



Government of **Western Australia**  
Department of **Mines and Petroleum**  
Resources Safety

## **Dangerous Goods Safety Guidance Note S02/09**

### **Risk assessment for dangerous goods**

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## Introduction

This guidance note 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 Storage and Handling Regulations). In particular, this guidance note will assist those storing and handling dangerous goods in quantities exceeding those specified as “placard quantities” in Schedule 1 of the Storage and Handling 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 obligation to develop a “written report” under regulation 26(2)(c) of the Storage and Handling Regulations. The Chief Officer has decided that the requirements under regulation 48 are the same as those for the “written report”, and the risk assessment described here may be applied to both.

This guidance note describes a detailed process that complements the discussion in Chapters 3, 4, 5, 6 and 7 of Resources Safety’s *Storage and handling of dangerous goods – code of practice*, and provides a template that can be used to document the risk assessment. The template is available in Word format from the Resources Safety website in the dangerous goods publications section.

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 guidance note 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 or
- if the site is involved in a (significant) dangerous goods incident or
- if there is a change in circumstances such that the risk assessment is no longer applicable, such as a change to the storage or handling system, the emergence of new vulnerable facilities off-site, or changes in the state of knowledge about the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: C1 combustible liquids are covered by the Storage and Handling Regulations, and are included in the term “dangerous goods” in this guidance note.*

## 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); and
- 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 Storage and Handling 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 Officer and have the expertise and experience to do the job competently.*

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.

For example, the storage of only one or two classes of dangerous goods at retail outlets, where handling is limited to placing the goods on shelving for display, is a relatively simple case and the hazard identification and risk assessment for the activity should be simple.

In contrast, a major warehouse handling a large range of dangerous goods or 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; and
- 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 template provided in Appendix 1 will assist in documenting the approach used to satisfy regulatory requirements.

The Storage and Handling 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.

## **Approach using approved codes of practice**

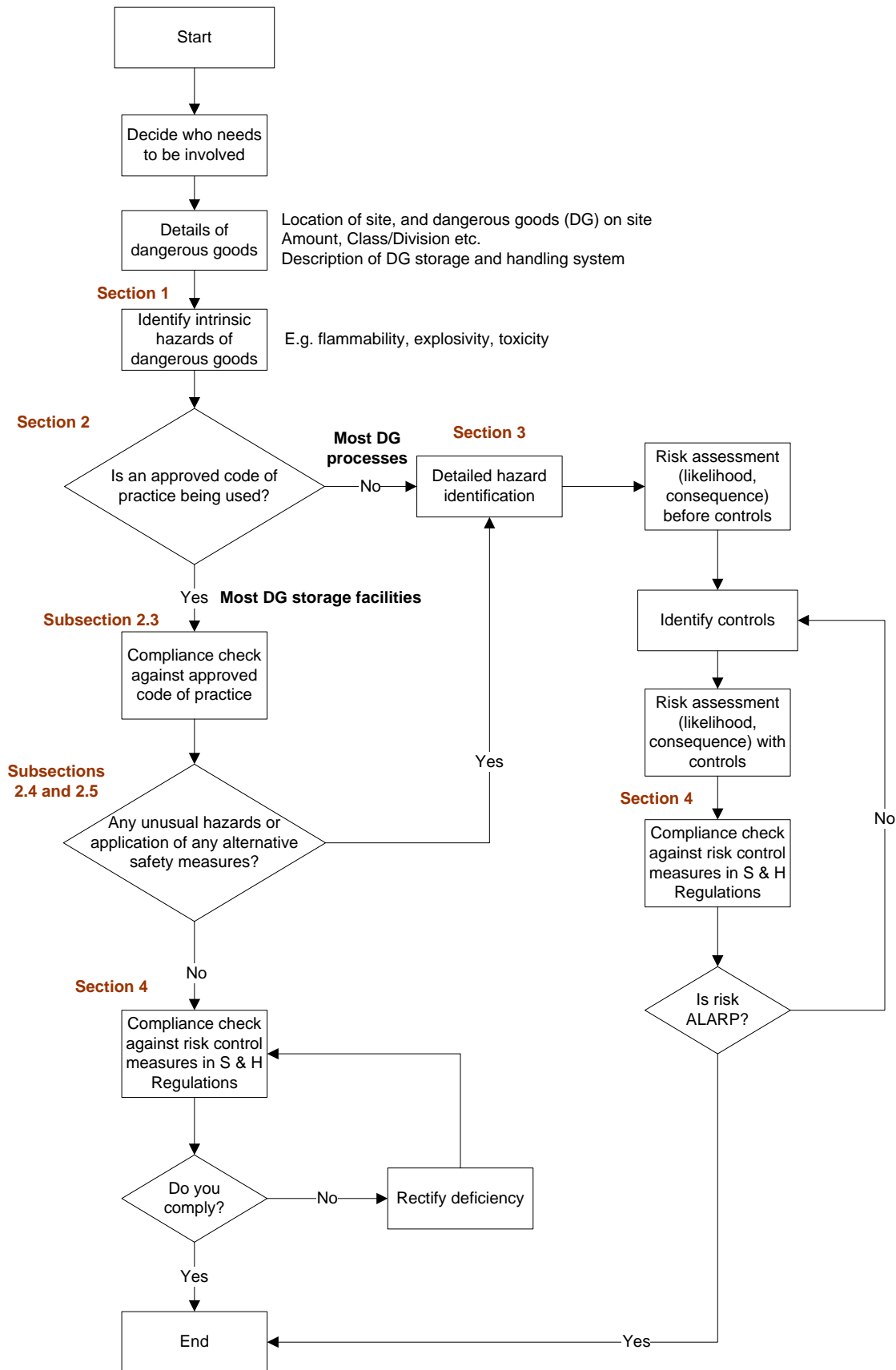
Approved codes of practice provide a useful and convenient mechanism to identify most control measures at the majority of dangerous goods *storage* installations.

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 Storage and Handling Regulations; and
- complied with the duty to minimise risk from dangerous goods as far as is reasonably practicable.

Approved codes of practice contain the accepted wisdom and experience of many safety professionals 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.



**Figure 1** Flow diagram showing steps in hazard identification and risk assessment for dangerous goods storage and handling. Sections refer to template in Appendix 1

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”. There is commonly more than one code that applies.

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

*Note: Resources Safety’s Design, installation and operation of underground petroleum storage systems – Code of practice also applies as a mandatory code under the Storage and Handling Regulations.*

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

- hazard identification;
- qualitative or semi-quantitative risk ranking in terms of severity and likelihood; and
- 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.

## Risk assessment template

### Template use

The template in Appendix 1 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.

Resources Safety’s *Dangerous Goods Safety Guidance Note M01/09 – Generating the supporting documentation for an MHF safety report* gives further information on all the steps of a risk assessment and should be consulted for risk assessments of process plants. For example, table 2 of Guidance Note M01/09 lists 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.

## 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.

It is not possible to identify all the hazards, understand the severity of the risk and find all the risk prevention and mitigation measures, without understanding the inherent chemical and physical hazards of the dangerous goods in question. An early step is therefore to identify the inherent chemical and physical hazards of a dangerous good. This can be achieved by studying the manufacturer's material safety data sheet (MSDS) for the substance and consulting with suitably knowledgeable persons.

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.*

Hazard	Class/Division (including Sub-risks)											
	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 fire fighting facilities and personal protective equipment;
- safety procedures;
- building competence in key personnel; and
- 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 AS/NZS 4360:2004 *Risk management* 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 should 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.

Refer to Resources Safety’s *Storage and handling of dangerous goods – code of practice* for a more comprehensive discussion of control measures.

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

Hierarchy of control measures	Examples
<b>Eliminating the risk</b>	Use a non-harmful substance instead of dangerous goods
<b>Substituting the system of work, substance or plant for something less hazardous</b>	Change the type of dangerous goods kept on site
	Reduce the quantities of dangerous goods kept on site
<b>Isolating the hazard</b>	Introduce a restricted work area
	Enclose the system
	Separate goods from other hazards
	Segregate incompatible substances
<b>Introducing engineering controls</b>	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
<b>Administrative controls</b>	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
<b>Personal protective equipment (PPE) and safety equipment</b>	Provide eye, respiratory and hand protection for the worker (and instruction on when and how to use it)
	Fire fighting 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 guidance note 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.

## Appendix 1 Dangerous goods risk assessment template

This template is available in Word format from the Resources Safety website.

### Site details

<b>Operator name</b>	<b>Dangerous goods site licence no. (if applicable)</b>
<b>Site address</b>	
<b>Site location and site reference no. (if applicable)</b>	<b>Description of dangerous goods storage or handling system</b>
<b>Persons involved in this risk assessment</b>	

### Supporting documentation (attached)

- Site plan and manifest (r. 78)
- Dangerous goods register (r. 77)
- Material safety data sheet/s (MSDS) (r. 79)
- Documents showing compliance with approved code of practice and Storage and Handling Regulations

## 1 Hazard identification

### 1.1 Product details

<b>Manufacturer</b>	
<b>Active constituents</b>	
<b>Physical state</b>	
<b>Physical appearance, odour, other characteristics</b>	

### 1.2 Details of dangerous goods storage and handling

<b>UN No.</b>	<b>Class or Division</b>	<b>Sub risk</b>	<b>Packing Group</b>	<b>Name of dangerous good</b>	<b>Quantity (kL or t)</b>

### 1.3 Review of MSDS for hazards arising from properties

[Focus on the intrinsic hazards of the dangerous goods arising from specific physical, chemical and toxicity properties]

### 1.4 List of previous dangerous goods incidents at this site and control measures adopted in response

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Complete Section 2 only if you are applying an approved code of practice for dangerous goods storage and handling, otherwise skip to Section 3.

## 2 Application of an approved code of practice

### 2.1 Name of approved code of practice and edition

Number	Title	Edition	Applied
<b>Australian Standards</b>			
AS/NZS 1596	The storage and handling of LP Gas		Yes / No
AS 1894	The storage and handling of non-flammable cryogenic and refrigerated liquids		Yes / No
AS 1940	The storage and handling of flammable and combustible liquids <i>Note that subsection 11.2(b) of AS 1940 does not apply as it is in conflict with Regulation 73 "Fire Protection" of the Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007</i>	2004	Yes / No
AS/NZS 2022	Anhydrous ammonia—Storage and handling		Yes / No
AS 2507	The storage and handling of agricultural and veterinary chemicals		Yes / No
AS 2714	The storage and handling of hazardous chemical materials—Division 5.2 substances (organic peroxides)		Yes / No
AS/NZS 2927	The storage and handling of liquefied chlorine gas		Yes / No
AS 3780	The storage and handling of corrosive substances		Yes / No
AS/NZS 3833	The storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers		Yes / No
AS 3961	The storage and handling of liquefied natural gas		Yes / No
AS/NZS 4081	The storage and handling of liquid and liquefied polyfunctional isocyanates		Yes / No
AS 4326	The storage and handling of oxidizing agents <i>Note that AS 4326 is not applicable to solid ammonium nitrate. Refer to Resources Safety's code of practice for the safe storage of solid ammonium nitrate.</i>		Yes / No
AS 4332	The storage and handling of gases in cylinders		Yes / No
AS/NZS 4452	The storage and handling of toxic substances		Yes / No
AS/NZS 4681	Storage and handling of Class 9 (miscellaneous) dangerous goods		Yes / No
<b>Resources Safety, Department of Mines and Petroleum (formerly Department of Consumer and Employment Protection)</b>			
Not applicable	Storage and handling of dangerous goods – code of practice	2008	Yes / No
Not applicable	Safe storage of solid ammonium nitrate – code of practice	2008	Yes / No

Number	Title	Edition	Applied
<b>Australian Explosives Industry and Safety Group Inc.</b>			
Not applicable	Code of good practice – precursors for explosives	1999	Yes / No

- 2.2 Is the storage or handling system fully covered in the scope of the approved code of practice?** YES NO  
If you have answered NO, you need to complete Section 3.
- 2.3 Is compliance documentation available?** YES NO  
If you answered NO, you need to conduct a compliance check for the approved code of practice and attach documentation to confirm compliance.
- 2.4 Are there any unusual hazards with this storage and handling installation?** YES NO  
If you have answered YES, you need to complete Section 3.
- 2.5 Have alternative safety measures been applied that is at variance to the approved code of practice?** YES NO  
If you have answered YES, you need to complete Section 3.

*If you have answered NO to Question 2.2 or YES to Questions 2.4 or 2.5, you need to complete Section 3, otherwise skip to Section 4.*



#### 4 Compliance check against risk control measures specified in Storage and Handling Regulations

Risk control measure	Complies?	Description and reference
Spill containment (r. 51)	[Y, N, N/A]	[Describe how this requirement is met and where this information is located]
Segregation of dangerous goods (r. 52)		
Stability (r. 53)		
Protection from impact (r. 54)		
Transfer points for dangerous goods (r. 55)		
Ignition sources in hazardous areas (r. 56)		
Ventilation (r. 57)		
Separation distance (r. 58)		
Containers for bulk dangerous goods and pipework (rr. 60, 61)		
Lighting (r. 64)		
Access and egress (r. 65)		
Security (r. 66)		
Placarding and pipe-work labelling (rr. 60, 68-72)		
Fire protection (r. 73)		
Other risk control equipment (r. 74)		
Emergency plan (r. 75)		
Measures to contain DG incidents (r. 76)		

## 5 Outstanding risk control actions

Summary of risk control actions still to be implemented (if any) – where risk has not been minimised

Item reference no.	Comments and action plan with implementation dates and persons responsible for action
[Ref. no. from Section 3 if applicable]	

## 6 Risk assessment summary

The risks from this **proposed / existing** dangerous goods storage or handling system **have / have not** been minimised to as low as reasonably practicable to people, property and the environment.

Name of assessor/s ..... Date .....

Signature/s .....

Date of next review .....

## Appendix 2 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 **severity** of that incident (i.e. consequence).

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 severity 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 severity.

Also, the results depend on judgements made about likelihood and severity 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 **severity** of risk that may arise from the possible event or outcome. The severity of risk is assigned a value (S) between 1 and 5 as shown below.

Severity (S)	Extent of consequences	Examples
1	Minor	Minor loss of containment Dealt with by site personnel No harm to personnel No environmental damage
2	Medium	Loss of containment Minor fire No structural damage No harm to personnel No long term environmental damage
3	Major	Major loss of containment Fire Some structural damage Minor injuries or personnel affected by fumes Some environmental damage
4	Catastrophic	Total loss of containment Major fire Major structural damage Injuries or harm to personnel requiring hospitalisation Death 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 **severity (S)**:

$$R = S \times L$$

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)	Assessment 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