Storages for bulk commodities

Much of following information is taken from *Storing, Handling and Drying Grain* by Alan Andrews, published by QDPI.

What is the essential role of the storage?

The storage must:

- keep the commodity in
- protect against rain, rodents and birds ❑
- allow efficient insect pest control
- minimise changes in temperature and humidity, except under aeration
- allow easy loading and unloading.

Is it best to have permanent or temporary storage?

This depends on the end-use. Permanent storage will require higher capital investment but will be more efficient in handling and preserving grain quality. Temporary storages are less costly per unit of storage volume but have a higher labour cost and less efficient utilisation.

What are the major considerations in choosing new permanent storage?

All new storage should be built to a sealed storage specification. In future it may not be possible to store grain, pulses and oilseeds on farm in unsealed storage, as the required pest control measures will not be acceptable to the marketplace.

All new storage should be either equipped with aeration or adaptable for aeration in store.

The storage should allow access for:

- checking temperature and humidity
- measuring fumigant gases
- inspection and periodic sample taking.

New storages should be designed to minimise carry-over residues of old season's grain or previous crops.

Full gravity discharge is a desirable feature which must be balanced against cost.

When considering expanding your storage enterprise, remember to look at the pros and cons of the existing structure.

What about storage construction material?

Storages should be light or white in colour to reduce temperature changes. Zincalume is effective, but galvanised steel will weather to grey with high solar absorption (Hill, Gorman & Banks 1989).

What about storage capacity?

Larger volumes will be cheaper per tonne capacity. The capacity will depend on current requirements but will also allow for future expansion as well as the possibility of increased segregation favouring smaller units. Think about the future market requirements.

What about the siting of the storage?

The site should have the following features:

- a solid earth base with a free draining soil. Avoid low lying areas where water will accumulate or where ground water is close to the surface.
- all weather vehicle access. This is most important and will allow year-round selling.
- power supply. This should be available for aeration and grain handling.
- no overhead power lines. Ensure that the site is clear of power lines that could contact augers, raised tip-trucks, or other equipment.
- a level surface. This is important for stability of vehicles and equipment.

It is advisable to set silos on cement slabs and to lay cement floors in sheds, as this makes it easier to remove grain spills and rubbish. It also ensures a weed-free storage area. Manufacturers supply slab specifications. If these are not adhered to, both concrete and silo fail.

What type of storage should be chosen?

In the next section we shall consider silos and storage sheds.

Silos

Silos are the most versatile type of storage, allowing rapid grain transfer, and changeover between different types of grain without contamination. Note that this CD addresses safety in chemical usage and hygiene. For information on general safety in relation to machinery and silos, see the book *Storing and Handling Grain* by Alan Andrews.

A wide range of silo types and sizes are available; contact a supplier for details (❑). The most common silos are metal kit-form structures which can be erected on site, except in WA where the norm is elevated steel silos (conical base), factory constructed and delivered to site.

The two basic types of silo are the above-ground conical based type and the flat bottomed type.

Above-ground conical based silos

Kit-form above-ground conical based silos are available up to 500 tonne capacity. This type of silo is generally the most expensive per tonne of storage capacity but offers ease of unloading. Footing failure is a common cause of silo collapse with this type of storage. To discharge under gravity, a minimum 35° to horizontal is required for dry grain, and at least 45° for moist grain. Elevated hopper bottomed silos are essential for holding wet grain and overhead discharge (Garner Bins). The extra cost of gravity discharge is easily justified by 3 or more loadings per year. A concrete slab under these silos

allows easy clean-up of grain spills, thus improving hygiene.

Flat bottomed silos

When larger capacities are required, the much cheaper flat bottomed silos are generally chosen, usually up to 2000 tonnes capacity. Mobile pneumatic grain conveyors are an efficient and safe way to empty flat floored silos, especially in the smaller size range. In-floor extraction augers and floor sweep augers are supplied by some silo manufacturers. Augers are faster for loading carriers. Flat floor silos are suited to fixed handling installations, which includes bucket elevators. In-ground concrete cones are a way of increasing the capacity and easing the unloading of flat floored silos. Water tightness is a big problem which must be taken into account before making this choice. Grain insect problems are more likely to occur in flat floored silos due to the accumulation of residues at the floor wall joint.

Why are sealed silos essential?

Sealed white or zincalume silos allow efficient insect control in stored grain using phosphine and other gases. Market flexibility and opportunity are greatly enhanced when sealed silos are used to store grain. This is because insect control can be achieved without insecticide residues being left on the grain.

A bin is considered sealed or gastight if, when pressurised to an excess internal pressure of 500Pa (or 250Pa), it takes longer than 5 minutes to decay to half the positive pressure (250Pa or 125Pa) when the pump is switched off. This can only be achieved if the silo was built to a gastightness specification or if a thorough sealing program has been carried out. Retro-sealing—that is, converting an unsealed silo into a sealed one after construction—is not usually effective.

What are the essential parts of a sealed silo?

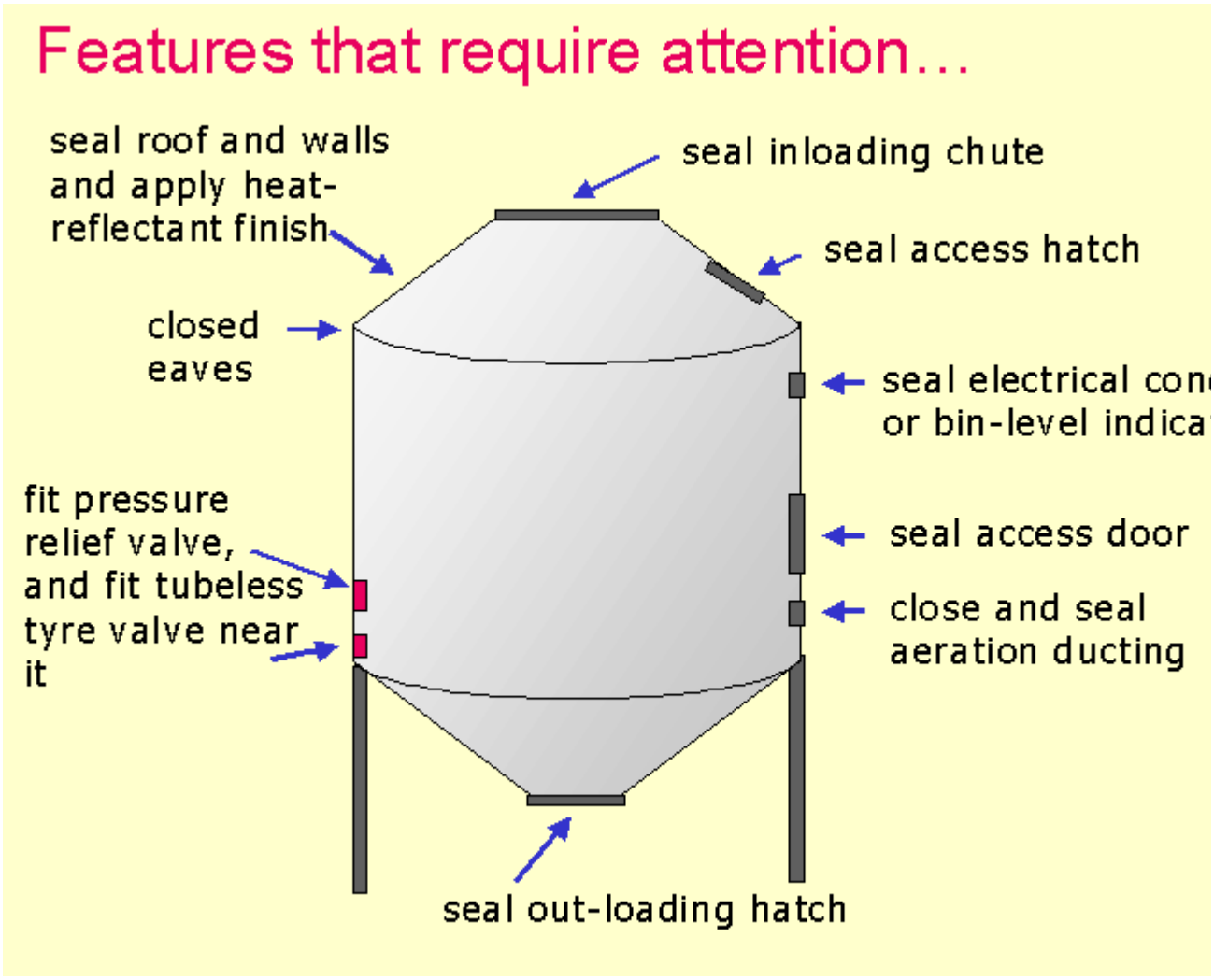
Pressure relief valve. A pressure relief valve is usually positioned on the side of the silo at eye level and is used to test the seal of the silo before each treatment. It also allows air to vent in and out of the silo as changes in temperature occur. Sudden drops in temperature can damage silos which either do not have a valve, or which have an ineffective valve.

Tyre tube inlet valve. A tyre tube inlet valve (or equivalent) is usually situated near the join of the bottom cone and the silo wall. It is used to pump air into the silo to pressurise it to test the seal. It is also used to apply carbon dioxide and nitrogen gas.

Seals on hatches and outlets. Sealed silos must have seals on all hatches and outlets. They may be made of rubber or other sealant material. Maintaining these seals, and preferably replacing them every 2 years, will help ensure the silo remains gastight.

The following diagram shows the position of the valves and sealing points.

Figure: Location of valves and sealing points on a silo



After an original diagram from CSIRO Australia

Figure: Replacing worn seals

Photograph by Chris Newman, Agriculture WA. Reproduced with permission of GRDC and CSIRO Australia.

How is gastightness checked?

To determine whether a silo is sufficiently gastight for sealed storage fumigation, it is necessary to carry out a pressure test. The pressure relief valve is used as a gauge for pressure testing. The test must be done when weather conditions are stable, as the readings are affected by fluctuations in temperature, strength of sunlight or windy conditions.

How to test the gastightness of a silo

Method one

1. First ensure the pressure relief valve is filled up to the central line with a recommended oil (i.e. light hydraulic oil).

2. Pressurise the silo by pumping air into the silo (often via a tubeless tyre valve) until a 25 mm difference in the heights of the fluid column is observed.

3. Measure how long it takes for the level to fall to 12 mm. The time taken indicates whether the silo is gastight:

- **If the silo is empty and it takes five minutes or more to fall to 12 mm, the silo is suitably sealed.**
- **If the silo is full of grain, then three minutes is acceptable.**

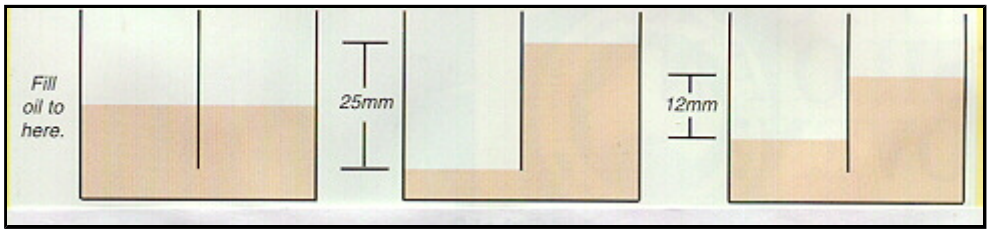
Method two

1. Connect a fan giving 3 m3/min at 1000 Pa to the silo through a ball valve and attach a manometer (inclined manometer, magnehelic gauge or U-tube manometer) to a suitable port in the silo.

2. Run the fan with the valve open until the pressure differential exceeds the chosen upper pressure limit by 10%.

3. Shut the valve, turn off the fan and measure the time it takes for the pressure to fall from the chosen limit to half the limit. The time should exceed 5 minutes.

Figure: Testing the gastightness of the silo using method 1



Start Fill up to central line with recommended oil	**Silo inflated Using a farm compressor, pump air through the tubeless tyre valve until the fluid moves down to the bottom line**	**Oil level should take at least 5 minutes to fall to the half-way mark**

Diagram from Chris Newman, Agriculture WA. Reproduced with permission of GRDC and CSIRO Australia.

Also see phosphine fumigation in the section Pests for more details about pressure testing for gastightness.

What happens if the silo fails the pressure test?

If a sealed silo fails the pressure test, the leaks must be found by checking leaky joints with soapy water. Small leaks can be sealed with silicone sealant or tape and defective flanges replaced. Repairs must be continued until the pressure test is successful.

What happens if the silo still fails the pressure test?

You would only test a silo that is factory or retro-sealed.

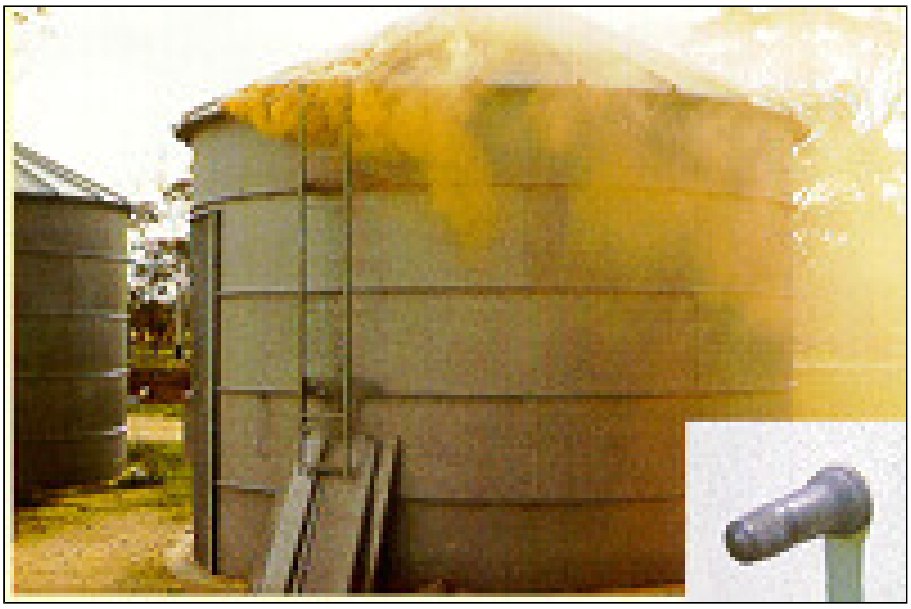
Carry out the following maintenance checks:

- First check the seals on the hatches and look for any damage or perishing of the rubber or sealant material. Check the rubber around the tubeless tyre valve. Replace any damaged seals prior to treating the silo.
- It is also important to ensure the pressure relief valve is maintained as per manufacturer's instructions.

- The oil level should always be maintained at the halfway level, using a light hydraulic or paraffin oil.

Grain above 12% moisture content should not be stored in a sealed silo. Above 12%, free moisture is likely to collect under the roof and wet the top layer of grain.

Figure: Silo with gas escaping. (Inset - tubeless tyre valve)



Photograph by Chris Newman, Agriculture WA. Reproduced with permission of GRDC and CSIRO Australia.

Storage sheds

The main advantages of storage sheds are:

- lower cost per tonne capacity
- multiple use capability.

On the other hand, their disadvantages are that they are:

- less easy to load and unload
- less easy to seal and fumigate
- less easy to segregate different grades and crops without comingling.

Compared with sheds, silos clearly have the most advantages, except for their cost.

Storage sheds and unsealed storage

Unsealed storage has been widely used to store grain on-farm, usually in unsealed silos and sheds. Silo manufacturers still make unsealed units and sheds which are widely used where large tonnages are to be stored.

Insect control is mainly by treating grain with chemical grain protectants as it enters into storage. Grain can be protected for up to 6 months if a high standard

of grain hygiene is maintained. Generally fumigation with phosphine should not be used as it will not be 100% effective and may lead to resistance (for CD users with Internet access: see the Australian Grain Insect Resistance Database for information on a resistance monitoring program.)

Infested grain can be treated with dichlorvos as it is moved from the infested storage (see Disinfestation), but the grain must be kept for the full withholding period before being transported from the farm.

The use of unsealed storages may limit market access, as chemical treatments will be unacceptable to specific markets requiring residue-free grain.

What are the points to look for when purchasing a shed for grain storage?

Two kit-form bulk grain sheds are available:

- conventional portal frame design
- single span arch construction igloo sheds. These are easy to build, cheaper and can be extended to any length.

In unsealed storage, the design and storage conditions have a major impact on preventing infestation:

- Storages must be rodent and bird proof to ensure the grain is not contaminated with rodent droppings.
- Structural supports should be located on the outside of sheds to provide a smooth internal surface with fewer areas for grain and insects to gather.
- There must be fittings to allow temporary wall sections for segregation.
- Provision should be made for on-floor aeration.

Special attention must be given to loading and unloading facilities. The alternatives are:

Loading	Unloading
Direct delivery from trucks	Front end loader
Mobile or fixed augers	Mobile augers
Mobile or fixed pneumatic conveyors	Mobile or pneumatic conveyors
Auger opening through roof	Auger holes in shed walls
Auger delivery to fixed roof conveyor	In floor conveyors

All farm structures must comply with AS 2867-1986 'Farm structures—general requirements for structural design'.

A list of suppliers of silos is given in Industry Contacts on the sidebar.

In the next section we look at temporary storage. Choose from the sidebar.