetylene and oxygen), these gases may be stored together in a purpose built cradle and separated when not in use for extended periods of time.
9. **For oxidizing agents**: although only dangerous goods and combustible liquids feature in the compatibility chart care must also be taken to segregate oxidizers from those dangerous goods and other materials that are combustible in nature (e.g. polymeric beads, cotton bales, excess packing materials). Chlorine and some other halogens are considered potent oxidizers even though their class and assigned with

any oxidizing agent subsidiary risk under the dangerous goods classification system.

Segregation techniques

When it comes to segregating dangerous goods the following methods are generally used:

- segregation by distance or by the use of inert materials
- segregation by the use of cut-off/partitioned storage areas
- segregation by the use of detached storage
- ensuring that incompatible goods are not stored above one another.

Segregation using distance or inert materials

The use of distance or inert (mutually compatible) materials between incompatible goods can be used when materials will not react violently together. A minimum separation distance of 3m will generally be suitable for most dangerous goods of packing group III.

Extra care should be taken with dangerous goods assigned to packing group II, as these can be more reactive or more dangerous in other ways (e.g. highly toxic). Where one or more of the incompatible goods are assigned to Packing Group II, or if they may react dangerously (e.g. calcium hypochlorite and petrol), a minimum segregation distance of 5m is recommended.

Where a violent reaction between dangerous goods may occur it may be necessary to consider storing such goods in separate compartments or rooms (cut-off storage). The HAZCHEM Code can be used as a tool to indicate whether there is an increased likelihood of a violent reaction. If the second digit in the HAZCHEM Code is a P, S, W or Y, the possibility of a violent reaction should be considered for that dangerous goods.

In the case of incompatible liquids, curbing, ramps, bunding or depressed floor areas can be used to prevent the flow and interaction of incompatible liquids. Distances should be measured from the edge of the spills catchment system.

Where both incompatible goods are solids and such solids are not likely to melt in the event of a fire, the minimum segregation distance can be reduced to 1m apart.

Segregation by the use of distance or inert materials may be suitable for dangerous goods such as class 3 dangerous goods and class 6.1 goods or ordinary combustible matter (not combustible liquids) and oxidising agents.

‘React dangerously’ means to react in a manner that directly creates a hazard due to the reaction:

- being violent
- producing an explosion
- producing a potentially explosive combination of products
- producing a fire or rapid evolution of heat
- producing toxic vapour or toxic gas.

Segregation by use of cut-off storage

The use of separate rooms or enclosures to isolate incompatible goods is known as “cut-off” storage. Segregation involves storing incompatible goods in separate compartments or rooms within a building. The rooms are separated by a fire rated partitions that are impervious to vapours and liquids. A fire resistance wall of at least FRL 120/120/120 fire rating for the partition is recommended.

Use of partitioned areas is useful for those materials that may react violently or offer high burning rate (e.g. large stores of class 4.2 or 5.2 dangerous goods).

Segregation by using detached storage

Detached storage segregation involves storing incompatible dangerous goods in separate buildings. This kind of segregation is used for materials that possess severe fire, reactivity or health risk.

“Dangerous when wet” goods such as aluminium phosphide and calcium carbide are materials that would warrant such precautions. Aluminium phosphide reacts with water to give off phosphine, a toxic and flammable gas. Calcium carbide reacts with water to generate acetylene gas. A separate building without water fire protection systems is needed to ensure water is not applied to these materials.

Other issues

Selecting appropriate fire fighting media

It is important to consider appropriate fire suppression needs are met for each dangerous goods you have in place. Incompatible fire fighting agents will make an emergency situation worse. The MSDS for each material needs to be consulted for the appropriate type of fire fighting media that is required. The HAZCHEM Code is also of use because the first digit is a number that

provides emergency responders with information about the most appropriate fire fighting medium to use.

In the case of mixed dangerous goods stores, a **resultant** HAZCHEM Code can be calculated to determine the most appropriate fire fighting technique for the mixture of dangerous goods.

The method for calculating the resultant code is described in Appendix 4 of the Australian Dangerous Goods Code (Australian Code for the transport of dangerous goods by road and rail). The HAZCHEM Code and resultant HAZCHEM Code for a mixture of goods can be used as a tool to ensure that compatible fire suppression media are selected for your situation.

The numerical values for the preferred fire fighting media as indicated by the HAZCHEM Code are as follows:

1. water jets
2. water fogs
3. foam
4. dry agent.

Spill clean up equipment

When selecting clean up equipment including absorbent products it is important to ensure the products will not react adversely with the goods you intend to use the products with.

Foodstuff and personal products

The contamination of foodstuff, food-packaging materials, items for direct personal contact, and medical or veterinary products must not be permitted to come into contact with dangerous goods. A 5m segregation distance between dangerous goods and these products is recommended. Dangerous goods must not be kept above the food or other products and the dangerous goods should not be opened in the same room.

Care with non-dangerous goods

Most approaches to compatibility deal only with identifying which combination of dangerous goods are incompatible. When storing dangerous goods it is important to consider that adverse reactions can arise between dangerous goods and other materials that are not dangerous goods. Some examples of incompatibility between dangerous goods and common products are provided below:

- Metals can react adversely with some class 8 dangerous goods to give off flammable hydrogen gas.
- Aqueous (water containing) solutions (e.g. detergents) react adversely with class 4.3 (e.g. calcium carbide) dangerous goods to give off flammable and or toxic gases and heat.
- Combustible products (e.g. saw dust, paper, timber products, asphalt, organic fibres can react with class 5.1 oxidising agents.
- Organic peroxides are unstable and can react violently even with small traces of zinc, copper, iron, combustible materials and other contaminants.

Situations involving small quantities

In some scenarios where consumer packages are stored and handled in smaller package sizes and aggregate quantities (e.g. retail places, laboratory work benches and cabinets), it may not be practicable to store dangerous goods apart by three or more metres. However, the risk from incompatible goods must still be managed. Incompatible goods must not be stored either vertically or horizontally on the same shelves.

Control measures may include:

- segregation using a liquid tight partition between incompatible materials
- segregation of incompatible goods in different fire rated, self bunded chemical storage cabinets
- storage on different shelves can be used so as to ensure that incompatible materials cannot come into contact
- storing glass bottles on lower shelves to minimise breakage
- ensuring liquid goods are not placed above solids and powders.