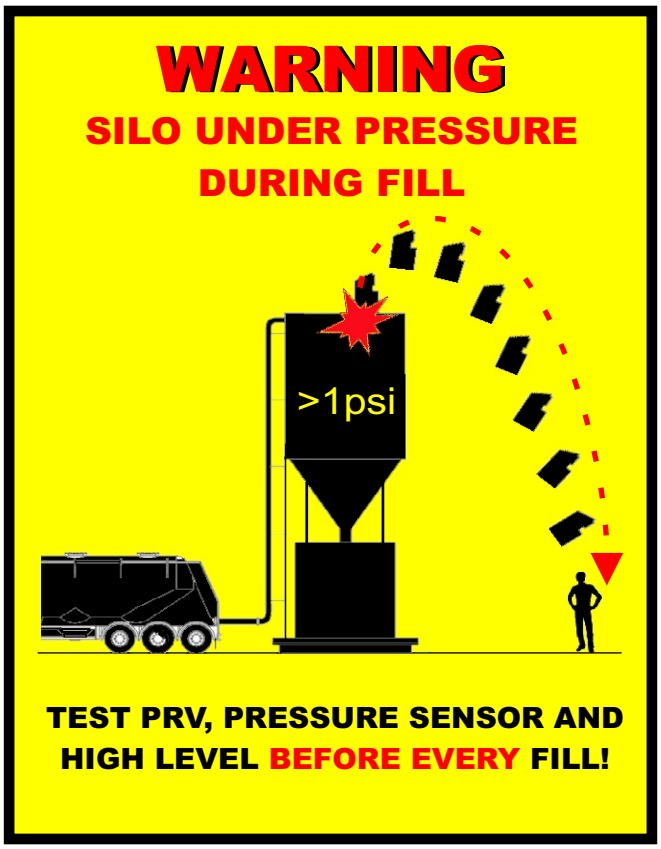
FLEX-501
MS0915

THE ONLY SYSTEM TO MEET CURRENT MPA GUIDELINES

HYCONTROL
LEVEL MEASUREMENT SOLUTIONS



SILO PROTECTION
AUTOMATIC SHUT-OFF SYSTEMS

SAFER BY DESIGN

SILO PROTECTION

Many industries - including food, pharmaceutical and quarry - handle and transport millions of tonnes of product every year. This may come in many different shapes, sizes and densities, but a great deal is shipped in powder and particulate form. These products are shipped from site to site, mainly by road tanker, and are then discharged by fluidising the powder and blowing it into a silo.

This pneumatic conveying operation uses pressurised air to carry the product into the silo and this air must then be vented from the vessel via a suitable filter. There are inherent risks with delivering product in this way:

1) Over-pressurisation: If the air blown in with the product is not vented then the silo can easily become pressurised. Most silos are not tested as pressure vessels, and a small increase (by as little as 1psi) may be sufficient to either **rupture the silo** or **blow the filter element off the silo roof**.

2) Overfilling: Another common problem is overfilling of the silo as a result of a level probe failure or using incorrect technology to monitor the product volume. Again, this results in **damage to the silo** and **loss of product**.

Both of these risks necessitate the implementation of a reliable, testable Silo Protection System (SPS).

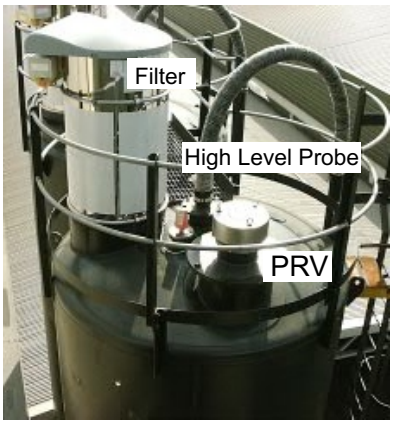
HOW DOES OVER-PRESSURISATION OCCUR?

Any basic silo which is pneumatically filled with powder product will probably have the following equipment fitted: a high level probe, a pressure sensor, an air filter and a pressure relief valve for protection if an increase in pressure occurs. These items are normally connected to a basic control panel.

A potentially dangerous situation can occur with one or more of the following:

Overfilling of the silo leading to filter blinding
Failure of the pressure relief valve
Failure of the high level probe
Failure or blockage of the pressure sensor
Failure of the filter
Inadequate maintenance of the above components
Uncontrolled discharge of the tanker

Please refer to the MPA Guidance Notes (page 3) for further details



Typical silo arrangement

WITHOUT PROTECTION WHAT ARE THE RISKS?

1. Danger to staff: Risk of death or severe injury to personnel resulting from heavy filter units falling from great heights. There are serious health and safety implications to be considered by site operators.

2. Damage to silo: Resulting in disruption and loss of production, expensive repair or even replacement of the silo or filters, as well as costly clean-up operations.

3. Overspill of product: Emissions into the atmosphere could have a serious effect on the environment, especially if the product is corrosive or hazardous; this may result in large fines, expensive clean-ups, negative publicity and damage to public image.

Pictured below: filters which have been blown from the tops of silos after over-pressurisation

Images taken from the Mineral Products Association's guidance notes to prevent over-pressurisation of storage silos:

www.mineralproducts.org

HOW TO PREVENT OVER-PRESSURISATION

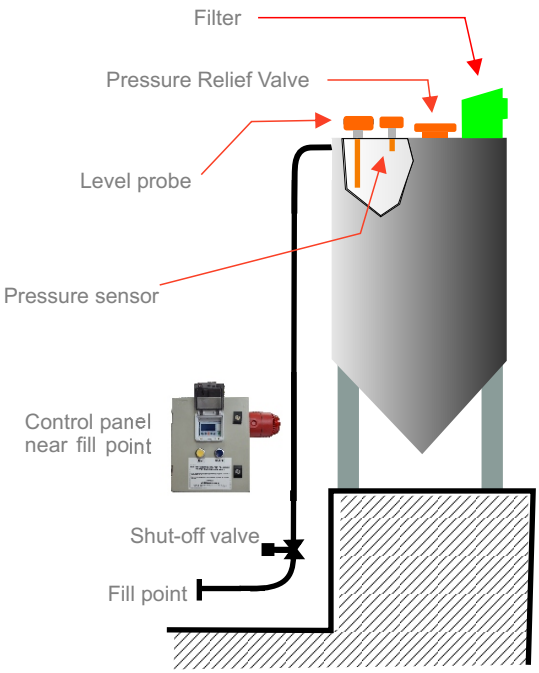
The key to preventing over-pressurisation is to monitor and protect the silo during a fill process, tracking the level and pressure within the silo, and controlling the inlet shut off valve should a dangerous condition arise.

This should be carried out by a local logic control panel mounted at the fill point (*see diagram opposite*).

Additionally, a Pressure Relief Valve (PRV) must be fitted to the silo, which is designed to open if any of the other silo protection devices fail. This will vent the silo to atmosphere before a critical pressure is reached. As mentioned previously this could be as low as 1psi, so this 'last resort' safety device is essential.

Please note: if the correct silo protection equipment is fitted, the Pressure Relief Valve should ***never*** *activate during a fill.*

Hycontrol's advanced Silo Protection Systems are now available with an ATEX option for dust!



SILO PROTECTION INTRODUCES ADDITIONAL ISSUES!

Fitting silo protection will inevitably create additional Health and Safety issues; namely, it becomes necessary to climb to the top of the silo to check equipment functionality as part of the essential maintenance program.

Many sites will inspect equipment before each delivery and in all weather conditions! Slips, trips and falls are *the* major cause of accidents in the cement industry* and therefore installing equipment which needs constant maintenance on the silo roof is not a preferable solution.

This is where Hycontrol *S*ilo Protection Systems differ from all other systems. Hycontrol silo protection provides a *full* functionality test of all items on the silo roof with a single ground level push-button. This is referred to as GLT (Ground Level Testing) functionality and it is the only way to ensure both a safe working environment and the correct operation of equipment on top of a silo.

(*) information from the Mineral Products Association

GROUND LEVEL TEST HELPS MEET MPA GUIDELINES

MPA (Mineral Products Association) guidelines have always stated that Pressure Relief Valves should be tested to ensure they will operate at the correct pressure. Historically this has not been possible unless the PRV were to be removed from the silo, which has never been practical. The same was also true of the critical pressure sensor - without removing it from the silo it could not have been tested, hence it was never deemed practicable to fully test its operation. This has lead to it being largely ignored from a maintenance point of view.

Recent advances in technology now allow a complete functional test of the PRV to ensure it will lift when required. Hycontrol's one-button Ground Level Testing (GLT) innovation now means testing of the PRV and pressure sensor can be completed with both feet on the ground in complete safety, and all in a six-second time frame!

HOW DOES GLT HELP?

REDUCES:	***Overspills***
	Filter and silo damage
	Product loss
AVOIDS:	***Costly maintenance***
	Expensive clean-ups
	Dangerous situations
PROVIDES:	***A safer working environment***

A Typical Silo Protection installation with Ground Level Test, plus an additional contents gauge

Hycontrol GLT enables site operators to fully test vital safety equipment and to guarantee the functionality of all the components of their SPS system before each and every delivery takes place, with merely the push of a button.

The advantages of using a Hycontrol GLT Silo Protection System are numerous.

1. Testing is an essential part of maintenance and is often ignored by staff as it is time consuming or has not been practical in the past. With the new Hycontrol system a silo **cannot** be filled without a full test operation. Testing of the safety equipment is strongly recommended in the latest Mineral Product Association guidelines to prevent over-pressurisation of silos during the delivery of powders.

2. As part of the GLT, the air supply to the filters is checked before every delivery and will not pass as 'OK to fill' if the filter air is not switched on. The test used to confirm that the Pressure Sensor and Pressure Relief Valve are operating correctly utilises the same air supply as the filters and cannot be performed if there is no supply. This is important because if the air compressors have not been turned on this can lead to the development of over-pressurisation. This function is controlled automatically by the Hycontrol silo protection auto shut-off system.

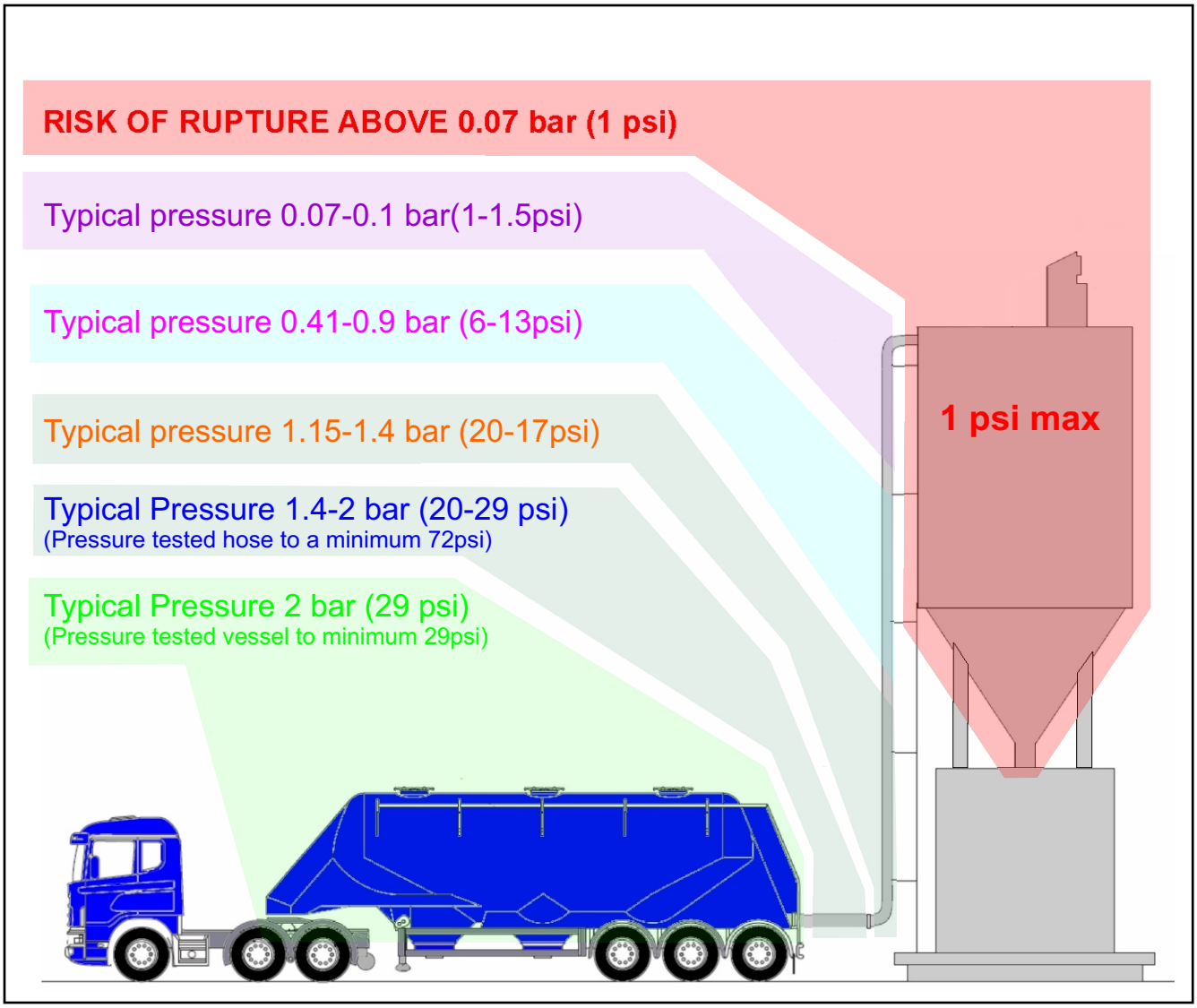
A typical auto shut-off control panel

3. The Pressure Sensor, Level Sensor and Pressure Relief Valve all have to pass a function test before each and every delivery. This means that operators know their equipment is functioning correctly before infilling begins, and that it will alarm as required at any pressure or level issues that arise during the fill.

4. The combination of tests described above will: **eliminate** filter damage by protecting and monitoring the pressure within the silo; **reduce** product loss through overfills and wastage; **avoid** incurring clean-up expenses - but most importantly, this system will **reduce maintenance levels** significantly and provide a **safer working environment** for site operators.

To ensure your safety system is fully operational it must be regularly tested!

SCHEMATIC SHOWING TYPICAL DELIVERY PRESSURES WITH POWDER IN THE PIPELINE



A typical delivery procedure displaying cement tanker offloading. This pressure is between 1-2 bar. The auto shut-off system can be seen located close to the fill point for the driver to monitor during delivery.

PRESSURE IS THE KEY PROBLEM

The key factor which will damage a silo and cause additional safety issues when filling is pressure. Pressures above 1psi may be sufficient to damage and rupture the silo or even eject the filter systems from the silo lid. A delivery road tanker is a pressure-tested vessel designed to operate at pressures of 29psi, whilst the tanker connecting hose is pressure-tested, typically to 72psi. However, the storage silo being filled will usually be a standard vessel that is only designed to withstand the load of the material to be stored within it, and will not be able to withstand an internal pressure much above atmospheric.

It is essential for any silo safety system to monitor pressure in the vessel and it is imperative to make sure this device is functional. All existing pressure sensors on silos must be periodically removed and tested; however in reality this is rarely carried out due to the complexity, time and cost requirements.

The **only** silo pressure sensor currently on the market which can self-test over its full operating range and provide a **100% fully operational guarantee** is the new, improved Hycontrol FLEX501.

FLEX501 PRESSURE SENSOR

GLT TEST

FLEX501
PATENTED
DESIGN

This sensor monitors pressure in the silo and transmits it to the control panel, where control actions and alarm signals can be initiated; for example a pressure increase signal would typically be used to close the discharge valve in the fill pipe, in order to stop the tanker over-pressurising and as a result damaging the silo.

The FLEX501 is Hycontrol's most advanced pressure sensor yet, and has been designed specifically for silo protection applications. It is the only sensor that can carry out the following essential test functions for a Silo Protection System:

1. **Detect if the sensor is damaged or blocked**
2. **Self-clean the sensor before and after every delivery**
3. **Test the sensor integrity and operation over its full working range**
4. **Confirm the air supply to the filter compressor is on**
5. **Records number of high level pressure events when used with HYCDPS250 panel**
6. **Records number of high level events when used with HYCDPS250 panel**
7. **Records number of PRV activations when used with HYCDPS250 panel**

All of the above are carried out with the simple press of a button at ground level before a delivery takes place. This ensures that the primary element is working correctly and it is safe to unload the tanker, providing the other Silo Protection components pass their tests!

FLEX501 Features

- Ground level test facility
- Simple to install and commission
- Simple retrofit to existing silos
- No moving parts or flexible rubber diaphragms
- 2-wire loop powered connection to control panel
- M20 electrical entry with cable gland
- 1" BSPP (G1) process connection
- Corrosion resistant PVC nozzle
- Reliable pressure monitoring of the silo
- IP67 rugged GRP enclosure
- Push-in connection for air supply

HIGH LEVEL SENSORS

This is the device that will detect when product in the silo has reached a high level (typically when there is 10% remaining of the full silo capacity) and will activate an alarm. There are many technologies available for this function, and whilst Hycontrol has many different options for determining a high level, **vibrating probes** are the most commonly used for dry products. The old design rotary paddle switches have now been superceded by technologies with no moving parts, GLT capacities and the ability to detect a wide range of materials.

VIBRATING LEVEL SENSOR

GLT TEST

Vibrating probes are the most effective high level probe option for solids and powders, for a variety of reasons. This technology is unaffected by changes in temperature, pressure, and humidity, and is unaffected by material changes such as dielectric. They require no calibration and the design has a self-cleaning effect.
Many vibrating 'twin fork' designs suffer from bridging whereby product gets jammed between the forks causing false alarms. The unique single diamond blade shape is immune to this. The Diamond Point (DP) Series from Hycontrol has one vibrating knife blade with another inside. This provides excellent sensitivity for light materials but also an extremely strong blade for vertical loading.

CAPACITANCE LEVEL SENSOR

GLT TEST

Capacitance probes are widely used within the powders market and offer a versatile universal switch for many different applications. They are available with rod or cable extensions and are simple to install and calibrate. Unlike many capacitive switches the Hycontrol probe works independently of the tank walls using an integral grounding sleeve and can measure low dielectric products such as cement.
These level probes will need to be calibrated for the product in which they will be used on as their sensitivity is based on the dielectric of the material. Once set it will provide reliable operation with a long life.

ADMITTANCE LEVEL SENSOR

GLT TEST

Admittance probes provide a solution for products which have a tendency to coat the level probe. The main advantage of this technology is that it has the ability to totally ignore product build-up on the sensing probe and differentiate between product level and coatings.
These level probes will need to be calibrated for the product in which they will be used as their sensitivity is based on the dielectric of the material. Once set it will provide reliable operation with a long life.

**** All of the above switches can be tested to ensure their correct operation before each fill takes place.***

PADDLE LEVEL SENSOR

NOT
RECOMMENDED

Paddle Switches have been used extensively in the cement industry as High Level Alarms (HLA) for many years, chiefly because they were a 'low-cost' option for the high level probe. However these devices offer little protection if the motor wears out, or the blade breaks or falls off. It is not possible to ground level test these units from Hycontrol. The latest vibration and capacitance technologies have been proven to be a superior solution as there are no moving parts to wear out or fail.
Paddle switches are the cheapest form of high level probe but for safety reasons Hycontrol do not advise them for use as silo protection.

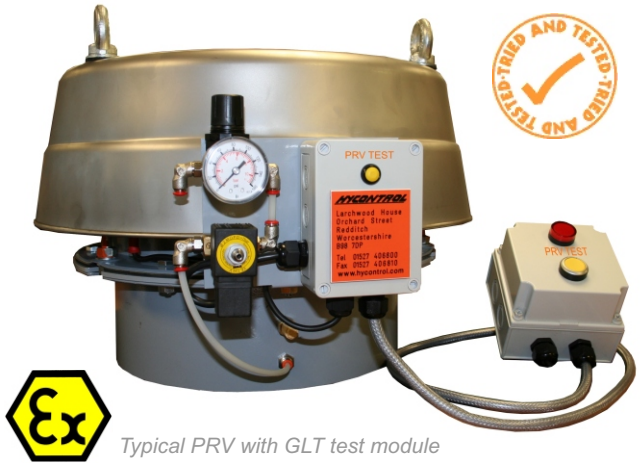
PRESSURE RELIEF VALVE

GLT TEST

The Pressure Relief Valve (PRV) is the last line of defence for a silo against over-pressurisation. This unit is normally fitted to the roof of the silo and prevents both over- and negative pressure occurring within the silo, since both of these may cause severe damage.

This valve is available in a number of different materials and has a wide range of upstand adaptors to simplify retrofitting to existing silos. These units can be fitted with the GLT module to provide a complete test before each delivery to ensure the valve is operational.

A PRV should **never need to open** if the correct Silo Protection System is fitted, as the inlet valve will close should an over-pressurisation condition occur. However in an emergency they will vent to protect the silo should the pressure exceed 50 millibars or 0.75psi.



Typical PRV with GLT test module

NOTE: IT IS VERY IMPORTANT TO SPECIFY THE CORRECT VALVE FOR YOUR SILO IN ORDER TO ENSURE IT WILL SATISFY THE AIRFLOW EXHAUST REQUIREMENT (THIS IS TYPICALLY 13,000 m³/hr).

PRV GLT TEST AND INSPECTION

GLT TEST

The ability to test the Pressure Relief Valve is a requirement of the MPA guidelines and is essential for many reasons. For the majority of its lifetime a valve will rarely, if ever, be operated. As with any mechanical device, the valve should be cycled periodically and tested to check it can lift correctly. It is good practice (and common sense) to ensure springs have not seized or clogged, or the valve seat is not stuck down with dried product.

Hycontrol know that regular cycle testing will help keep the valve clean, and in doing so will also extend the life and functionality of the product. The Hycontrol GLT module achieves this goal and provides several features which will improve safety on site. Firstly, it tests the PRV to ensure it will lift correctly. This test is done from ground level at the silo base, making it a hazard-free operation. Secondly, it has a manual 'valve open' function for a visual inspection as described below. This is for a quarterly or half-yearly inspection to check the seals and to make sure there are no leaks. This test is carried out at the top of the silo. With the cover removed, the valve can be operated to open the seals for inspection. The GLT module can be retrofitted to existing PRVs to help reduce costs on site.

Many companies will claim to inspect and test these items as part of a maintenance regime but it is not possible to test a regular Pressure Relief Valve without removing it and installing it on a pressure test rig.

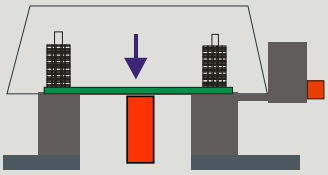
The Hycontrol PRV with GLT allows a working pressure test to be carried out without removal from the silo.

How does your site test your pressure relief valves and confirm they will operate?

Operational positions for the pressure relief valve

1. Normal position

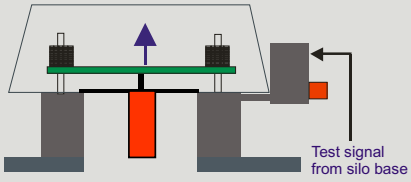
PRV **CLOSED**



1. Normal operation: the valve is closed ready for a test and fill.

2. Valve test position test from silo base

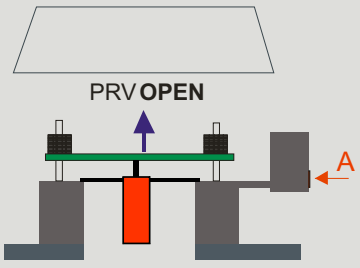
PRV **OPEN**



2. Valve is tested from ground level to check the operation before every delivery takes place. If test passed an LED at silo base will confirm the PRV is ok.

3. Valve inspection & clean test from silo roof

PRV **OPEN**



3. The cover is removed for inspection and button A is pressed to raise valve seat. Inspect and clean if necessary. When button is released the valve closes.

CONTROL PANEL WITH AUTO SHUT-OFF

GLT TEST

The control panel provides the control functions which complete the Silo Protection System. Hycontrol offers a wide variety of panel options from the standard model through to an out-of-hours delivery panel for multiple tank installations. The current standard panel is the new, budget-sensitive **HYCDPS250-3F**, incorporating advanced silo technology with preventative maintenance and diagnostic features, control and display functions.

Hycontrol Silo Protection Systems will provide the following:

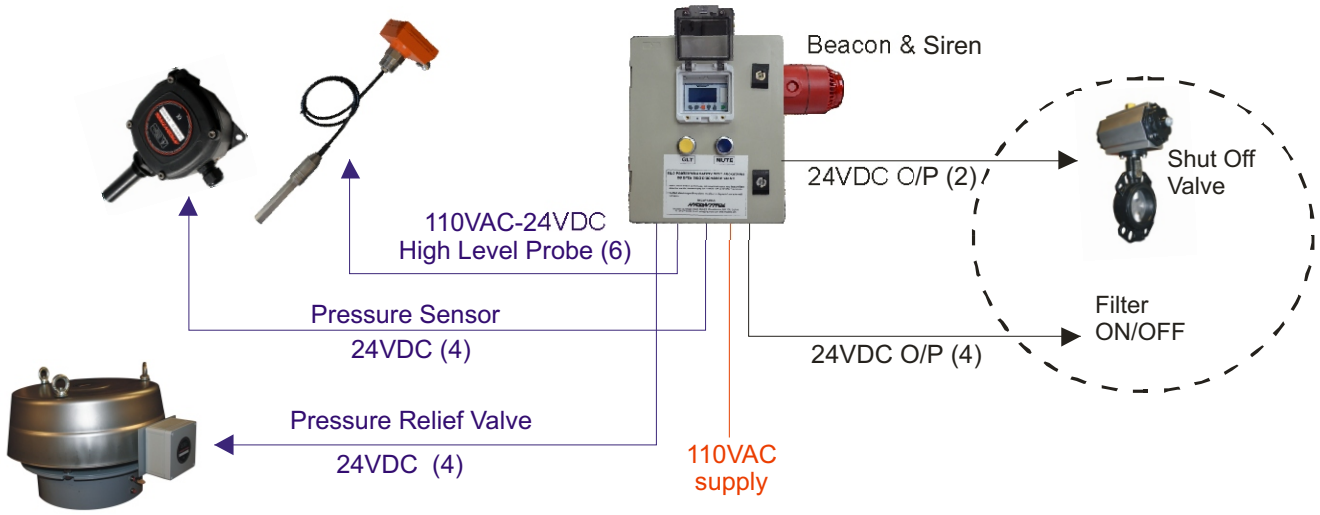
- Pressure, level, PRV testing (**essential functions**)
- Silo auto shut-off control
- Record the number of events on incidents of over-pressure (time / date stamped)
- Record the number of events of PRV lift and opening (time / date stamped)
- Record the number of events of high level probe activation (time / date stamped)
- Filter ON / OFF output option
- Air supply monitoring alarm option

HYCDPS250-3F WITH AUTO SHUT-OFF

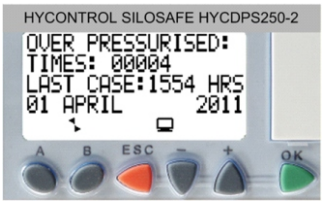
This system will control the inlet valve to prevent over-pressurisation and overfilling of the silo, providing warnings via sirens and beacons. The GLT operates from one highly visible yellow button, pressed prior to delivery. If a problem arises during this the information is displayed on the panel screen (*see status message examples below*).

This system will also time-and-date stamp the last high pressure event, last high level event and the last PRV lift, as well as count the number of times each event alarm is reached. **This is important for preventative maintenance purposes. If the total figure for events is high this would indicate possible filter blockages, filter problems or that tanker discharges are uncontrolled - all issues that need to be addressed!**

Please note if a high level warning is activated the inlet valve will close after 30 seconds and if a high pressure condition is reached it will close immediately. After a successful GLT test the inlet valve will open to admit product and then remain open for 90 minutes, after which it will close until the test is run again.

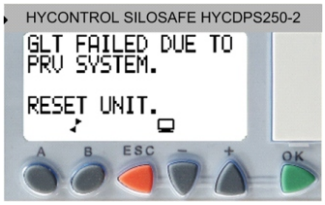


Examples of status messages on panel screen display:



Above screen displays this silo has had four events of over-pressurisation, and the last event was on the 1st April 2011 @15.54.

Above screen displays this silo has passed the GLT everything is working ok, the valve is open and will close in 90 minutes.



This silo has failed the GLT due to a problem with the PRV. This requires investigation before the inlet valve will open!

ANCILLARY ITEMS REQUIRED FOR SILO PROTECTION

Inlet Control Valve

Pictured above is a typical 4" flange-mounted inlet valve, supplied in a 'normally closed' configuration with spring return. It is pneumatically operated from the control panel HYCDPS250 and should be linked to the Tamper-Proof Control.

Silo Safety Pod with GLT Level and Pressure Sensors, fitted on one flange

This GLT module is a retrofit option for silos, requiring only one process connection to fit all four systems - the PRV, PRV tester, high level probe and pressure sensor. Ideal for a smaller footprint on the silo-top with a lower cost of installation.

Tamper-Proof Fill Valve Control

Used in conjunction with the Inlet Control Valve, this device prevents manual overrides or bypasses. This ensures that GLT alarms cannot be ignored and must be resolved before filling can take place.

DESIGN / BUILD / INSTALL / SUPPORT

Our experience has shown that many companies simply do not have the expertise or resources to correctly install and maintain the complete level measurement system. This is often overlooked when making the purchasing decision, resulting in unnecessary mistakes. Problems such as incorrect process connections, mounting in the wrong position and the use of incorrect cables can easily be avoided by letting Hycontrol take care of the complete project.

Hycontrol have the experience and skill needed to survey, supply, install, commission and service their complete range of equipment, offering a complete solution to our clients. All our highly experienced Sales and Service Engineers have the relevant training, product knowledge and qualifications to ensure a professional solution is provided from start to finish.

After-sales service and support is a key reason many customers choose Hycontrol. Our team of UK Service Engineers are able to respond quickly to urgent service requests and our dedicated in-house Technical Support Engineers are always on hand to offer free telephone advice.

When working on sites, it is essential that all personnel are familiar with the potential dangers and this is why all Hycontrol Sales and Service Engineers are safety passport trained.

Service contracts to check calibration and confirm safety systems are fully operational are all part of Hycontrol's day to day support activities.

HYCONTROL LEVEL TECHNOLOGIES

Product Range For Solids :-

(1) TDR Radar For Solids

(2) Ultrasonic, 'Through Air'

(2) 2 Wire Ultrasonic Transmitter

(3) FMCW 2 Wire Radar

(4) Continuous 'Servo' Level Indicator

(5) FMCW 2 Wire Radar

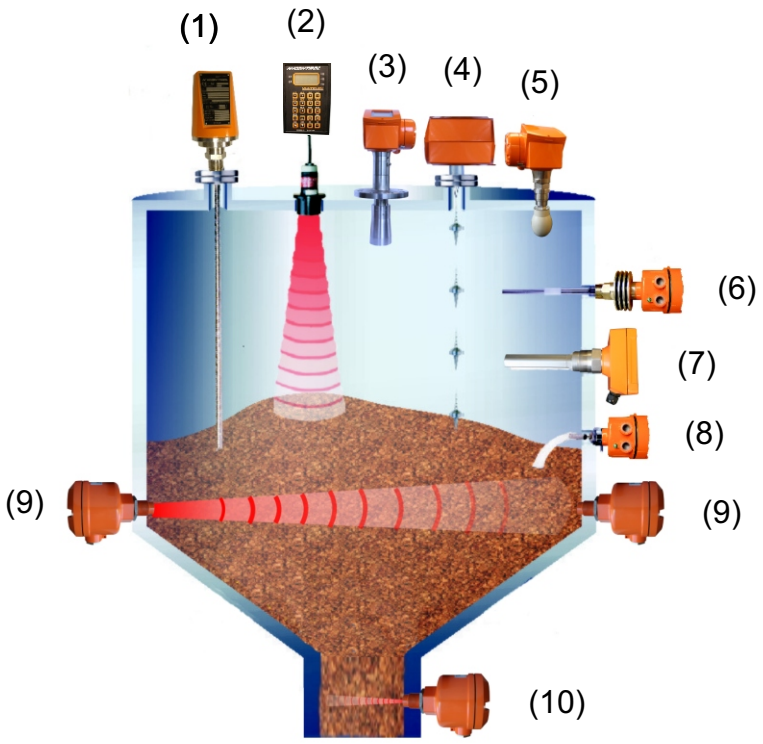
(6) Capacitance Level Switch

(7) Vibrating Probe Level Switch

(8) Rotating Paddle Level switch

(9) Microwave Level Switch

(10) Doppler Flow Switch



Product Range For Liquids :-

(1) By-Pass Level Indicator With Radar

(2) TDR Radar For Liquids

(3) 2 Wire Ultrasonic Transmitter

(4) FMCW 'Horn' Radar 2 Wire

(5) Magnetic Float Switches

(6) FMCW 2 Wire Radar

(7) Foam Level Switch

(8) Capacitance Level Switch

(9) RF Admittance Level Switch

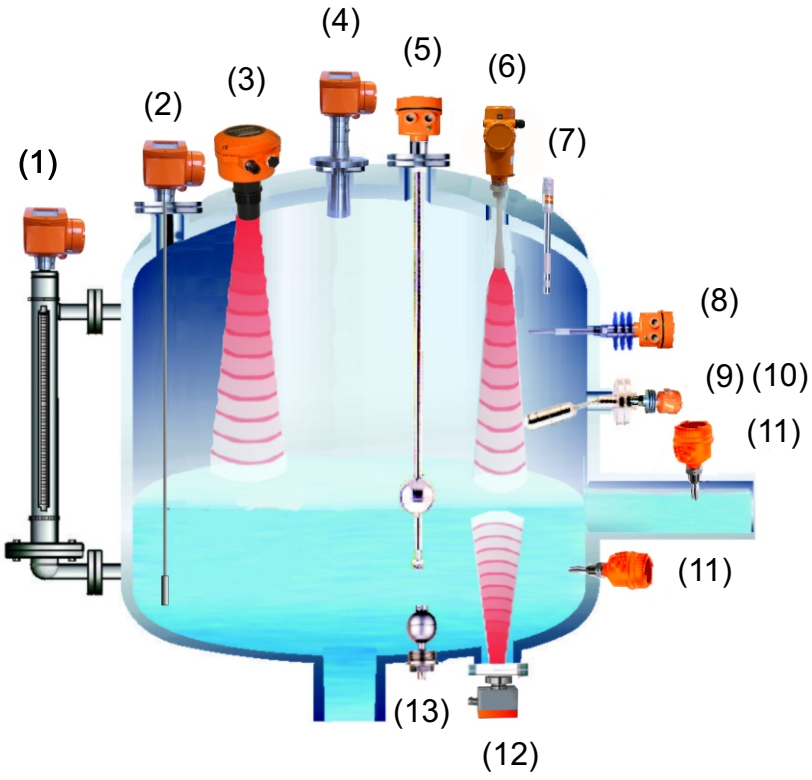
(10) Side Mounting 316 SS Float Switch

(11) Tuning Fork Level Switch

(11) Tuning Fork Level Switch

(12) Ultrasonics 'Through Wall'

(13) Mini Magnetic Float Level Switch



Hycontrol Ltd, Larchwood House, Orchard Street, Redditch, Worcestershire, England, B98 7DP
Tel : 01527 406800, Fax : 01527 406810, sales@hycontrol.com, www.hycontrol.com