Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**

# Dangerous Goods Safety Guide
# Risk assessment for dangerous goods

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# Introduction

This guide will assist operators of dangerous goods sites in Western Australia to complete a risk assessment under the Dangerous Goods Safety (Storage and Handling of Non-Explosives) Regulations 2007 (the regulations) and demonstrate minimising risk to people, property and the environment under Section 8 of the *Dangerous Goods Safety Act 2004* (the Act). In particular, this guide will assist those storing and handling dangerous goods in quantities exceeding those specified as "manifest quantities" in Schedule 1 of the Regulations to comply with regulation 48 relating to risk assessment.

It will also assist applicants for a dangerous goods site licence to comply with their duty to supply a risk assessment under regulation 26(2)(b).

The Department provides a *dangerous goods risk assessment template* that can be used to formally document the risk assessment.

It is not intended that use of the procedure and template should be regarded as the only way to carry out the risk assessment, but this guide does identify the types of issues that need to be addressed in a thorough risk assessment for dangerous goods. Alternative processes may be used, but should give a realistic assessment of the risk.

The ultimate aim of any risk assessment is to identify appropriate control measures that will reduce the risks from the dangerous goods to people, property and the environment to as low as reasonably practicable (ALARP).

The risk assessment must be reviewed:

- at least every five years
- if the site is involved in a (significant) dangerous goods incident
- if there is a change in circumstances such that the risk assessment is no longer applicable, such as a change to the storage or handling system, the emergence of new vulnerable facilities off-site, or changes in the state of knowledge about the hazards or availability of control measures.

*Note: Combustible liquids are a dangerous goods for the purpose of the Regulations.*

# Risk assessment process

For a dangerous goods site, a risk assessment is a document that:

- identifies all hazards relating to the dangerous goods at the site
- for each hazard
  - assesses the probability of the hazard causing a dangerous goods incident
  - assesses the consequences of the incident to people, property and the environment
  - identifies the risk control measure(s)
- explains the rationale behind the judgements made.

A separate hazard identification and risk assessment should be undertaken for each dangerous good and for each dangerous goods installation.

Anyone carrying out a risk assessment should be familiar with the requirements of the regulations and have a practical understanding of how the dangerous goods are stored and handled at the site.

A single person such as the works manager or works chemist may be suitably competent to perform simple assessments. In more complex cases, several people representing a variety of skills will probably be involved in collecting and assessing the information.

*Note: If you are considering contracting the services of external consultants, ensure they are approved by the Chief Dangerous Goods Officer and have the expertise and experience to do the job competently. See the accredited consultant list on the Department's website.*

Hazard identification and risk assessment can be relatively simple or highly complex, depending on circumstances. The nature of the dangerous goods involved and complexity of the handling systems will dictate the level of complexity of the risk assessment and associated documentation. The risk assessment can range from a short simple document perhaps referring to a single code of practice, to a longer more complex document that contains both approved codes of practice and risk assessments for processes not covered by any codes of practice.

A major warehouse handling a large range of dangerous goods or a chemical manufacturing plant is likely to require detailed investigations of the hazards and risks, involving people who have specialist knowledge of:

- dangerous goods
- processing of those materials;
- safe work practices employed in connection with those materials.

Figure 1 illustrates the two approaches to risk assessment – one using approved codes of practice and the other based on first principles. The *dangerous goods risk assessment template* will assist in documenting the approach used to satisfy regulatory requirements.

The regulations require that the risk assessment be made available to all employees for comment and that employee comments should be considered before preparing a revised assessment or plan.

At the conclusion of the risk assessment process the operator must sign and date the document.

## Approach using approved codes of practice

Section 62 of the *Dangerous Goods Safety Act 2004* allows the operator of a dangerous goods site to adopt and comply with approved codes of practice, where applicable (e.g. spillage containment, impact protection), and thereby be deemed to have:

- achieved the outcome required by the regulations
- complied with the duty to minimise risk from dangerous goods as far as is reasonably practicable.

Approved codes of practice provide a useful and convenient mechanism to identify most risk control measures at the majority of dangerous goods storage and handling installations.

Approved codes of practice contain peer guidance as to what is required by legislation and are updated as necessary in the light of incidents in Australia and elsewhere. While these approved codes do not usually document the hazard identification and risk assessment, they do have an almost complete set of risk control measures based on a very large number of potential hazards. It is usually too difficult for a single person or even a single enterprise to identify all these risk control measures from first principles in a satisfactory way, but innovation is still encouraged in the quest for more effective and efficient control measures.

Hence, those adhering to approved codes of practice may adopt a streamlined, simplified risk assessment process, which can be used for almost all situations where dangerous goods are stored — as opposed to being processed — since most storage situations are covered with by one or more of the long list of approved codes of practice. A full list of approved codes of practice is available on the website.

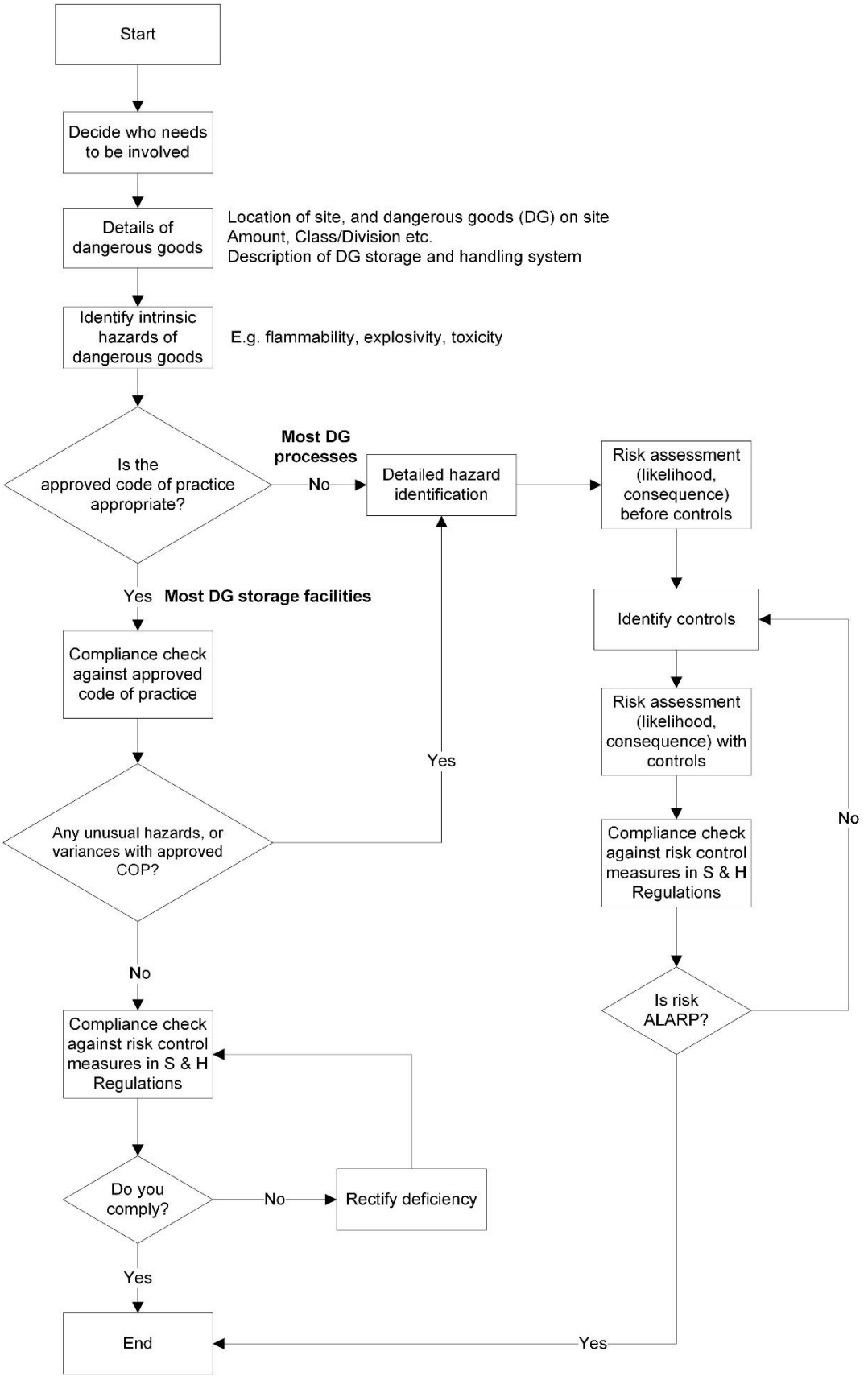


*Figure 1 Flow diagram showing steps in hazard identification and risk assessment for dangerous goods storage and handling. Aligns with relevant sections of the dangerous goods risk assessment template*

The steps involved when using an approved code of practice are described below and shown in Figure 1.

1. Carefully establish the applicable code(s) of practice for the particular situation. When using an Australian Standard (AS or AS/NZS), ensure it is gazetted and approved by the Minister as an "approved code of practice". More than one approved code of practice may apply.

   For example, at a service station, two approved codes of practice may apply – AS 1940 *The storage and handling of flammable and combustible liquids* and AS/NZS 1596 *The storage and handling of LP gas*.

2. Demonstrate compliance with all relevant risk control measures stipulated in the approved code(s) of practice, identifying and rectifying any non-compliance.

   *Note: Checklists to help confirm compliance with Australian Standards are available at www.dmp.wa.gov.au/Safety/Templates-16214.aspx*

3. Justify alternative risk control measures, if any, by using the first principles approach. The risk assessment should demonstrate an equal or lower level of risk than that achieved by following the approved code of practice.

4. Identify any unusual hazards unique to the particular dangerous goods installation and not covered by an approved code of practice, and assess the levels of risk.

   For example, unusual hazards not covered by a code of practice may be those posed by a small process operation, a transfer of dangerous goods that is out of scope, unusual weather conditions (e.g. cyclone, flooding or severe lightning) or special traffic hazards (e.g. movement of large mobile mining equipment).

### Approach based on first principles

For situations where there are no approved codes of practice, such as for a process plant, a risk assessment from first principles needs to be conducted using the well-known stepwise process (see Figure 1) of:

- hierarchy of control
- hazard identification
- qualitative or semi-quantitative risk ranking in terms of consequence and likelihood
- judgements about the selection of the correct mixture of control measures to demonstrate that the risk has been minimised to as low as is reasonably practicable.

Most dangerous goods sites containing process plant also have associated static storage for which the streamlined risk assessment using approved codes of practice can be used to complement the risk assessment from first principles.

For more information on hazard analysis tools please see Table 2 of the *Dangerous Goods Safety Guidance Note M01/09 – Generating the supporting documentation for an MHF safety report*.

## Risk assessment template

### Template use

The *dangerous goods risk assessment template* follows the step-by-step process (Figure 1) for carrying out a hazard identification and risk assessment for dangerous goods. It can be used at any site where dangerous goods are stored or handled.

Additional guidance on risk assessments relevant for process plants is the *Dangerous Goods Safety Guidance Note M01/09 – Generating the supporting documentation for an MHF safety report*. This guidance note details hazard identification techniques such as HAZOP and Fault Tree Analysis that can be used to identify hazards in process plants. Table 3 of the guidance note gives typical considerations during likelihood analysis.

The purpose of risk evaluation is to assist in making decisions, based on the outcomes of risk analysis, about which risks need treatment and the priority for treatment implementation.

## Hazard identification

Except for hazards and associated risks treated by risk control measures in line with an approved code of practice, all hazards and their associated risks to people, property and the environment arising from the physical, chemical and toxicological properties of the dangerous goods need to be identified and subsequently assessed by conducting an estimation of their likelihood and consequence.

As a quick guide, Table 1 shows the main types of intrinsic hazard associated with various dangerous goods Classes and Divisions.

It is most important that all relevant hazards are identified. A hazard is any activity, procedure, plant, process, substance, situation or circumstance that could be the cause of an accident.

*Table 1 Intrinsic hazardous properties of dangerous goods*

*Note: This table is not intended to cover all the hazardous properties of dangerous goods. Additional hazards may apply.*

| | Class/Division (including sub-risks) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hazard** | **2.1** | **2.2** | **2.3** | **3** | **4.1** | **4.2** | **4.3** | **5.1** | **5.2** | **6.1** | **8** | **9** |
| Flammability | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ |
| Chemical explosion | ✓ | | | ✓ | ✓ | | | | | | | |
| Physical explosion | ✓ | ✓ | ✓ | | | | | | | | | |
| Physical and chemical explosion | ✓ | | | | | | | | | | | |
| Explosive atmosphere | ✓ | | | ✓ | | ✓ | | | | | | |
| Toxic by inhalation | | | ✓ | | | | | | | ✓ | | |
| Toxic by skin/eye contact | | | | | | | | | | ✓ | ✓ | |
| Toxic by ingestion | | | | | | | | | | ✓ | | |
| Temperature sensitivity | | | | | | ✓ | | | ✓ | | | |
| Asphyxiation risk | | ✓ | | | | | | | | | | |
| Hot liquid | | | | | | | | | | | | ✓* |
| Corrosivity | | | | | | | | | | | ✓ | |
| High reactivity | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Cryogenic burns | | ✓ | | | | | | | | | | ✓ |
| Chemical instability | | | | | | | | ✓ | ✓ | | | |
| Hazardous decomposition products | | | | | | ✓ | ✓ | ✓ | | ✓ | ✓ | |
| Environmental pollutant | | | | | | | | | | ✓ | | ✓ |

** Hazard applies to some Class 9 goods*

It helps to understand that dangerous goods hazards arise from five major causes and to ask the following five questions.

In what ways could:

- a loss of containment occur from the storage or handling system (e.g. containers, tanks, reaction vessels or pipes)?
- an external fire impinge on the dangerous goods?
- ignition sources cause a fire or explosion (to prevent fire and/or explosion where explosives or explosive atmospheres are a potential problem during transfer operations)?
- unwanted mixing or contamination of the dangerous goods with other substances occur and lead to a violent chemical reaction?
- one maintain the stability of inherently unstable dangerous goods, such as some explosives or peroxidisable liquids (e.g. by preservation of small concentrations of an inhibitor or a maximum control temperature, or avoidance of impact, friction and ignition sources)?

Answering these questions will identify five sets of hazards, and their elimination will directly lead to the necessary *preventive* risk control measures.

However, it is worth remembering that these preventive risk control measures can fail and they should, as far as possible, be backed up by risk *mitigation* measures such as:

- separation between dangerous goods and risk receptors by distance or barrier
- emergency equipment such as firefighting facilities and personal protective equipment
- safety procedures
- building competence in key personnel
- emergency plans.

The process described here takes the user to the step beyond risk assessment – to the identification and assessment of risk controls.

## Assessment of risk

You need to assess the risk from each of the hazards you identified above. This will be important in deciding what control measures may be required to ensure that risk from the storage or handling of the dangerous goods is at an acceptable level. Assessing the risk will also prioritise the urgency of implementing the risk control measures.

The assessment may be quantitative or qualitative.

The semi-quantitative risk score calculator in Appendix 2 may assist, but other methods such as those in *ISO 31000:2018 Risk management – Guidelines* may also be used. The use of this or other risk assessment matrices is not mandatory. In some cases, qualitative assessments may be just as beneficial as semi-quantitative methods.

## Risk control measures

You need to decide what risk control measures, systems or procedures are required to minimise the risk to an acceptable level. In determining this, a hierarchy of control measures must be considered, with a preference for high-order controls (Table 2). When selecting the control measures, the aim is to achieve an acceptable level of risk, i.e. to minimise risk by taking “all reasonably practicable measures”.

Section 8(2) of the Act lists the factors and considerations that will guide the operator in deciding what “all reasonably practicable measures” means and, therefore, whether the risk has been sufficiently minimised.

*Table 2 Hierarchy of risk control measures for dangerous goods storage and handling*

| Hierarchy of control measures | Examples |
|---|---|
| **Eliminating the risk** | Use a non-harmful substance instead of dangerous goods |
| **Substituting the system of work, substance or plant for something less hazardous** | Change the type of dangerous goods kept on site |
| | Reduce the quantities of dangerous goods kept on site |
| **Isolating the hazard** | Introduce a restricted work area |
| | Enclose the system |
| | Separate goods from other hazards |
| | Segregate incompatible substances |
| **Introducing engineering controls** | Forced ventilation to remove fumes |
| | Spill containment |
| | Impact protection |
| | Use flameproof or intrinsically safe electrical equipment in hazardous areas |
| | Safety relief valves |
| | Overfill protection |
| | Control stability of dangerous goods |
| **Administrative controls** | Modify the system of work, such as changing the times at which certain tasks are done |
| | Use placards or hazard warning signs |
| | Specific training and work instructions |
| **Personal protective equipment (PPE) and safety equipment** | Provide eye, respiratory and hand protection for the worker (and instruction on when and how to use it) |
| | Firefighting equipment |
| | Safety showers |
| | Spills clean-up equipment |

### Access to risk assessment

Preparation of a risk assessment is a critical element in the safe management of a dangerous goods site. It should form the basis of the control measures adopted, and be included in the induction and training of staff.

Following the steps outlined in this guide should enable operators to fulfil their obligations under the Regulations. Dangerous goods officers will ask to see the risk assessments when auditing or inspecting sites, and the documentation must be made available upon request.

## Further information

Contact Dangerous Goods Safety Branch:
Phone 08 6251 2300
Email dgsb@dmirs.wa.gov.au
Web www.dmirs.wa.gov.au

# Appendix 1 Risk score calculator

The following method may be used to determine risk semi-quantitatively. An initial ranking of the risks to be controlled can be made with the risk score calculator. It accounts for the likelihood of an incident arising from the hazard and the possible consequence of that incident.

To determine a final ranking for the risks to be controlled, the feasibility of mitigating the risk (i.e. availability and suitability of ways to do this) and the cost of mitigating the risk must be considered. An occupier may identify a risk that needs to be controlled for which the likelihood and consequence are relatively low, but the risk can be controlled easily and at low cost. In such circumstances, it may be practicable to control that risk before others that have a greater likelihood or consequence.

Also, the results depend on judgements made about likelihood and consequence so little reliance should be placed on the results in an *absolute* sense. However, provided the assumptions and assessments are carried out in a consistent manner for all hazards and resultant risks, the calculator can provide a good indication of relative risk ranking.

Step 1 – Determine the likelihood of events that may cause harm to people, property, or environment from storage and handling activities, and assign them a value (L) between 0 and 5 as shown below.

| Likelihood (L) | Likelihood of occurrence | Indicative frequency |
|---|---|---|
| 0 | Totally eliminated | Zero |
| 1 | Rare | Once in a thousand years |
| 2 | Unlikely | Once in a hundred years |
| 3 | Likely | Once in ten years |
| 4 | Certain | Less than once a year |
| 5 | Imminent | More than once a year |

Step 2 – Determine the consequence of risk that may arise from the possible event or outcome. Consequence is assigned a value (C) between 1 and 5 as shown below.

| Consequence (C) | Extent of consequences | Examples |
|---|---|---|
| 1 | Minor | Minor loss of containment<br>Dealt with by site personnel<br>No harm to personnel<br>No environmental damage |
| 2 | Medium | Loss of containment<br>Minor fire<br>No structural damage<br>No harm to personnel<br>No long term environmental damage |
| 3 | Major | Major loss of containment<br>Fire<br>Some structural damage<br>Minor injuries or personnel affected by fumes<br>Some environmental damage |

| Consequence (C) | Extent of consequences | Examples |
|---|---|---|
| 4 | Catastrophic | Total loss of containment<br>Major fire<br>Major structural damage<br>Injuries or harm to personnel requiring hospitalisation<br>Death<br>Impact largely confined to the site |
| 5 | Catastrophic external | Significant impact beyond the boundaries of the site |

Step 3 – Calculate the relative level of risk (R) to assist you to rank and prioritise your risks.

Multiply the value obtained for the likelihood (L) by the value obtained for the consequence (C):

$$R = C \times L$$

Once this value is obtained, assess the priority for action based on the criteria shown below, remembering to consider the practicability of implementing control measures as the score is merely a guide. If the risk is relatively low and relative the cost of control measures is low then risk control measures ought to be implemented immediately regardless of the score.

| Relative risk (R) | Level of risk | Priority for action |
|---|---|---|
| 1-2 | Low | Schedule for action after other risks |
| 3-4 | Medium | Further improvement required |
| 5-9 | High | Immediate action required |
| 10 or more | Totally unacceptable | Shutdown or cease operation or part of operation unless additional controls instigated immediately |