

ResearchReport

Kondinin Group

SEPTEMBER 2026 No. 200 www.farmingahead.com.au



GRAIN STORAGE PREPARATION

CLEAN, CONTROL,
CHECK AND COMPLY

Independent information for agriculture



Denny's — now offering a wider range of silo solutions for your business.

Denny's now offers a full range of silo options through the DE Silos and Denny's brand including:

- Transportable cone-based silos (3T to 137T)
- Field Bins (45T to 60T)
- Cone base silos (159T to 2900T)
- Flat bottom bulk storage (1100T-25000T)
- Grain Handling Equipment
- Aeration fans, fumigation and recirculation systems
- Aeration control boxes, both standard and custom

Visit satake.com.au to view our full silo, accessories and spare parts range, or contact the team to discuss your business needs.

Contact us now Office 07 4666 3266
info@satake.com.au | www.satake.com.au
32 Haigs Road, Allora, QLD 4362

Well prepared: Change is in the wings for phosphine. Regardless of the timing, getting up to speed now with safety and monitoring equipment will see a smoother transition to using our cheapest form of disinfection.

Successful storage starts with pre-harvest preparation

Successful grain and seed storage starts well before the first load is put into the silo with hygiene being the first line of defence against an insect attack. Grain storage insect pests are resourceful and require only a small amount of food and shelter to survive. The use of structural treatments and the application of phosphine to disinfest the grain stack must therefore be applied correctly to ensure both efficacy and safety. With changes to the available chemicals and tools used to preserve the quality of grain in storage, Research engineer **Ben White** and the **Grains Research and Development Corporation (GRDC)** Grain Storage Extension team provide an important update on best practices, available tools and likely changes to rules and regulations around chemistry for grain and seed storage.

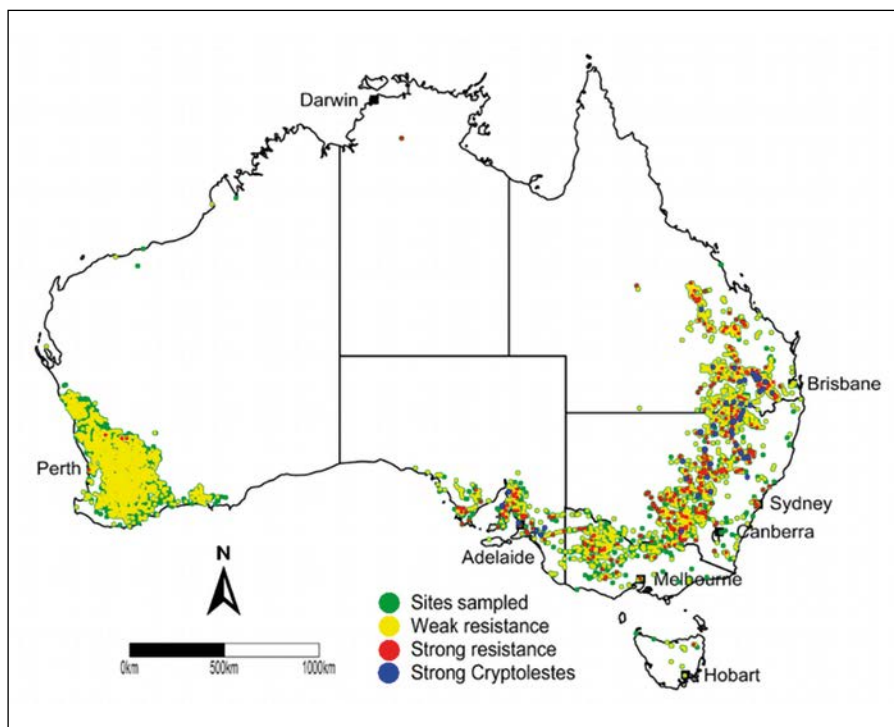
There is no knockdown spray-on chemical for an insect infestation in grain and seed in storage. Once the infestation is in the grain stack, the only option for disinfection is fumigation in a gas-tight sealable storage. Fumigation options available for farmers to apply include phosphine or controlled atmospheres like nitrogen and carbon dioxide.

Professional fumigators with specific licenses can apply other fumigants such as sulfuryl fluoride which has trade names including ProFume or Zythor. Another alternative is a highly flammable gas, ethyl formate, which, when mixed with CO₂ has a trade name of Vapormate.

COSTS AND ALTERNATIVES

Phosphine is significantly cheaper than all of the other available fumigation methods.

The product in tablet or blanket form costs under \$0.35 per tonne of wheat storage volume. Alternative fumigant prices vary but are typically up to ten times or more than phosphine. Alternatives have their place where timelines or resistance are an issue. But growers are reminded that claims of a complete 24-hour fumigation with Sulfuryl Flouride are false.



Resistance map: Phosphine resistance has been measured over the last 25 years with broad weak resistance detected across the country as well as instances of strong resistance found in multiple populations, particularly in *Cryptolestes* spp. (flat grain beetle). Source: DPIRD

RESISTANCE TO PHOSPHINE

Some populations of grain storage insect pests have become increasingly resistant to phosphine fumigations. The flat grain beetle (*Cryptolestes ferrugineus*) in particular has been detected with high levels of resistance to phosphine while other populations of insects, including lesser grain borer, have also demonstrated some phosphine resistance.

Australia is not alone in this regard, with other countries detecting strong phosphine resistance.

Phosphine resistance generally develops through multiple fumigations in grain storages that are not gas-tight sealed.

Resistant populations can be transported with the grain, in machinery, or can fly between grain storage facilities.

If live adult insects are detected after a fumigation, they can be tested for resistance by sending a sample to one of three laboratories around the country. Details of locations, sampling and packaging can be found at: www.storedgrain.com.au/insect-resistance-testing

EXCEPTIONAL ENGINEERING & INGENUITY FOR GRAIN STORAGE & HANDLING



- ✓ Silos (Gas-tight sealed to Australian Standards AS2628)
- ✓ Mobile Belt Conveyors and Grain Augers
- ✓ Bucket Elevators, Drag Chain Conveyors and Belt Conveyors



1800 689 433



Resistant: Rusty grain beetles (one of the flat grain beetles) have been detected with high levels of resistance to phosphine. Photo: Dr Raj Jagadeesan



Good times: Kondinin Group researchers together with the Grain Storage Extension Team tested cone-bottom and flat-bottom silos across the country to check for Australian Standard sealing compliance. Photo: Chris Warrick

OVERCOMING PHOSPHINE RESISTANCE

Where resistant populations are detected, there are a few options available to control them. As with most chemical resistance issues, alternative chemistry is one solution, which means growers would have to engage a certified professional fumigator to apply sulfuryl fluoride or ethyl formate fumigants.

But information from the Queensland Department of Primary Industries suggests that when used at label rates in a gas-tight sealable silo meeting Australian Standards for sealing (AS 2628:2010), even resistant populations can be eradicated. In these storages, concentrations of over 550 parts per million, sufficient to kill resistant populations (except strains of flat grain beetle with strong resistance), are achievable when following the label directions.

AS 2628:2010 compliant storages must meet a half-life pressure test ($t^{1/2}$) of five minutes. Kondinin Group researchers in collaboration with the GRDC Grain Storage Extension team have tested dozens of makes and models of silos sold as gas-tight sealable to check AS 2628:2010 compliance. See *Research Report* No. 187 – Sealable Storage Options, August 2025 for more details.

FA

PROTECT YOUR GRAIN. PROTECT YOUR PROFIT.

MAINTAIN QUALITY

REDUCE COSTS

MINIMISE INSECTS

MAKE BETTER DECISIONS

GrainSafe 7000

AUTOMATED GRAIN AERATION CONTROLLER

- Maintains grain quality, germination and moisture content
- Reduces running costs and management time
- Minimise insect activity in grain storages

GrainWatch

REAL-TIME GRAIN MONITORING

- Make informed decisions based on grain condition
- Receive alerts before grain deterioration occurs
- Highly adaptable for all grain storage formats

ONE SYSTEM. TOTAL CONTROL.

KEEP GRAIN IN PEAK CONDITION.
All year round.

CONTROL
UNLIMITED PTY LTD

(07) 4634 4706

info@grainaeration.com.au

www.grainaeration.com.au

Trusted technology.
Local support.

Proudly
**AUSTRALIAN
MADE**

Metering requirements on the horizon

Impending changes to the phosphine label are likely to coincide with flagged future changes in the Safe Work Australia (SWA) Standards for airborne contaminants. At the time of writing, the latter are scheduled to take effect on 1 December 2026. Victoria has indicated a likely delay of the proposed changes which will see workplace exposure limits significantly reduced.

Even if these flagged changes to the SWA standards are delayed, knowing gas concentrations is likely to become significantly more important, particularly for those who deliver grain to commercial sites where low-level phosphine detection monitoring is likely to become more common.

Under the SWA changes for phosphine, workplace exposure limits are to be tightened substantially. The current short-term exposure limit (STEL) of 1 part per million (ppm) is to be replaced by a peak exposure limit of 0.15 ppm, while the eight-hour time-weighted average (TWA) is to be reduced from 0.3 ppm to 0.05 ppm.

Current limits and compliance requirements should always be checked against the latest Safe Work Australia Workplace Exposure Standards, with current phosphine fumigation guidance used for practical advice on managing exposure risks.

Phosphine odour is not a reliable safety warning. Its characteristic smell may only become detectable at around 2 ppm, which is well above workplace exposure limits. By the time phosphine can be smelled, exposure may already be unsafe. Never use smell as an indication that an atmosphere is safe.

Always follow the product label directions and current Safety Data Sheet (SDS) for handling requirements, exposure controls and required personal protective equipment (PPE).

METERING OPTIONS

To understand concentrations during a phosphine fumigation and to check for clearance for safe delivery of fumigated grain, there are a couple of different meter types.

High-range meters are a fumigation-management tool used to confirm that ►



Testing times: Monitoring a fumigation and ventilation for clearance before delivery is likely to become more common as exposure limits are to be tightened. Photo: Chris Warrick

TAKE TOTAL CONTROL OF YOUR GRAIN!



Defend your storage

Eliminate pests and mould before they ruin your yield



Grain Temperature Probe & Reader

Phosphine Fumigation Detectors



Insect Sieve and Probe Trap



Grain Cooling Systems



Protect your trade value

Stop weighbridge downgrades and guarantee premium returns



Pfeuffer HE 50 Grain Moisture Meter



Perten IM8800 Grain Protein & Moisture Meter



Perten IM9500 Grain and Flour Analyser

**Smart testing. Safe storage.
Maximum profit.**

Let's connect and make it happen!



graintec.com.au

info@graintec.com.au
1300 640 299

40
Years

Graintec

Scientific Est. 1986

Specialist in Grain
& Food Testing Equipment

Also supplies all commodity sieves, test weight kits,
and a wide range testing instruments plus farm equipment



Monitoring tool: High-range meters like this Dräger X-am series can measure achieved concentrations during fumigation.



Clearance confidence: A low-range meter like this Silo Safe from the Canary Co can provide confidence grain has been adequately ventilated after fumigation. Photo: Chris Warrick

phosphine has reached and maintained an effective concentration within the grain mass. Lines running into the grain mass during a fumigation are used to draw gas out to monitor fumigation concentrations and observe gas level distributions. The upper measurement range may extend to 2000 ppm (or more) and many of these meters can be purchased with a pump and data logging function while resolution at lower concentrations is typically limited. Examples include the Dräger X-am series with a DrägerSensor XXS PH3 HC sensor, or an Australian-built FumiTest PH3-2000 or the Canary Silo-Chek which is also made in Australia.

Prices of high-range meters vary but expect to pay \$3000-\$5000.

Low range personal monitors are usually worn by operators as a safety precaution to detect low (but still dangerous) concentrations of phosphine fumigant but can also be used to ensure grain clearance after a fumigation. Some models can be paired with a pump to draw any residual concentrations out of a grain stack to check for clearance. The range rarely exceeds 20 ppm with the resolution to 0.01 ppm. Examples include the Riken

Keiki SC-04 PH₃, Dräger Pac 8000 PH₃ or the Canary Silo Safe V. Expect to pay around \$1000-\$2000 for a low-range meter like this with an additional cost for the sampling pump.

Because personal monitors are designed to detect phosphine at very low concentrations, accuracy and regular calibration are essential. In line with Australian Standards and manufacturer guidance, monitors should be calibrated at least every six months, with alarm settings checked to ensure they reflect the current SWA workplace exposure limits.

Although the purchase price may be difficult to justify for growers who fumigate only occasionally, a personal phosphine monitor provides an important additional safeguard against unintended exposure and avoid grain delivery rejections.

COMBINATION METERS

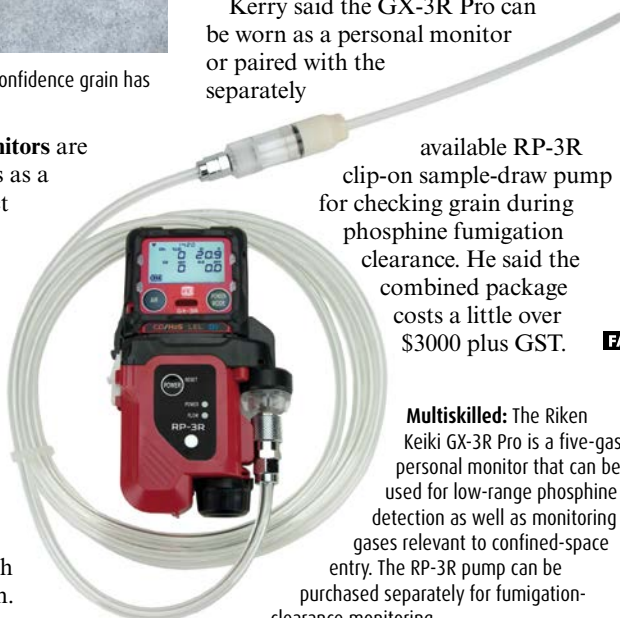
Some phosphine meters incorporate multiple gas sensors, broadening their usefulness beyond fumigation work. However, a single instrument cannot generally serve as both a high-range and low-range phosphine meter, as exposure to high phosphine concentrations can damage the low-range sensor cell.

Kerry Miles from Grain Protect said that, for many growers storing grain on farm across a range of storage types, a multi-gas personal monitor such as the Riken Keiki GX-3R Pro can provide a useful combination. In addition to low-range phosphine detection, it can be configured to monitor gases relevant to confined-space entry, including oxygen, flammable contaminants and potentially harmful gases such as hydrogen sulphide and carbon monoxide.

Kerry said the GX-3R Pro can be worn as a personal monitor or paired with the separately

available RP-3R clip-on sample-draw pump for checking grain during phosphine fumigation clearance. He said the combined package costs a little over \$3000 plus GST. **FA**

Multiskilled: The Riken Keiki GX-3R Pro is a five-gas personal monitor that can be used for low-range phosphine detection as well as monitoring gases relevant to confined-space entry. The RP-3R pump can be purchased separately for fumigation-clearance monitoring.



Type of Gas-tight Sealable Storage	Cone Bottom Silo	Cone or Flat-bottom Silo (No Powered Recirculation)	Cone or Flat-bottom Silo (with Powered Recirculation)	Well-sealed Bunker #	Well-sealed Grain Bag #
Storage capacity (wheat)	Less than 300 t	More than 300 t	More than 300 t	More than 1000 t	200–300 t
Dosage if using tablets (per tonne of wheat capacity)	2 tablets /t	2 tablets /t	2 tablets /t	N/A	2 tablets /t
Dosage if using bag-chains or blankets (per tonne of wheat capacity)	1 x 340 g chain per 60 t or 1 x 680 g chain per 120 t	1 x 340 g chain per 60 t or 1 x 680 g chain per 120 t or 1 x 1.7 kg blanket per 300 t	1 x 340 g chain per 60 t or 1 x 680 g chain per 120 t or 1 x 1.7 kg blanket per 300 t	1 x 340 g chain per 150 t or 1 x 680 g chain per 300 t or 1 x 1.7 kg blanket per 750 t ^{##}	N/A
Phosphine exposure (days)					
Grain 15–25°C	10	20	10	20	10
Grain > 25°C	7	20	7	20	10
Minimum ventilation (days)					
No aeration fan	5*	5*	5*	2–5 days with flowthrough draft (wind)	35+ ^{**}
Aeration fan	1+*	1+*	1+*		2+ ^{**}
Withholding Period (days)	2	2	2	2	2
Total fumigation process (days)	10 to 17	23 to 27	10 to 17	24 to 27	14 to 47

This table is a guide only – always refer to the manufacturer label directions.

High-range phosphine meters should be used in storages that cannot be pressure tested, to monitor concentration over time.

This 'half-rate' application is unlikely to provide reliable control. A fumigation contractor licensed to use cylinder phosphine is an alternative option.

*Label-stipulated requirement, but experience suggests longer periods may be required pending clearance target levels.

**Guide only, based on research conducted; not label specified. Check using a low-range monitor.

Source: Kondinin Group



One System. Multiple Materials. Unlimited Applications.

GripLine™ is a fast, non-penetrating bunker tarp anchoring system for steel, concrete, and earthen walls. It provides continuous, secure edge retention with quick and easy tarp locking and unlocking, as well as sealing bunker faces.

Key Benefits:

- Non-penetrating
- Fast Installation
- Reusable & Durable
- Wind-Resistant
- Safer Worksites
- Clean & Professional
- 1190kg/m Holding Force



For more information visit www.grainprotect.com.au

Silo buyers' checklist

Buying a silo is an infrastructure investment of 25 years or more, so spending a little extra to get a quality product that is fit for purpose will ensure the silo will provide years of service. A silo that is fit for purpose will help preserve the quality of the grain stored in it, which is typically worth significantly more than the silo itself. This checklist highlights the features worth considering when comparing options.

Gas-tight sealable silos should always be the preferred specification as they provide options for growers to successfully disinfest stored grain using a fumigant. Adding aeration cooling provides multiple benefits including reduced insect activity, faster fumigation ventilation and maintenance of germination and vigour for seed grain.

ESSENTIAL FEATURES OF A GAS-TIGHT SEALABLE SILO

- ☐ Certified to AS 2628:2010, with the manufacturer conducting a pressure test after construction.
- ☐ Has a pressure relief valve large enough to suit the silo and conditions with clear markings for pressure testing.
- ☐ Has a facility to add air, for example, a tyre valve stem, water trap or blower port which can be used to conduct a half-life pressure test.
- ☐ Has high density rubber seals (EPDM) with strong memory and UV resistance.
- ☐ Lasting seals between sheet joints, rivets, screws and bolts. Maintains seal integrity when filled.
- ☐ Has latches for pressure testing the silo when empty and providing even seal pressure.
- ☐ Has aeration cooling fans sized appropriately to deliver a minimum of 2-4 litres per second per tonne of capacity for cooling grain (under grain back pressure).
- ☐ Has fans sized appropriately to deliver 15-20 litres per second per tonne of capacity if planning to dry grain (under grain back pressure).
- ☐ Automatic controller capable of operating fans for cooling and/or drying (aftermarket or manufacturer supplied).
- ☐ Outlet access for unloading should be simple to operate and permit ample auger access.
- ☐ Has an aeration distribution plenum to disperse air evenly throughout the grain.
- ☐ Allows easy and safe ground access for cleaning out the silo.
- ☐ Has an easy to clean design including aeration ducting, particularly in flat-bottom silos.
- ☐ Has a workplace health and safety compliant ladder and platform to access the inlet lid and an inspection opening in the roof.
- ☐ Is fabricated with a sturdy steel design with sound weldments and a galvanised or quality painted finish.
- ☐ Has a sealed passive recirculation system (for silos with a capacity greater than 150-tonnes), or a powered recirculation system (for silos with a capacity greater than 300 tonnes) which are UV stabilised and will not compromise seal integrity in the future.
- ☐ Has wall sight glasses or level sensors to indicate grain level, particularly near the top and bottom of the silo to assist filling and emptying.
- ☐ A chalkboard patch painted on the silo base can be useful for recording grain and treatment details.
- ☐ Consider grain segregation requirements when determining silo size. Smaller silos allow better segregation but require more frequent auger moves. A variation of sizes often works well.
- ☐ Ensure adequate venting is fitted to the roof of silos. Vents should be easy to clean and near the roof access ladder to enable maintenance.

FUMIGATION CHAMBERS

- ☐ If a sealed fumigation application chamber for phosphine tablets is fitted, ensure it has a sufficiently large tray to spread tablets without excessive stacking.
- ☐ Trays should be easily removed for residual disposal.
- ☐ The chamber should also have passive or active sealed recirculation to carry released gas out of the chamber.

SILO STANDARDS FOR CONSIDERATION

The design and construction of Australian grain silos draws on a range of Australian and international standards covering grain loads, wind, earthquakes, structural steelwork, fasteners, foundations, corrosion protection, access and fumigation sealing. Australian Standards are not automatically mandatory, but may become requirements where referenced by legislation, approvals, engineering specifications or contracts.

For silo structures, AS 3774:1996, Loads on Bulk Solids Containers, was historically an important Australian reference for calculating forces generated by stored grain, including hoop tension and vertical wall loads during filling and emptying. Although withdrawn, many Australian silos were designed to this standard and it remains relevant when assessing existing structures.

A more contemporary international reference is EN 1991-4:2006, Eurocode 1 – Actions on Structures – Part 4: Silos and Tanks. This European standard provides a more comprehensive approach to calculating bulk-solids loads, including classification of silos according to factors

such as capacity. It considers both filling and emptying loads and applies to corrugated silos. While it has not formally replaced AS 3774 in Australia, it is commonly used as an international engineering reference.

The American ASABE S433, Loads Exerted by Free-Flowing Grain on Bins, provides another, but less comprehensive, reference for grain-bin loading.

Grain loads are only part of the structural design equation. AS/NZS 1170.0, Structural Design Actions – General Principles, provides a framework for considering combinations of structural actions throughout the life of a structure, such as an empty silo exposed to a significant wind event.

ENVIRONMENTAL CONSIDERATIONS

AS/NZS 1170.2:2021, Structural Design Actions – Wind Actions, provides the methodology for determining wind loads according to location, terrain and design life. Australia is divided into wind regions, with higher design wind speeds applying in some northern coastal areas and other designated regions. Wind loading can ►



Structured: Grain loads are only part of the structural design equation. Environmental conditions should also be accounted for with standards pointing to design requirements pending location.



Burando Hill

Burando Hill partners with industry-leading manufacturer Akron to provide Australian farmers high-performance, scalable grain bagging and extraction systems renowned for their reliability and quality.

GRAIN BAGGERS

- ✓ **Flexible Storage:**
On-site bagging to manage peak volumes and grain.
- ✓ **Strategic Marketing:**
Store or blend grain for better market prices to maximize returns.

GRAIN BAG EXTRACTORS

- ✓ **High-Capacity Output:** Delivers up to 360–380 tonnes/hour for 9-ft and 10-ft bags.
- ✓ **Transmission System:** Uses upper and lower right-angle gearboxes connected via a driveshaft instead of high-wear chains.



AKRON



1300 287 263 / www.burandohill.com.au



Fit for purpose: Gas-tight sealable silos should meet the Australian Standard AS 2628:2010.

be particularly important for tall, lightly loaded or empty silos.

Earthquake loading is addressed by AS 1170.4, Earthquake Actions in Australia. Requirements vary according to location and site conditions, with some parts of the WA wheatbelt subject to higher seismic loading requirements. Design life and subsoil classification are also considered.

Once expected loads are established, standards including AS 3990:1993, Mechanical Equipment – Steelwork, and AS 4100:2020, Steel Structures, may be

used to determine the strength, dimensions and material properties required of the silo and supporting structure.

FASTENERS AND FIXINGS

Fasteners are an important part of the structural system. Standards including AS 1252, AS 1275 and AS 4291.1 address matters including bolt, nut and washer dimensions, screw threads and mechanical properties of steel fasteners. Some editions are historical or withdrawn, so applicable requirements should be confirmed with

the engineer or manufacturer. They nevertheless remain relevant when assessing silos designed to earlier standards.

Safe access is covered by AS 1657:2018, Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation. It provides requirements for ladders, cages, stairs, handrails, structural strength and intermediate platforms, with obvious implications for inspection, maintenance and fumigation work on tall silos.

CONSTRUCTION MATERIAL SELECTION

Corrosion protection is particularly important in coastal, saline or otherwise aggressive environments. The AS/NZS 2312 series provides guidance on protective coating systems for structural steel, while AS 4312:2019, Atmospheric Corrosivity Zones in Australia, classifies the severity of corrosive environments. Together, they can inform protection requirements for silo walls, roof panels, structural members and fasteners.

For silos incorporating cold-formed stainless steel, AS 4673:2001, Cold-Formed Stainless Steel Structures, may also be encountered. Although withdrawn, it remains relevant to older structures designed to its requirements.

The connection between a silo and its concrete footing is addressed by AS 5216:2026, Design of Post-installed and Cast-in Fastenings in Concrete. It covers fastenings including through-bolts, cast-in anchors and chemically anchored threaded rods used to transfer structural loads into the foundation.



The Canary Company Pty Ltd

Canary Co is one of the most experienced local manufacture, service providers and suppliers to Australia's agricultural technology industry, of accurately calibrated fumigation measuring instrumentation, commencing operation in 1995 over 30 years ago.

In 2026, in readiness for the new phosphine PEL of 0.05ppm becoming law, Canary is now offering two new pocket size/belt worn PH3 alarm units with custom sensor & firmware to meet the new mandatory 0.05ppm standard. To accompany this Canary will also provide even tighter more accurate 3rd party NIST traceable calibrations as well.

Remember the accuracy of your PGM gas detection strategy is only as good as the last calibration performed, and the old 5ppm PH3 calibration test gas will soon become 100 times higher than what a worker may be exposed to come December 26.



Contact Howard or Terry at Canary Co on +61 2 9418 6666 to discuss options or get in touch via our web page



Canary Co.

FUNCTIONALITY AND FIT FOR PURPOSE

For fumigation, AS 2628:2010, Sealed Grain-Storage Silos – Sealing Requirements for Insect Control, is particularly important. It establishes sealing requirements for silos intended to retain fumigant gas and includes the familiar five-minute pressure half-life test used to assess whether a silo is sufficiently gas-tight for effective fumigation. A sealed silo must also tolerate pressure changes without structural damage.

Electrical, hazardous-area and machinery-safety requirements may also apply where grain-storage installations incorporate electric motors, conveyors, augers, aeration fans and other powered equipment. Minimum Energy Performance Standards (MEPS) currently apply to most three-phase cage induction motors rated from 0.73 kW to less than 185 kW. Incoming changes will expand coverage to motors rated from 0.12 kW to 375 kW and introduce higher minimum efficiency requirements, with the new requirements expected to be legislated from 2027.

STANDARDS SUMMARY

There is no single standard that defines a grain silo. Instead, silo design may draw on a suite of standards covering grain loads, wind, earthquakes, structural steel, fasteners, foundations, corrosion, access, sealing and associated machinery. Some are current, while withdrawn standards remain relevant where existing silos were originally designed in accordance with them or where they continue to provide useful engineering guidance.

Failure to follow appropriate standards or engineering requirements can contribute to poor fumigation performance, unsafe access, accelerated corrosion, structural deformation or foundation problems and, in severe cases, structural failure. It may also create difficulties with engineering certification, approvals, warranty or insurance where particular standards have been specified.

For this reason, the design basis should be confirmed with the silo manufacturer or engineer, particularly when assessing imported silos, older structures or installations in higher wind, seismic or corrosive environments.

FA



Standard features: Standards include fasteners, construction materials and protective coatings.

Reference acknowledgements:
Andrew and Ben Kotzur



HE

SILOS

**STORE SMART.
PROTECT YOUR HARVEST.**

**Your grain is worth preserving!
Because better grain storage
means greater control.**



AUSTRALIAN MADE

1800 046 046

HESILOS.COM

1-12 JONES STREET, FORBES NSW 2871



Clean start is key

Cleanliness is next to godliness when it comes to grain storage. Minimising the risk of infestation involves cleaning up sources of food and shelter for insects which only require a handful of grain, grain dust or organic material to survive and then go on to reinfest clean grain. Machinery and equipment also need to be considered as these can often be sources of infestations despite best efforts in and around the silos. The use of a structural treatment reinforces the cleaning effort but with limited options, has to be applied correctly.

Thorough grain hygiene, combined with structural treatments such as diatomaceous earth (DE), can significantly reduce pest populations before new-season grain enters storage. Grain residues and carry-over grain from previous seasons provide ideal breeding sites for insect pests.

Even small amounts of infested grain can become a significant source of stored-grain pests, with a single bag capable of producing more than one million insects in a year.

These pests can then walk or fly to surrounding storages and establish new infestations. Good storage hygiene breaks this cycle by eliminating residual grain and other material where pests can survive and breed.

Seed and stockfeed grain should also be checked regularly so any pest activity can be identified and treated before it spreads.

OLD GRAIN IS HIGH RISK

New-season grain is particularly vulnerable to insect infestation when residues from

the previous harvest remain in storage and handling equipment. Even equipment that appears clean can harbour substantial pest populations. In one on-farm study, more than 1,000 lesser grain borers were collected from the first 40 L of wheat through a harvester that had been considered clean at the end of the previous season.

Before harvest begins, thoroughly clean silos, field bins, harvesters, augers and other grain-handling equipment to remove residual grain and dust. Blow out or wash down equipment as appropriate and, once annual maintenance is complete, consider applying a suitable structural treatment.

Pay particular attention to grain left in hoppers, bags and equipment around the storage site. Remove and dispose of these residues before harvest, as even small quantities can provide breeding sites for stored-grain pests during the off-season.

HYGIENE FOCUS

Grain hygiene aims to remove the grain residues and sheltered areas where stored-grain pests can survive and breed between seasons. Pests favour dark, protected locations and reproduce rapidly in warm conditions, so cleaning should extend to all grain storage and handling equipment.

Common sources of infestation include:

- empty silos and other grain storages
- aeration ducts
- augers and conveyors
- harvesters
- field bins and chaser bins
- trucks
- bags, drums and other containers holding leftover grain
- spilled grain around storage areas, particularly accumulations more than 20 mm deep
- equipment, rubbish and debris around storages
- seed grain
- stockfeed grain and feeding equipment.

Effective hygiene means cleaning anywhere grain can collect or become trapped. Even small amounts of residual grain can harbour insect pests, providing a ready source of infestation when new-

season grain passes through equipment or enters storage.

GET THE TIMING RIGHT

The period immediately after harvest is an ideal time to clean grain-handling equipment and storages, before residual grain provides an opportunity for pest populations to build.

At the start of the following harvest, consider discarding the first few bags of grain through the harvester, as these are more likely to contain insects or residues carried over from the previous season.

Queensland Department of Primary Industries research has shown that stored-grain insects are less active during the cooler months, providing another opportunity for thorough cleaning and structural treatments.

Cleaning silos and surrounding areas during July and August can help reduce pest populations before warmer conditions increase insect movement and breeding activity.

TOOLS FOR CLEANING UP

Thorough cleaning reduces the opportunity for stored-grain pests to survive and breed in residual grain. No single cleaning method will reach every part of a storage or piece of equipment, so use a combination of:

- sweeping
- vacuuming
- compressed air
- blow/vacuum guns
- pressure washing
- fire-fighting hoses.

A broom or compressed air will remove most loose grain and residues, while a follow-up wash-down can dislodge dust and grain trapped in cracks, crevices and other difficult-to-reach areas. Choose a warm, dry day for washing so equipment and storages dry quickly, reducing the risk of corrosion.

Use appropriate PPE to protect your lungs, eyes and ears, and follow relevant safety procedures when cleaning requires access inside or on top of a silo.



Keeping it clean: A clean storage site with well-maintained grain storages is a solid place to start, but maintenance and structural treatment applications are also part of the mix.

While storages are empty, inspect them for areas where grain can become trapped. Seal or fill cracks, gaps and crevices where practical to make future cleaning easier and remove potential harbourage sites.

DISCARDING OLD GRAIN

Do not leave bags of old grain, spills or residues around storages or sheds, as these can support large pest populations. Collected grain can be buried, fed to livestock or spread thinly (less than 20 mm deep) well away from the storage area so it germinates or decomposes. Avoid dumping unwanted grain within 1 km of

storage facilities, where it can become a breeding site for insects that may reinfest clean stored grain.

MAINTENANCE

Having made a significant investment in gas-tight, sealable silo infrastructure, growers often overlook regular maintenance, according to professional fumigator Kerry Miles from Grain Protect.

“Hygiene is essential, but maintenance is often overlooked,” Kerry said.

“It’s often just the basics, including seal-plate rubbers, oil in valves and sealing faces on inlets and outlets, which can get bumped around when shifting augers.”

Kerry said outlet sealing plates were often found discarded beside silos, where their seals had been chewed by birds or the plates had corroded.

“Those plates should have a storage mount under the silo, where they are protected from the elements and birds,” Kerry said.

Seal-plate rubber seals can be replaced using the same pinch-weld profile fitted by the manufacturer. Where seals are glued in place, they can be replaced with a closed-cell rubber profile matching the original and secured with a suitable windscreen adhesive or sealant, such as Sika Sikasil.

FA

Structural treatments

After thoroughly cleaning out silos, a structural treatment is required to eliminate any remaining insect pest residents. From mid-August 2026, the use of fenitrothion as a structural treatment was not supported by the Australian Pesticides and Veterinary Medicines Authority (APVMA) review completed a year earlier. Alternatives are limited but diatomaceous earth (DE) is an effective alternative that can be used in grain silos and sheds.

Fenitrothion is no longer an authorised structural treatment for grain storage facilities and equipment in Australia.

The APVMA completed its fenitrothion review in August 2025 and specifically determined that use on “grain storage facilities and equipment (examples include silos and storage bins)” is not supported, due to worker health and safety concerns.

After a 12-month phase-out, which ended on 15 August 2026, the old labels authorising structural treatment uses can no longer legally be applied.

Importantly, fenitrothion itself hasn’t disappeared entirely. The APVMA has retained its use as a *protectant* applied to stored cereal grain, subject to the new label requirements.

DE STEPS UP

Prior to the decision on fenitrothion, many growers had switched to a less toxic (and less pungent) alternative in the form of DE.

DE has a physical mode of action. Under a microscope, DE dust has abrasive, sharp-edged surfaces. When insects move across the dust, the abrasive particles damage the protective cuticle, causing moisture loss, desiccation and death.



► **Improving methods:** With fenitrothion no longer registered as a structural treatment, DE dust is the go-to for silos and sheds but recent research has shown that application methods can be improved.



Dynamic diatomaceous earth: DE is made from the fossilised remains of microscopic organisms called diatoms. Its fine particles have abrasive, sharp-edged surfaces that damage an insect's protective outer layer, causing it to lose moisture and eventually die from dehydration.

APPLYING DE

The key to good DE application is air movement in the storage facility as the dust is introduced. This provides uniform distribution throughout the surfaces where grain dust would settle.

Previously, small compressor-powered venturi-style Blo-Vac guns were recommended for applying DE. But GRDC-supported research in Victoria found higher air volumes using an 18-volt cordless leaf blower and custom-made venturi delivered a more uniform delivery of dust at all levels of a cone-base silo.

For larger flat-bottom silos, a petrol-powered or 36-volt leaf blower with the custom-built venturi provided a satisfactory distribution of product as a structural treatment.

Shed applications were also tested with high-output petrol or 36-volt blowers. But rather than a single measure of the required DE, multiple measures were spaced throughout the shed at regular intervals.

Spacing DE volumes to cover designated shed sectors assisted the operator in walking a grid and metering the DE at the appropriate rate across the large expanse of the shed.

APPLICATION RATES

The recommended application rate is 2 g/m² of treated surface area, with uniform coverage essential for effective residual control. After treatment, remove any excess dust by vacuuming or rinsing before filling the storage with grain.

Table 2 should be used as a guide only. Higher application rates may be required where aeration ducting, false floors or corrugated wall profiles increase the total surface area, potentially by around 10 per cent.

SAFETY

DE is a naturally occurring material formed from the fossilised remains of microscopic aquatic organisms called diatoms and consists largely of amorphous silica. While amorphous

Table 2: Diatomaceous earth (DE) application guide

Storage capacity (t)	DE quantity (kg)
80	0.22
100	0.27
120	0.29
150	0.33
300	0.52
1000	1.24
2000	1.94
3000	2.57

Source: Kondinin Group

silica is considerably less hazardous than crystalline silica, the use of a P2 or P3 dust mask is required, as is eye protection.

A pair of ear muffs or plugs should also be considered if operating a noisy blower.

FA



Dust busters: Use a P2 or P3 mask when applying DE as well as a pair of goggles. Hearing protection should also be considered.



Venturi ventures: Making your own venturi to fit on an 18 V blower is simple using this design. The PVC parts can all be purchased from a building trade supplies store, for example Bunnings.

Playing it safe: Phosphine is a highly toxic cellular poison capable of causing rapid, multi-organ failure following significant exposure. Using the correct Personal Protective Equipment (PPE) in good condition as per the label is essential to keep the operator safe.



Breathe easy: Respirators required

Phosphine is an extremely toxic fumigant gas, capable of causing serious illness or death at relatively low concentrations. Because it is colourless and odour cannot be relied upon as a warning, dangerous exposure can occur without obvious signs. Its use therefore carries strict workplace health and safety obligations, including appropriate training, gas monitoring, respiratory protection where required and procedures to prevent worker exposure.

Phosphine odour is not a reliable warning of unsafe exposure. By the time it can be smelled, concentrations may already be above safe workplace exposure limits. Most people can smell phosphine at two parts per million, but at one part per million it can already be absorbed into the bloodstream.

Phosphine is a highly toxic gas that is readily absorbed through the lungs and interferes with the body's ability to use oxygen at a cellular level. Poisoning can damage the lungs, heart, liver, kidneys and nervous system, with severe exposure causing pulmonary oedema, cardiovascular collapse, unconsciousness and death.

All users need to carefully read and adhere to the label instructions for PPE to minimise their risk of exposure.

According to the label: "When opening the container and using the product wear elbow-length PVC gloves and full face piece respirator with combined dust and gas cartridge (canister) or supplied air respirator. After each day's use wash gloves and respirator (if rubber wash with detergent and warm water)."

FULL-FACE RESPIRATORS

Determining the appropriate respirator and cartridges can be difficult. Firstly, the mask must be a good fit with many manufacturers making a range of masks to suit a range of face shapes.

To determine if a mask is suited to the shape of the operator's face, a suction test can be used. A suction test requires the

user to fit the full-face mask firmly before covering the empty filter holes to seal them off and breathing in. A well-fitting mask will not let any air past the face seals but will pull the mask in tighter to the operator.

If the mask lets air in past the seal, adjust the fitting straps for a closer fit. Try another mask shape before performing another suction test. ►



Fit check: A suction test can help determine if a mask size and shape matches your face. Fit the mask, tighten the straps and cover the filter ports with your hands to seal them off. A well-fitting mask should not let any air in around your face.



Specified: Only use filter cartridges suitable for phosphine gas that are made to fit your mask. These 6096 A1 Hg P3 R filters are suitable for phosphine gas and fit the 3M 6000 series respirators.



Safe storage: Because the filters contain activated carbon, they will continue to absorb gases in the environment. After fumigating is complete, remove and store the filter cartridges in a sealed bag and replace according to manufacturer instructions.

FILTER CARTRIDGES

Unless ordered specifically, most masks ship with no filter cartridges or at best, a pair of dust filter cartridges. To make matters more difficult, determining which filter cartridges are suitable for phosphine applications can be tricky, requiring perusal of multiple catalogues and charts with a call to the manufacturer often the last resort.

Once opened, filter cartridges need to be stored in a sealed container away from heat and sunlight. Because the cartridges contain activated charcoal, sealed storage prevents them from absorbing gases from the surrounding atmosphere when not in use.

Filters do have a lifespan and should be replaced every six months once opened – regardless of usage. But in their factory-sealed packaging, most filters will last 5-6 years, so can be safely stored.

3M has conducted phosphine testing on filter durability which involves time and gas concentration testing. All other manufacturers recommend regular filter change intervals to avoid the risk of “breakthrough” where phosphine penetrates the filter and can be smelt or tasted.

As a rule of thumb, bayonet-style filters are cheaper to buy than canister-style filters, a worthy consideration at the time of a mask purchase.

GLOVES

As a minimum requirement, the label directs the use of elbow-length PVC gloves. Check condition for holes and replace if needed. A soft pair of gloves can make phosphide canisters easier to handle, as removing the lids with specialised spanners requires a degree of dexterity.

CLEAN-UP

Wash mask and gloves with warm water and detergent after each day’s use and store the mask back in the protective sleeve it came in to prevent scratching of the lens.

Once finished administering phosphine and cleaning up the PPE, it’s a good idea to also put the clothes you were wearing through the wash too.



Protected: Clean up your mask and gloves with warm water and detergent before safely stowing your mask in the protective sleeve.

MORE INFORMATION

For more information visit the GRDC Stored Grain website: www.storedgrain.com.au or contact the team on 1800 WEEVIL (1800 933 845)

A catalogue of grain storage equipment with active QR links can be found here: <https://tinyurl.com/GSEQUIP26>



10 GRAIN STORAGE MANAGEMENT EQUIPMENT CATALOGUE, JULY 2026

Phosphine monitoring equipment

Low range phosphine meters

Low range phosphine meters measure phosphine concentrations accurately in a range between 0-20 ppm for venting clearance or personal safety. Single gas monitors such as the Dräger Pac 8000 and Riken SC-04 can be clipped onto an operator’s shirt for personal safety, or purchased with a cradle (calibration clip), hand pump and spear to measure low level, intergranular gas concentration. Multi gas monitors such as the Dräger X-am 5000 and the Riken GX-3R can be clipped onto an operator’s shirt for personal safety, or coupled with an external pump to draw a sample from a gas line to measure low level, intergranular gas concentration. Note that the X-am 5000 can be equipped at the time of purchase with either a low range sensor or a high range sensor, not both. The Canary Co Silo-Safe and the Uniphos FumSense Pro-Lo both have inbuilt pumps to draw a sample from a gas line and while the FumSense is claimed to be wearable the Silo-Safe is not.

Hi-range phosphine fumigation meters

Hi range phosphine meters are used measuring gas concentration during fumigation, particularly in bunkers and bags where a pressure test to check the seal prior to fumigation is not possible. While these meters measure 0-2000 parts per million (ppm), they are not precise at low range so can not be relied on for venting clearance or safety. The Canary Co Silo-Check, Control Equipment FumTest and Uniphos FumSense Pro-Lo are single gas meters with an inbuilt pump to draw a sample from a storage via a gas line. The Dräger X-am 5000 is a multi-gas meter that can be equipped at the time of purchase with either a high range or low range sensor (not both) and requires coupling to an external pump to draw a sample from a storage.

PRICE: Approximately \$3000-5000
SUPPLIERS: Grain Protect, Canary Co, Control Equipment, Uniphos, Grantec Scientific

PRICE: Approximately \$800-5000
SUPPLIERS: Grain Protect, Canary Co, Control Equipment, Uniphos, Grantec Scientific

Sundstrom SR200

SPECIFICATIONS

Filter form: Canister

Weight (mask only): 400-450g

Indicative price: \$500-650

Compatible filters for phosphine use: SR 510 P3 R + SR 315 ABE1 (filters can be stacked) or SR 510 P3 R + SR 294 A2B2E1 (filters can be stacked)

Filter price range: \$70-\$140 (for the filter combination)

Filter lifespan for replacement: Lifespan or duration not specified for phosphine – replace regularly.



Dräger X-plore 5500

SPECIFICATIONS

Filter form: Bayonet

Weight (mask only): 540g

Indicative price: \$330-550

Compatible filters for phosphine use: A2B2 P3 R D or A2B2E2K1 Hg P3 R D or A2B2 + P2R (+ retainer)

Filter price range: \$35-80

Filter lifespan for replacement: Lifespan or duration not specified for phosphine – replace regularly.



3M 6000 series

SPECIFICATIONS

Filter form: Bayonet

Weight (mask only): 400g

Indicative price: \$250-450

Compatible filters for phosphine use: 6096 A1 Hg P3 R

Filter price range: \$60-90

Filter lifespan for replacement: More than 40hrs of use or before six months after opening.



MSA 3200 series

SPECIFICATIONS

Filter form: Bayonet

Weight (mask only): 500-800g

Indicative price: \$420-585

Compatible filters for phosphine use: A2B2E1K1 P3

Filter price range: \$70-85

Filter lifespan for replacement: Lifespan or duration not specified for phosphine – replace regularly.



Kondinin Group Bookstore



Browse through our variety of practical manuals, the popular *Workshop Series*, educational resources about farming and agriculture and much more on the **Kondinin Group Bookstore!**

www.kondininbookstore.com.au