



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

Dangerous Goods Safety Guidance Note

Storage of explosives

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Introduction

Stringent criteria apply to the possession and storage of explosives to ensure people storing explosives do so without creating an unacceptable risk to the community.

This guidance note assists in identifying the regulatory requirements for the storage of explosives in Western Australia.

With few exceptions, licences are required to possess and store explosives in Western Australia, as prescribed by the Dangerous Goods Safety (Explosives) Regulations 2007 (the Explosives Regulations). The exceptions include small quantities of some low-risk explosives commonly used within the community for business or personal purposes (e.g. nail gun cartridges, sparklers, emergency devices, ammunition).

A Western Australian dangerous goods security clearance is a prerequisite for obtaining an explosives storage licence. The licence application forms contain detailed information about security clearance requirements and how to obtain the security card.

A licence holder may authorise an employee to have either supervised or *unsupervised* access to explosives, provided the appropriate requirements are satisfied (Table 1). An employee is considered a *secure employee* if the requirements are met for unsupervised access.

Further information on the licensing system, security clearance requirements and applying for a licence is available on the Resources Safety website.

Table 1 Requirements for supervised and unsupervised access to explosives

Supervised access	Unsupervised access (secure employee)
<p>Employee* must be employed by licence holder</p> <p>Employee must be authorised by licence holder to access and possess explosives in the course of their duties</p> <p>Employee must be supervised by: licence holder while having access to explosives, or a secure employee of the licence holder acting in the course of his or her duties</p>	<p>Employee* must be employed by licence holder</p> <p>Employee must be authorised by licence holder to access and possess explosives in the course of his or her duties</p> <p>Employee must have a valid Western Australian dangerous goods security clearance</p> <p>Licence holder is satisfied the employee is suitably trained to safely handle the explosives</p> <p>Licence holder must keep a record of secure employees</p>

** An employee of a licence holder includes a partner of and a person employed under a contract for services by the holder.*

Low-risk explosives exempt from storage licensing

The explosives listed in Table 2 are considered low risk and do **not** require a licence for storage provided they are stored in accordance with the Explosives Regulations.

Table 2 Explosives that may be stored without a licence

Explosives not requiring a licence	Storage requirements
Unrestricted fireworks (e.g. fireworks containing small quantities of explosives and generally for personal entertainment, such as party poppers, bonbons, Christmas crackers, throwdowns and caps for starter pistols and toy pistols)	No specific requirements
Model rocket motors with NEQ of 62.5 g or less	No specific requirements
Explosives stored in school, university or commercial laboratory for analytical or research purposes	No more than 0.5 kg of any kind of explosive may be stored in the laboratory
Sparklers	<p>A storage of more than 1,000 kg of sparklers must:</p> <ul style="list-style-type: none"> • Be in a building or container that is separated from other buildings and containers by at least 5 m • Be a dedicated storage for sparklers and other explosives of 1.4S and 1.4G • Display at entrance a division 1.4 orange diamond (as shown in Figure 3.1 of AEC3, minimum 250 mm square) • Display at entrance a sign saying “Fireworks (sparklers)” in black capital letters at least 100 mm high on white or silver background • Ensure a fire extinguisher with at least 9 L of water is located close to the building • Ensure no combustible material is within 5 m of the storage • Display a HAZCHEM outer warning placard • Ensure the building/container is locked when not in use
Power device cartridges (e.g. deployment devices for air bags and parachutes)	<ul style="list-style-type: none"> • A person storing more than 10,000 power device cartridges must ensure the outside of the cabinet or container in which they are stored has a clearly visible sign saying ‘Explosives’ • A person storing a power device cartridge must store it in a place not easily accessible to a person under the age of 14 years

Explosives not requiring a licence	Storage requirements
Power tool cartridges (e.g. nail gun cartridges)	<ul style="list-style-type: none"> • A person storing more than 10,000 power tool cartridges must ensure the outside of the cabinet or container in which they are stored has a clearly visible sign saying 'Explosives' • A person storing a power tool cartridge must store it in a place is not easily accessible to a person under the age of 14 years
Emergency devices if, at the place, there is not more than: <ul style="list-style-type: none"> • 2.5 kg (gross weight) of emergency devices with a classification code of 1.1 or 1.2 • 15 kg (gross weight) of emergency devices with a classification code of 1.3 • 30 kg (gross weight) of emergency devices with a classification code of 1.4 	Must be stored in a place not easily accessible to a person under the age of 14 years
Ammunition (any quantity)	A person may possess ammunition only if authorised under the Firearms Act 1973, in which case there are no specific storage requirements
Ammunition propellant or black powder at any place if: the NEQ of any ammunition propellant, excluding any ammunition propellant in ammunition, stored at the place is not more than 15 kg there is not more than 4 kg of black powder at the place	A person may possess ammunition propellant or black powder only if authorised under the Firearms Act 1973 Must be stored in non-ferrous receptacle clearly marked 'Explosives', which is kept closed and locked, and protects the explosives from weather, contamination, sources of ignition and access by unauthorised individuals No more than 2 kg of black powder may be stored in any one container

NEQ = net explosive quantity; i.e. net quantity of explosive in the article or substance, excluding other constituents

Limited storage under a 'user' licence

The licences for shotfirers, pyrotechnics (special use), fireworks contractors and fireworks operators authorise the holder to store limited quantities of explosives (Table 3) but a storage licence is required when these quantities are exceeded.

If the limited quantities of explosives are stored at a place that does not have an explosives storage licence, then they must be stored:

- safely; and
- not in any part of a building used wholly or partly as a dwelling or a shop.

Note: 'Safely' in this context means the explosives need to be stored in a non-ferrous receptacle clearly marked 'Explosives' that is kept closed and locked (except during use by authorised personnel), and protects the explosives from the weather, contamination, sources of ignition and access from unauthorised individuals.

Fireworks event permits may also authorise the storage of a firework at a place at the display site — the permit will specify the conditions of storage.

Table 3 'User' licences authorising limited storage of explosives

Licence type	Maximum quantity (gross weight) of explosives authorised by licence
Shotfirer – on 2 ha or less of land	2.5 kg of blasting explosives and 100 detonators
Shotfirer – on more than 2 ha of land	10 kg of blasting explosives and 100 detonators
Pyrotechnics (special use)	2.5 kg of HD 1.1 or 1.2 and 15 kg HD 1.3 and 30 kg HD 1.4
Fireworks contractor or fireworks operator	2.5 kg of HD 1.1 or 1.2 and 15 kg HD 1.3 and 30 kg HD 1.4

HD = Hazard Division

Storage under an explosives storage licence

There are three main categories for storage of explosives under an explosives storage licence:

- explosives storages totalling 50 kg NEQ or more;
- explosives storages totalling less than 50 kg NEQ; and
- underground explosives storages.

Storage of 50 kg NEQ or more

Magazines are required to comply with the requirements of Australian Standard AS 2187.1:1998 *Explosives – Storage, transport and use – Storage*, which addresses issues such as:

- design and location of the magazine;
- security, inventory and management of the explosives; and
- safety concerns.

Separation distances

Explosives storages are not permitted in residential areas.

The storages must meet the separation distances to Protected Works Class A (PWA) and Protected Works Class B (PWB) as detailed in table 3.2.3.2 of AS 2187.1:1998 (summarised in Appendix 1).

Protected Works Classes A and B are as defined in Australian Standard AS 2187.0:1998 *Explosives – Storage, transport and use – Terminology*. Open-space, frequently used public areas (e.g. public roads, parks, docks) and utilities (e.g. main electrical substations) are examples of PWA. Populated structures (e.g. houses, office buildings, hospitals, factories) and flammable or dangerous goods depots are examples of PWB.

Where there are two or more explosives magazines in the same compound that are not separated by the inter-magazine distances, the aggregate explosives quantity must be used in determining the required separation distances to PWA and PWB.

The minimum separation distance required between an explosives magazine and a detonator magazine depends upon the number of detonators stored (Table 4).

Table 4 Separation distances between storages of detonators and explosives

Number of detonators	Separation distance (metres)	
	Unmounded	Mounded
2,000	10	3.0
5,000	10	3.0
10,000	10	3.5
20,000	13	4.5
40,000	16.5	5.5
50,000	18	6.0
100,000	22	7.5

Mounding requirements

Mounding of an above-ground magazine reduces risk to nearby protected works in the event of an incident at the magazine, and protects the magazine itself from projectiles and debris if there is an explosion at a nearby explosives storage magazine.

In general, mounding should satisfy the following criteria:

- earth used for mounding should essentially be free of stones;
- length of the mound should exceed the length of the magazine by 1 metre at either end; and
- the mound, if next to a magazine, should be a minimum 300 mm above the height of the explosives in the magazine.

Specific guidance for the mounding of magazines, such as the minimum dimensions for various mounds, is given in appendix B of AS 2187.1:1998.

Earthing and lightning protection for magazines

Lightning protection requirements for above-ground magazines are given in AS 2187.1:1998. All explosives magazines must be effectively earthed where the resistance to ground is less than 10 ohms. Dry earth is not a good conductor of electricity, therefore the resistance is to be measured while the soil has minimal moisture, such as during the hottest, driest season.

In some instances it may be necessary to use a significant earthing structure (e.g. large brass rods, frames), rather than one or two earthing terminals. The earthing terminal or related earthing structure must be free from paint or other coatings that may reduce its ability to conduct and dissipate the electrical charge to earth.

Relocatable steel magazines should be earthed at diagonally opposite corners and require no further lightning protection unless placed in a vulnerable location, such as:

- elevated positions (e.g. hills, top of waste dumps); and
- high risk areas known to be highly susceptible to lightning strikes (e.g. coastal tropical regions) as deemed by Australian Government Bureau of Meteorology.

Lightning finials should be fitted to magazines in vulnerable locations and for any permanent magazine. The Australian Standard AS/NZS 1768:2007 *Lightning protection* describes the requirements of finials for lightning protection.

Safety, security and management

The safety, security and management of explosive storages must comply with the requirements of AS 2187.1:1998. Explosives must be kept in a locked magazine or receptacle of appropriate security and should be kept in a locked detached building not permanently occupied by people.

Where more than 2.5 kg of Hazard Division 1.1, 1.2 or 1.5, more than 15 kg of Hazard Division 1.3, or more than 30 kg gross weight of Hazard Division 1.4 is stored on a site, every perimeter entrance to the site must be labelled with a 'HAZCHEM' placard in accordance with the Explosives Regulations. The explosives magazine or receptacle must be labelled with the word 'Explosives or 'Detonators', as appropriate, in red uppercase lettering at least 75 mm high for storages of 500 kg or less, and 100 mm high for storages of more than 500 kg of explosives.

The requirements for an emergency management plan are detailed in section 5.3 of AS 2187.1:1998. Where a fire extinguisher is provided, it should be located close (6–15 m) to the storage.

Warning: Do not attempt to fight any fire involving explosives. *The extinguishers may be used to fight a fire before it reaches the explosives storage.*

Incompatible explosives such as blasting explosives and detonators must be stored in separate receptacles or magazines. Depending on the quantity stored, magazines containing incompatible explosives must be spaced at least 10 m apart where unrounded. If the magazines will be located at a certain place for a long period (i.e. more than a year), it is recommended that there is an intervening mound between incompatible storages.

Adequate security needs to be provided for the explosives store. Only those people who are authorised for unsupervised access to the explosives (in accordance with the explosives management plan) may have the means to unlock the explosives storage magazine. Explosives storages need to be locked at all times, other than when transferring product in or out of the receptacle, or when under constant supervision.

Fencing requirements

Appendix C of AS 2187.1:1998 provides the fencing requirements for above-ground magazines. In summary, explosives and detonator magazines must be surrounded by fencing that is:

- 2,450 mm high, comprising 2,000 mm of a galvanised chainwire (link mesh) and three strands of barbed wire spaced 150 mm apart;
- located at least 3 metres from the magazines, and 600 mm from the outside edge of the base of mounds;
- extended to or into the ground so as to prevent entry to the compound from under the fence; and
- electrically continuous and bonded to all magazines in the compound.

The fence may encompass all the magazines to form one compound or individually to form separate compounds.

Alternatives to the fencing requirement may be accepted, under certain circumstances, for storages located at a site for no more than three months. Written application must be made to the Chief Officer detailing the circumstances of how security will not be compromised with the alternative fencing design.

Explosives management plan

An explosives management plan (EMP) must be prepared for all licensed explosives storages. Resources Safety has produced a guide to assist in preparation of an EMP, covering the types of documents, procedures or actions to be considered. Completion of the associated template will satisfy the requirement to submit an EMP with the licence application. If further evidence is required for assessment, verification of the measures in place may be requested. The guide and template are available on the Resources Safety website.

The EMP describes how the licence holder ensures safe and secure operations in relation to the storage of explosives. These operations must be documented, communicated to all relevant persons, implemented, enforced and reviewed regularly and when circumstances change.

EMPs should be based on the risk management approach and provide details of the hazards identified, risks assessed and risk control measures adopted. Set procedures should be prepared for routine operations.

The EMP includes:

- a) a site plan showing the location of the storage in relation to buildings and other structures on site, roads, buildings on neighbouring properties (and a second, more detailed, site plan of the storage compound showing separation distances within the compound and to the fence is also recommended);
- b) the measures that will be taken to ensure the required details of any explosive received at, or despatched from, the site are recorded and reconciled with the required details of any explosive on the site;
- c) the measures that will be taken to ensure no explosive at the site is supplied to a person unless the person is an authorised person;
- d) the measures that will be taken to ensure a record is kept of the details of any person to whom an explosive at the site is supplied and the person's authority to possess the explosive;
- e) what measures will be taken to ensure any unlawful entry or attempted unlawful entry to the site or any theft, attempted theft or unexplained loss of any explosive is investigated and reported to the Chief Officer;
- f) general matters (including emergency management plans, incident reporting, training, monitoring and record keeping); and
- g) security matters (including the assessment, minimisation and monitoring of security risks).

Note: For quantities not exceeding any of the threshold quantities of 2.5 kg of Hazard Division 1.1 or 1.2, 15 kg of Hazard Division 1.3, 30 kg of Hazard Division 1.4 and 100 detonators, the EMP only needs to include the information in points a) through e), although a brief discussion of the management of general and security matters is recommended.

Inventory and inspection of explosives

An inventory of explosives stored must be kept. A written record of all transfers of explosives in and out of the magazine must be recorded. Details recorded must include the date and time of the receipt or dispatch, name of person to whom an explosive has been supplied and his or her authority to possess the explosives (e.g. licence details), type and quantity of explosive transferred and the balance of stock. A stocktake must be taken every month to reconcile records. Any explosives found to be missing or stolen are to be reported in writing to the Chief Officer within one month, and the report must detail:

- the unexplained loss;
- findings of the investigation; and
- measures taken to ensure an unexplained loss does not recur.

The explosives storage must be inspected monthly to determine compliance with the Explosives Regulations. A written record detailing the date and time of the inspection, the matters inspected and the findings of the inspection must be completed and retained.

Storage of less than 50 kg NEQ

Blasting explosives of Hazard Division 1.1 totalling less than 50 kg NEQ must be stored in external portable magazines, as described in AS 2187.1:1998.

Generally, an external portable magazine is preferred for all explosives but alternate receptacles (i.e. internal portable magazines) may be acceptable for explosives of other Hazard Divisions depending on the type of explosives and level of security afforded in the building or on site. For example, propellant powders may be stored in a locked wooden receptacle provided there is adequate security (i.e. physical, electronic or both) protecting the storage.

To maximise safety, it is preferable to store explosives outside. For outdoor storages of explosives *up to 50 kg NEQ*, the separation distances to Protected Works, as detailed in AS 2187.1:1998, are the same as those for explosives storages of 50 kg NEQ (see 'Separation distances' and Appendix 1).

If separation distances cannot be satisfied because the explosives storage is inside a building, which is only allowed for quantities less than 50 kg NEQ, then a safety risk assessment must be done to determine whether the risk is acceptable. The assessment must ensure that the requirements listed in Table 5 are satisfied, and consider factors such as:

- number of people and duration of time they spend within the blast radius predicted for the explosives — the aim is to minimise the exposure of people to the area likely to be affected if there was an explosion;
- separation to buildings, people and public off site — the risk assessment may simply reference any mandatory separation distances or other requirements, if applicable; and
- who will have access to the explosives at the proposed location.

The risk assessment must be documented and include details of:

- date when it was conducted;
- individuals who were involved in its preparation;
- its findings, including hazards identified and whether or not they were acceptable; and
- for those hazards identified as being unacceptable, what control measures were adopted.

For indoor storage, further minimisation of risk is achieved by using a blast barrier, as specified in Table 5. These are to be constructed from sandbags, and limit the hazardous effects of an explosion by directing the blast upwards. An appropriately reinforced wall or walls — not load bearing — may be used as part of the blast barrier, but if there are no such walls then the sandbags need to completely surround the magazine.

The distance between the base of the magazine and the sandbags should be sufficiently wide to sweep and keep clean, while still being practical and adequate to reduce blast effects. The height of the sandbags should be 500 mm higher than the magazine.

Measures should be taken to ensure that the magazine can be safely accessed and that injury is not sustained trying to climb over sandbags. Constructing the sandbag wall to include a walkway (Figure 1) will address this issue.

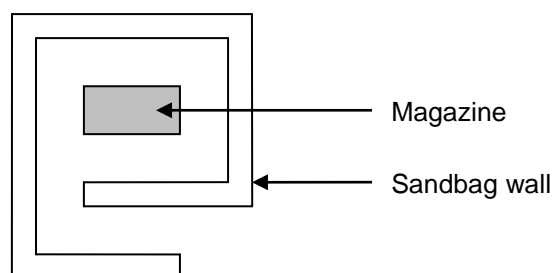


Figure 1 Plan view of sandbag wall surrounding indoor magazine

Table 5 Requirements for explosives storages of less than 50 kg NEQ inside a building

Parameter	Requirement
Permitted storage location	Inside or outside (for outside storage, follow requirements for 50 kg NEQ)
Magazine or receptacle required	<i>Hazard Division 1.1 blasting explosives</i> : external portable magazine, constructed as per requirements of AS 2187.1:1998 <i>Other Hazard Divisions</i> : external portable magazine recommended, but alternate receptacles may be acceptable depending on type of explosives and level of security afforded in the building or on site
Separation distance	Safety risk assessment required Storage must be in a light industrial or commercial area Maximise separation distances to all people, including those in neighbouring shops, buildings and floors both above and adjacent to storage Storage must be on ground level, away from structural supports and <i>not</i> above a basement For storages inside a building, separation distance may be reduced to 3 m for receptacles containing less than 1,000 detonators from an explosives storage For safety and security reasons, it is recommended that incompatible explosives are stored in separate locked buildings
Blast barrier	<i>Hazard Division 1.1 blasting explosives</i> : sandbags must surround magazine, about 300 mm from base, and at least 500 mm higher than the magazine <i>Hazard Divisions 1.2 and 1.3</i> : sandbags recommended <i>Hazard Division 1.4</i> : sandbags not required
Distance to nearest exit	Maximum 3 m from magazine
Fire fighting equipment (e.g. fire extinguishers, hose reel) for indoor storages	Between 6–15 m from the magazine <i>Note: Not for fighting any fire involving explosives; only for fighting fire before it reaches explosives storage</i>
Fuel loading within building	Minimise all fuel loading within building housing the magazine
Inventory of explosives	Minimise inventory, especially for Hazard Division 1.1 blasting explosives
Separation distances to dangerous goods storages	Minimum 6 m separation distance from magazine, depending on quantity of dangerous goods involved
Sources of ignition (e.g. hot work, welding, grinding, smoking)	Minimum 6 m separation distance from magazine
Combustibles (e.g. inside: paper, rags, oil, paint; outside: grass and leaves)	Minimum 8 m separation distance from magazine
Safety, security, management	See requirements under ‘Safety, security and management’
Signage	See requirements under ‘Safety, security and management’
Explosives management plan (EMP)	See requirements under ‘Explosives management plan’

Underground storage of explosives

The Explosives Regulations permit three types of magazines for underground storage of explosives:

- external portable magazines;
- relocatable magazines; and
- underground storage magazines at a fixed location.

External portable magazines and relocatable magazines may be used as underground working party magazines but *all* underground magazines must comply with the applicable design requirements of section 2 of AS 2187.1:1998.

The quantity of explosives that may be stored in an external portable magazine used as an underground working party magazine must not exceed 250 kg of explosive or 500 detonators.

The quantity of explosives stored in a fixed underground magazine should be minimised. A combination of both surface and underground storages may provide operational flexibility for sites requiring large quantities of explosives. A risk assessment must be conducted to determine the maximum quantity that may be safely stored. No more than one week's worth of explosives may be stored in an underground magazine, and justification of this quantity must be demonstrated through historical blast records.

Research papers indicate that the overpressure from unconfined underground blasts is more destructive than is generally understood. Blast waves propagate significantly further through underground tunnels than on the surface. Cross-cuts and corners have limited effect and decrease overpressure by only ~10% - 25% for high pressures. Pressure waves may be intensified as they reflect off walls and other surfaces resulting in peak pressures that are greater than the initial blast overpressure.

The consequence of an unconfined explosion of many tonnes of explosives within an underground mine must not be underestimated. Such an event could be fatal. Ventilation fans would be damaged or destroyed, people and plant both near and far from the magazine would be thrown against walls and objects, the mine or portions of the mine may collapse, access and escape routes may be isolated and refuge chambers may not be adequately engineered to withstand the forces of the blast or the resulting reverse-blast wave (backdraft). The rescue effort may involve challenges and difficulties unlike other anticipated emergencies.

Risk assessments must ensure the potential effects of an unconfined explosion are adequately addressed. Crib rooms and other non-production facilities must be adequately separated from the magazine. As a rule of thumb, a separation distance of twice the vulnerable facilities distance specified in Australian Standard AS2187.1 Table 3.2.3.2 for the NEQ stored is suggested, as measured through tunnels and passages. For example, the separation distance between a crib room and a magazine storing 15 tonnes of explosives would be 2,200 m. An emergency response plan for the worst-case scenario of an unconfined explosion at a magazine must also be developed.

Appendix 1 – Separation distances

The following table summarises the separation distances for the storage of Hazard Division 1.1, 1.5 or 1.6 explosives as given in AS 2187.1:1998.

NEQ stored (kg)	Separation distance (metres)								
	Protected Works – Class A	Protected Works – Class B		Vulnerable facilities	To other explosives storage		To process building		To ammonium nitrate storage
		Unmounded	Mounded		Unmounded	Mounded	Mounded	Unmounded	
50	25	180	30	180	18	9	18	30	7
100	25	180	38	210	23	12	23	38	9
200	35	180	52	260	29	15	29	47	11
300	45	180	68	300	33	17	33	54	13
400	55	180	82	330	36	18	36	59	14
500	63	180	95	360	39	20	39	64	15
1000	100	180	150	450	48	24	53	80	18
1500	135	200	200	510	55	28	66	92	22
2000	160	240	240	560	61	31	78	105	23
2500	185	280	280	610	66	33	90	110	25
3000	205	305	305	650	70	35	105	120	26
4000	235	350	350	710	77	39	130	130	29
5000	255	380	380	760	83	42	140	140	31
7500	295	435	435	870	94	47	155	155	35
10 000	320	480	480	960	105	52	175	175	39
15 000	370	550	550	1 100	122	61	200	200	45
20 000	405	610	610	1 220	135	66	220	220	49
25 000	435	650	650	1 300	145	71	235	235	53
30 000	460	690	690	1 380	150	75	250	250	56
40 000	510	760	760	1 520	165	83	275	275	62
50 000	550	820	820	1 640	180	89	295	295	67
75 000	625	940	940	1 880	205	103	340	340	77

NEQ stored (kg)	Separation distance (metres)								
	Protected Works – Class A	Protected Works – Class B		Vulnerable facilities	To other explosives storage		To process building		To ammonium nitrate storage
		Unmounded	Mounded		Unmounded	Mounded	Mounded	Unmounded	
50	25	180	30	180	18	9	18	30	7
100 000	690	1 040	1 040	2 080	225	115	375	375	84
120 000	730	1 100	1 100	2 200	240	120	395	395	89
140 000	770	1 160	1 160	2 320	250	125	420	420	94
160 000	810	1 220	1 220	1 440	265	135	435	435	98
180 000	840	1 260	1 260	2 520	275	140	455	455	105
200 000	870	1 300	1 300	2 600	285	145	470	470	110
250 000	940	1 400	1 400	2 800	305	155	510	510	115