

# 6 Considerations for Success

## *A Sensible Guide to Silo Inventory Monitoring Systems*

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Chances are you are familiar with level sensors and the many measurement technologies that are offered. But do you know how the sensors work and the other components available to deliver a complete inventory management solution for your silos? Do you understand the differences in the types of sensors and the pros and cons of each?

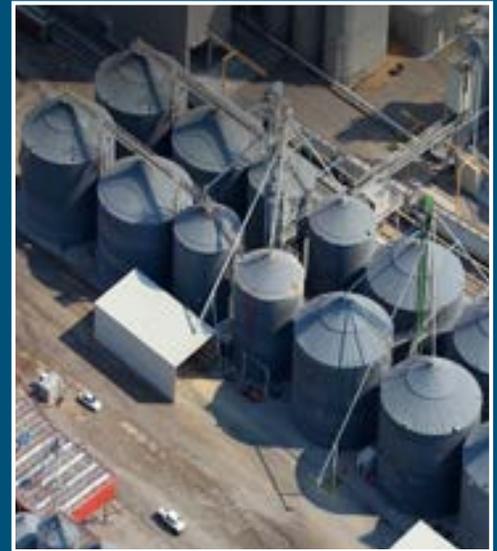
This guide is designed to give you a basic understanding of the components of a silo inventory system to help you ask informed questions of your vendors. It will also provide insights into some things you might not have thought about to make your plant run even more efficiently.

Here are 6 things to consider when designing a silo inventory system.

- 1 Sensor Selection
- 2 High Level Alerts
- 3 Wireless Options
- 4 Remote Monitoring
- 5 Local Data Access
- 6 Flow Detection



**LIQUIDS**



**SOLIDS**



**POWDERS**

# 1

## Sensor Selection

When looking to monitor changes in inventory, [continuous level sensors](#) will measure repeatedly over time to provide the most up-to-date information. These sensors are generally broken into two categories.



Non-contact sensors use technologies such as acoustic, radar, laser, and ultrasonic.

The advantage of non-contact sensors is they do not intrude into the silo and do not physically contact the material. There is no risk of cables interfering with augers or other internal structure in the silo.

Cabled sensors, on the other hand, will have continuous or intermittent contact with the material. These include guided wave radar and weight-and-cable or bob-type sensors.

Both types are highly reliable when applied, installed, and maintained properly. Each technology has its place dependent on the size of the vessel, the material being measured, the physical environment, and the relative cost of the sensor.

Continuous level sensors take frequent readings



[Click to Skip to Technology Comparisons](#)

# 2

## High-Level Alerts

Another type of sensor important to an inventory management system is a [point level indicator](#). As the name implies, it detects and alerts when material reaches a certain point in the silo. The most common point level indicators used in an inventory management system are [rotaries](#), [capacitance probes](#), and [vibrating rods](#).



Point level indicators are a low-cost addition to silo equipment that can reap time and cost savings. They serve as a redundant alert when a silo is almost full. Preventing overfills saves time cleaning up messes, but more importantly protects the more expensive continuous level sensor at the top of the silo that might be damaged by an overflow.

Another role for a point level sensor is a low-level alert when the silo is almost empty. It lets you know inventory is running out before a process needs to be stopped.

Although the continuous level sensor will be tracking inventory as it gets low, the point level sensor will ensure you are alerted to replenish before production is interrupted.

Think of a point level indicator as an insurance policy. You might not ever need it, but are sure glad you have it. It pays for itself quickly and has a long service life.





### 3 Wireless Options

Expensive wiring does not need to stand between you and an automated inventory management system. There are options to partially, or almost entirely, replace long spans of wire that run up installation costs.

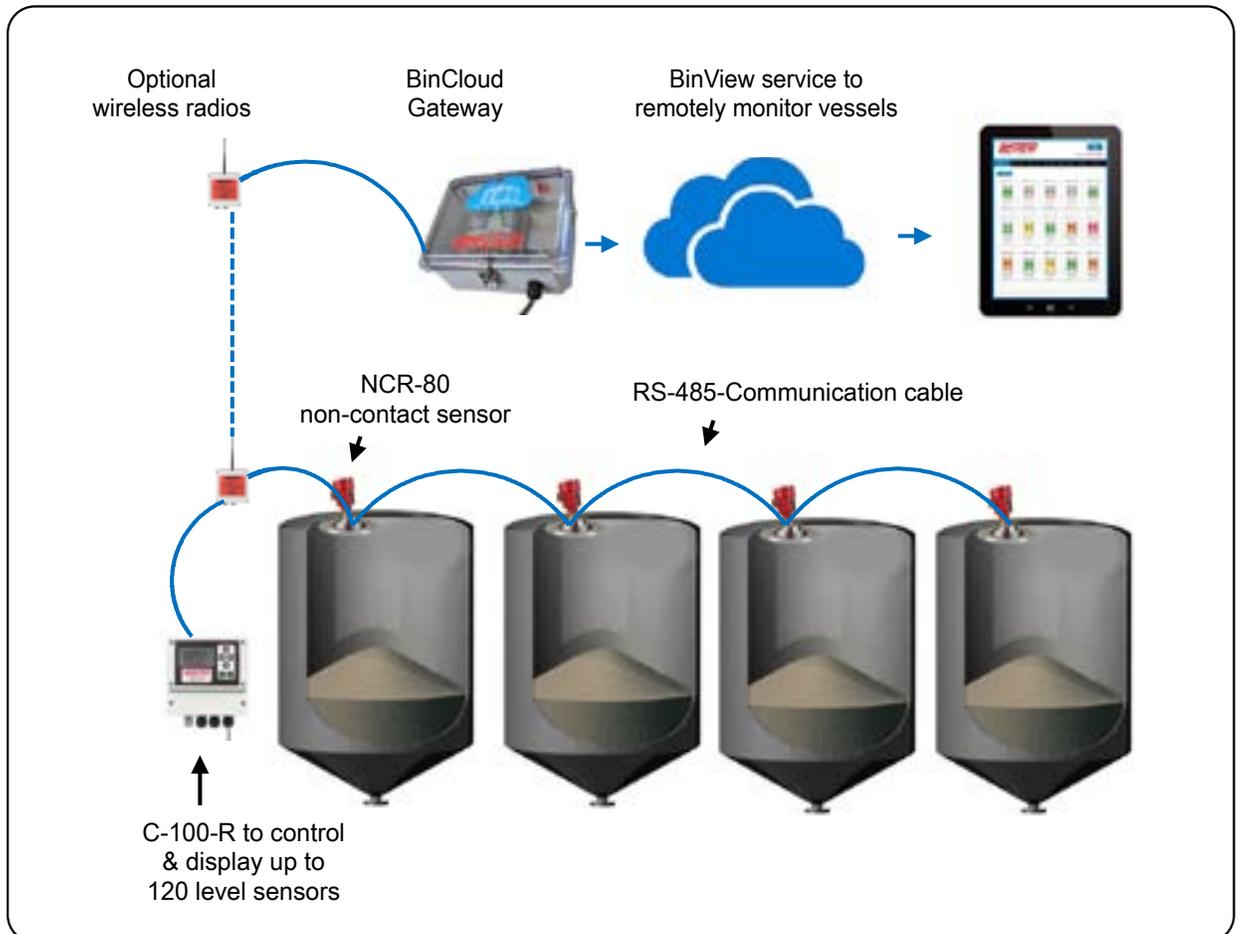
One of the more common solutions is to daisy-chain a group of silos together in a ring. This wiring scheme allows multiple sensors to be wired together in a sequence to greatly reduce the amount of wiring needed. This allows a single wireless gateway to send level data for multiple sensors seamlessly to the cloud for processing.



In large plants where there are multiple groups of sensors, daisy-chaining and gateways allow for an entire plant to be connected at a much lower expense than traditional wiring.

Antennas and wireless transceivers can also be used to span large distances. LoRa or long-range communications can be used for distances up to one mile with an unobstructed line of sight.

Daisy-chaining reduces wiring costs



# 4

## Remote Monitoring

With working from home a reality for many, remote monitoring is not a luxury, but a necessity. Even personnel still at the plant or office need access to inventory data in real time. Plus, many people are responsible for locations across town or across country.

SaaS web sites provide inventory data



[Inventory management programs](#) accessed from a corporate server, a website, or an app are easy to use and provide people across many functional areas of an organization the information they need to do their jobs. Many companies provide inventory access to production, logistics, purchasing, and financial groups simultaneously. When inventory information is self-service, current, and automated, personnel spend less time in meetings, sending emails, and on phone calls.

Many operations are asking their suppliers to tag-team in the ordering and delivery process. In this case, access to the plants' silos is shared with the vendor. Vendor managed inventory lets plants and their suppliers work together sharing real time data to keep the supply chain running smoothly.

Vendor managed inventory reduces material outages



After connecting level sensor data to the cloud, the next step is monitoring inventory using a secure website. There are many types of inventory monitoring programs emerging. Some are for specific industries or materials, while others can be used across a wide variety of industries, materials, and geography.

Developers have recognized that the needs of chemical or [cement plants](#) can be somewhat different than a plastics plant or a [feed mill](#). Cement plants need to connect dispatchers to suppliers and batch plants. Hog feeders need to monitor bins in tandem, track different types feed, and monitor daily feed intake.

It is important that everyone involved is basing decisions on the same data at the same time. This leads to improvements in inventory turns, reduced safety stock, improved cash flow, increased profitability, and shorter lead times.

## Local Data Access

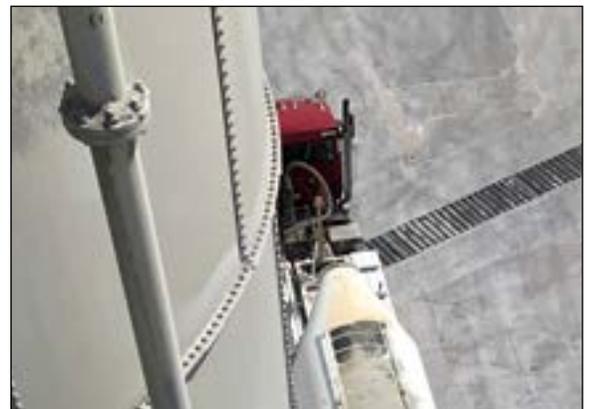
# 5

During a busy workday repeatedly running to the office or a control room is just not feasible. Climbing a silo is even less desirable. Often production personnel want a quick reading of what is in stock. Drivers want to know if an entire load will fit into a silo.

Adding a [control console](#) or a [digital panel meter](#) allows people to walk or drive up to a console installed at a convenient location. These compact and rugged devices can be configured to monitor one or many silos at the push of a few buttons. They provide silo levels in real time and can display headroom (distance to material) or the height of the material.



They work by programming the basic parameters such as silo height and diameter into the console. Users easily scroll through the silos associated with the console without walking to each individual silo. Consoles are compatible with sensors with a 4-20 mA or Modbus output and easily integrate into an inventory management system or can be used as a standalone display.



# 6

## Flow Detection

Another feature to consider in your inventory management system are sensors to monitor flow. Distributors, chutes, and conveyors that move material into silos or from one process to another can become clogged, overfilled, or



run empty. Plants that run multiple products need to be sure that the correct ingredients are fed into the process without cross contamination.

A [flow detection sensor](#) detects flow or no-flow conditions. They are very sensitive and can detect minute amounts of flow of small granules or powders.



Flow detection is important when changing from one ingredient to the other while processing in industries such as human or animal feed, chemical processing, or cement manufacturing.

Flow detectors can also alert if material is not flowing through a chute or pipeline or if a conveyor has run empty. This could prevent material from being conveyed into a silo creating a material shortage or shutting down a process.

Flow detectors ensure continuous processing

## Reasons Inventory Systems Fail

*Has this ever happened to you?*

- People creating their own ways of managing inventory
- Reliance on spreadsheets or tape measurements
- Nobody (but nobody) wants to climb silos
- It is too far to walk to the control room
- Wrong sensor technology for the job
- Sensor installed incorrectly
- Inventory data was not current
- Everyone looking at different data
- People need their data now!

This guide helps you avoid these pitfalls



# Sensor Technologies

## Weight & Cable

The bob-style or [weight-and-cable sensor](#) works like an automated tape measure. Mounted on top of the silo, the sensor drops a weighted cable to the material surface. Upon impact, the cable



retracts while counting pulses that are converted to a level measurement. Measurements are programmed at predetermined time intervals to monitor changes in inventory over time. These sensors are used in solids or liquids and can also measure the level of sediment settled in a tank containing liquids.

## Strengths

- Reliable in dust or other adverse process conditions
- Not affected by material buildup on sensor
- Can be used in extremely light, signal-absorbing materials
- Measures bins up to 150 feet
- Not affected by material characteristics such as low dielectric constant or angle of repose
- Does not require calibration
- High temperature models available up to 1000°F
- Low purchase cost (\$1,800 to \$2,000)
- Consistent, repeatable, and accurate measurements
- Minimal contact with stored material
- Compatible with Binventory® and BinView® software
- A variety of digital and analog outputs available
- Wireless communications available to reduce cost of installation
- Hazardous location approvals available



## Considerations

- On-demand system, does not provide an instantaneous response to changes in the material level
- Seasonal maintenance may be required to clean out mechanical cavity in very dusty conditions, if air-purge is not used
- Not recommended in high pressure bins

## 3DLevelScanner

The [3DLevelScanner](#) uses acoustics-based technology. Three transducers send very low frequency sound waves to the material surface. The sensor receives echoes back from multiple points on the surface which are converted to distance measurements. Advanced algorithms in the software assign each measurement an XYZ coordinate that is mapped into a 3D image. The software generates a graphical representation of the material topography in the bin. Surface variations are accounted for in volume calculations.



## Strengths

- Continuous level measurement
- Non-intrusive, non-contact design
- Measures uneven powder or solid material surfaces
- Detects cone up, cone down and sidewall buildup
- Provides minimum, maximum, and average distances
- Performs in extreme levels of dust
- Calculates highly accurate bin volume due to mapping the surface of the material with multiple measuring points
- Measuring range up to 200 feet
- Self-cleaning with minimal maintenance
- High temperature applications up to 365°F
- Automatic compensation for temperature changes
- Analog and digital communication options
- 3D MultiVision networkable PC software available for multiple vessel monitoring
- Can generate a 3D image of material surface
- Cable-replacing, wireless interfaces available
- Approved for hazardous locations
- Not affected by material characteristics or low dielectric constants

# Sensor Technologies



## Considerations

- The 3DLevelScanner is an acoustic device and elevated background noise can influence its performance
- Setup requires care in mounting the sensor in the proper location, and mapping the vessel
- Time required to process multiple pulse echoes limits the sample rate
- Not recommended for liquid applications
- Corrugation on small vessels can cause false echoes
- Not recommended for materials with a bulk density under 11 lb./cu. ft. due to absorbing the acoustic pulse

## Non-Contact Radar

[Non-contact radar level sensors](#) transmit a narrow beam of microwaves from an antenna system through the air to the surface of the product. The microwaves are reflected by the product surface and received back by the antenna system. Internal electronics calculate the time of flight (TOF) or how long it took the pulse to return to the antenna. The TOF is converted into a level measurement based upon the vessel parameters programmed into the sensor. Non-contact radars measure liquids or solids continuously with levels being updated in just seconds.



## Strengths

- Powerful 80 GHz radar significantly outperforms old 26 GHz technology
- 4° versus 10° beam angle for better precision
- Narrow beam can be precisely targeted to avoid structure
- Fast reaction/update time tracks filling or emptying activity
- Substantial 393-foot measuring range
- Same sensor technology used by self-driving cars
- Strong signal performs well in dust
- Versatile for use in solids, liquids, and slurries
- Signal not affected by corrugation
- Loop power capability
- Compatible with BinView® software
- 4-20 mA and Modbus RTU communications
- Wireless communications available to reduce cost of installation



## Considerations

- Single point measurement will not account for variations in material topography
- Minimum dielectric constant of material must be above 1.3

## Guided Wave Radar

A [guided microwave level transmitter](#) utilizes time domain reflectometry (TDR) to continuously measure the level of

solids or liquids. The transmitter emits a high frequency microwave pulse guided along a cable or rod. When the pulse reaches the material surface, the pulse energy is reflected back up the cable to the sensor head. Level is calculated based on the time difference between the pulse being sent and the reflected pulse received.



# Sensor Technologies

## Strengths

- Continuous level measurement in powders, granules, bulk solids, and liquids
- Measuring distance up to 100 feet for solids and 75 feet for liquids
- For light to heavy bulk solids
- Level or interface measurement in liquids
- 4-20 mA and Modbus RTU communications
- Performs in solids prone to high dust
- Suitable for vessels of most any shape or diameter, including narrow tanks or standpipes
- Immune to condensation
- Virtually maintenance free
- Reliable accuracy within 0.08"
- Hazardous location approvals
- BinDisc simple setup and configuration
- Compatible with BinView® software
- Wireless communications available to reduce cost of installation



## Considerations

- Sensing rod or cable is in constant contact with material
- Minimum dielectric constant of material must be above 1.3
- Maximum range for solids is limited to 100 feet, and may not be suited for heavier materials due to tensile load
- Material like large rock may damage probe and be difficult to sense

## Lasers

[Laser-level measurement sensors](#) transmit a laser beam to the material surface. Like a non-contact or guided wave radar, the sensor uses a time-of-flight calculation to measure the distance to the material. The sensor has an integrated microprocessor that calculates the distance utilizing the time it takes the laser pulse to travel from the transmitter to the surface and back.



## Strengths

- Measures in a very tight 1° beam with no beam divergence
- Accuracy of +/- 1 inch
- Can track during fill in low dust environments
- Ideal for very narrow vessels or constrained spaces
- Unaffected by corrugated bin walls
- Can be precisely targeted to avoid structure inside vessel
- Use for plugged chute detection or monitoring sidewall buildup
- Versatile for bulks solids, pellets, granular materials, and opaque liquids
- Can be used in most any dielectric material
- Unaffected by heavy vapors and pressure
- Adjustable 10° mounting flange for precise aiming
- Integrated dust protection for minimal maintenance
- Configuration can be performed without filling or emptying vessel



## Considerations

- Single point measurement will not account for variations in material topography
- Laser will penetrate clear liquids
- Dusty environments will diminish performance
- Potential buildup on lens in dusty environments



# Conclusion



## ***Applying the Guidelines***

Now that you are armed with practical knowledge about your silo inventory management options, it is time to put know-how into practice. [Contact a vendor](#) with your requirements and share your expectations to get the system that is right for you. Want to know even more before you get started? [Watch this webinar](#).

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*BinMaster designs and manufactures reliable, solid-state point and continuous bin level indicators, control systems, and sensing devices used while storing powders, bulk solids, and liquids, the company is a subsidiary of Garner Industries, a custom manufacturer of plastic and metal parts. Established in 1953, Garner Industries is certified to ISO 9001 quality management systems—requirements.*

