Level Measurement Application Guide

SRS INTERNATIONAL direct

Solids Measurement Characteristics

Measuring the level of solids can be a challenge. Due to the material properties, solids surfaces are usually uneven with irregular shapes, and there are usually high levels of dust. Along with these challenges, solid materials often have low dielectric constants making them hard to measure.

When selecting a measuring device, it is important to understand the purpose of the measurement. Solids measurements differ from liquid in many ways. There are different process characteristics to consider that may or may not require special features in the level device of choice.

Continuous Level Measurement

The main benefit of a continuous level measurement is having continuous access to information, which allows for better materials tracking and control.

In solids level measurement there are often relatively fast level changes and low dielectrics. Having a continuous insight into the process enables process optimization, reduced interruptions, and a higher level of safety.

Radars usually provide appropriate solutions for small to medium sized silos where the filling rate can be high and the environment can be rough, but also in large silos for inventory management.

Point Level Measurement

Limit detection is required in most silos and containers to avoid overfilling and overspills, or run-dry/empty situations, both of which can lead to unnecessary downtime.

Solids level switches consist of several technologies that are suitable for full, demand, or empty detection for all bulk media in all types of vessels.

They can be used for simple process control, in heavy or very light materials, and handle extreme conditions such as high temperatures, pressure, mechanical stress, and tensile forces.

Point level measurement devices are simple to use and install, they are robust and reliable, insensitive to dust, electrical charge and adhesion, which makes them suitable for increasing safety, preventing downtime, and reducing waste.

Typical Solids Application Characteristics

Uneven surface

All level measurement instruments are affected by the uneven surfaces in solids applications. The material characteristics and silo size will affect the structure of the surfaces, which affects the preferred installation location and choice of technology.

Most technologies for measuring the continuous level of solid materials are top-down measurements and depend on a signal reflecting from the surface back to the device.

Guided wave radar is less affected by uneven surfaces since the microwave signal is more compact, guided by the probe and reflected from the contact point on the surfaces.

Non-contacting radar is affected by uneven surfaces since some of the signal is not reflected directly back and instead may be re-directed away from the device. The device gathers several smaller echoes concentrated from its footprint on the surface and then merges them into a single echo that represents an average of the measured area. The radar signal becomes more concentrated as antenna size increases. While the overall surface area measured is reduced, the return signal is strengthened.

When installing solids switches, it is good to consider where the level will be changing, to achieve a reliable and accurate point level detection.

Best practice is to have both continuous and point level measurement instrumentation to ensure a safe and reliable operation.

Dielectrics and bulk density

Materials with very low dielectric constant and low density may attenuate the measurement signal so that it becomes insufficient.

The dielectric constant of many solids is fairly low. For radar technology, this is a key indicator of the amount of signal that will be reflected back to the gauge and thereby the possible measuring range. For level switches, capacitance technology is affected by the bulk solid dielectric constant. Both radar and capacitance can handle low dielectrics with ease.

Radar is unaffected by bulk density, while many solids switches are not. The bulk density is therefore an important selection parameter when choosing technology for point level measurement.

Filling

The mounting location in relation to the filling location is important for most measuring technologies. The closer the device is mounted to the filling point, the larger the risk that the device will be affected. There are also cases where the material is blown into a silo through a pneumatic process. Dust and the actual stream from the filling can disturb the measurement to a large extent.

Dust

There is often a considerable amount of dust created during the fill cycle of solid materials. The amount of dust depends on the type of filling and the material.

Both radar and level switches can handle dust in the vapor space without being disturbed. Other technologies such as ultrasonic and laser devices are less suitable since their signal is significantly impacted by dust.

Although a heavy layer of dust on the radar antenna can block the signal in applications where the dust is especially sticky, this can be compensated for by alternatives such as non-stick antenna materials and air-purging.

Condensation

In many solids applications, condensation is present. Since the vessel ceiling is normally the coldest spot, it is a common location for condensation. Unfortunately, this is typically the location of top-down measurement devices, so consideration needs to be made regarding the effects of condensation on the technology. Condensation can also tie up dust and create a layer on the wetted parts, which may cause problems if no action is taken.

Open air applications

Open air applications include measurements on piles and distance control between conveyor belts and the pile. These types of applications have different properties compared to standard bin or silo applications. There are no walls or roof to install instruments onto so the biggest challenge in these applications is to find an installation point. Protection from external factors like wind and rain can also be a challenge.

Selecting the Right Technology

All of the different characteristics and challenges found in solids level measurement will affect the preferred choice of technology.

No technology is perfect for all applications and the choice of technology is most often application dependent.

Guided wave radar is well suited for very low dielectric constants, long ranges, smaller vessels and where the installation area is restricted.

Non-contacting radar is an all-around technology for use in a large variety of applications. It can provide precise measurements over a smaller surface area, or work well even in large storage silos. It has no restrictions with respect to material weight and may be used in applications where guided wave radar may be prone to probe breakage.

Many solids switch technologies can be used in most applications, but they differ from each other to cover all applications, including even extreme conditions.

An overview of the different technologies, their advantages and limitations is described in the following chapter.

Non-contacting Radar Level Transmitter

Reliable and Robust in Tough Environments, and Easy to Use with Smart Technology

Non-contacting radar can be used on a large variety of applications and is suitable for a wide range of solids media. The mount is a great option for smaller and medium sized vessels, when surface mapping is not needed, and when level changes are more rapid.

- Flexible installation on the silo or bin with connections as small as 2 in. (50 mm)
- Technology provides outstanding signal to noise ratio and allows measurements on low DC products over long ranges
- A unique solids algorithm emphasizes the reflection from rough and inclined surfaces
- Signal Quality Metric diagnostics detect process conditions such as a dirty antenna

Typical Applications

Non-contacting radar is used on a large variety of applications. It has no restrictions with respect to the weight of the material so it can be used in applications where guided wave radar may not be appropriate due to pull forces or concerns about probe breakage. Non-contacting radar can see more of the surface than guided wave radar, so it will be slightly more accurate. As a radar device, it reacts quickly to level changes so it is also appropriate for process applications and small vessels.

Mounting Considerations

Positioning

Non-contacting radar should not be mounted in the center of the silo or very close to the tank wall. General best practice is to mount the non-contacting radar at two-thirds of the tank radius from the tank wall. The inlet stream of the product will interfere with readings if it is in the path of the radar beam.

Antenna options

The antenna types available for non-contacting radar are: cone antenna, parabolic antenna, and process seal antenna.

Application Considerations

Advantages

- Narrow beam
- Small vessel intrusion
- Internal obstructions
- 2-wire
- Process seal antenna provides an all PTFE solution
- Signal Quality Metrics to predict maintenance requirement for dust build-up
- Dedicated solids algorithm, calculating average level from footprint instead of a single point
- Easy to install and configure

Limitations

- May need purging
- Inferred volume

Nozzle

For solids applications, it is essential to minimize potential disturbances from the nozzle. A shorter nozzle typically results in a stronger surface reflection. This is applicable to all antenna types.

Dust management

Dust is often present in solids applications. Non-contacting radar may not be affected by the dust in the vapor space, but dust can be sticky and create a layer on the antenna. If this layer becomes too thick, it may affect the measurement. Of all the radar antennas available, the process seal antenna is the one that is least affected by dust and/or condensation, due to its all PTFE design. In extreme cases air purging can be used.

Guided Wave Radar Level Transmitter

Perfect fit for Solids Control Management Including Rapid Changes

Guided wave radar can be used in many different applications. It is especially suitable for vessels containing powders and small granular materials and low DC, where the installation area is restricted and levels are changing rapidly. It is virtually unaffected by dust, moisture, density changes, and temperature.

Typical Applications

Guided wave radar measurement is suitable for level control measurements in smaller silos, bins and hoppers with restricted access and, with its probe end projection feature, it is ideal for media with low dielectric properties.

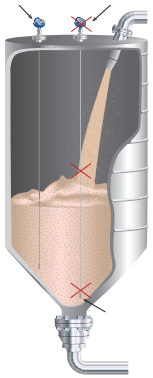
Mounting Considerations

Guided wave radar is especially well suited for smaller vessels with diameter <33 ft. (10 m) and connections as small as 1 in. (25 mm), containing powders and small granular materials and where the installation area is restricted. As vessel height increases, wear on the probe becomes more of a factor in the suitability of its use. Always install the probe in an empty silo and regularly inspect the probe for damage.

Positioning

Mount the probe as far away as possible from filling and emptying ports. This will minimize load and wear and will help to avoid disturbances from the incoming product

Nozzle



Keep the nozzle as short as possible (maximum recommended height = 4 in. (102 mm) + nozzle diameter). With taller nozzles, a long stud is recommended to prevent the probe from contacting the nozzle. Avoid larger diameter nozzles, especially in applications with low dielectric constants.

Probe anchoring

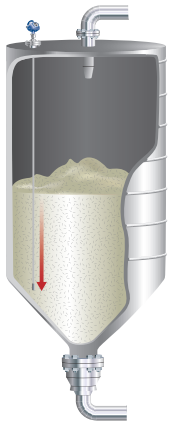
Best practice is to have a free-hanging probe, but an anchored probe is sometimes needed for application reasons. The probe end should not be fixed for 98 ft. (30 m) or longer probes. The probe must be slack when anchoring the probe to reduce the risk of probe breakage.

Electrostatic discharges

In some applications, such as plastic pellets, electrostatic charges can build up and eventually discharge. While the electronics can tolerate some static charge, providing a good earth ground for the electronics by anchoring the end of the probe will lead away the discharges from the electronics.

Pull forces

Exposing a flexible cable to moving solid material may result in excessive pull force on the cable that could result in probe breakage or roof collapse. These pull forces will vary with the material properties, height, and cable size and could impact the technology choice. It is also important to remember that the roof must withstand the probe's maximum tensile load. In general, this is more of a concern for taller vessels (> 49 ft./15 m) or heavier material (rocks).



Application Considerations

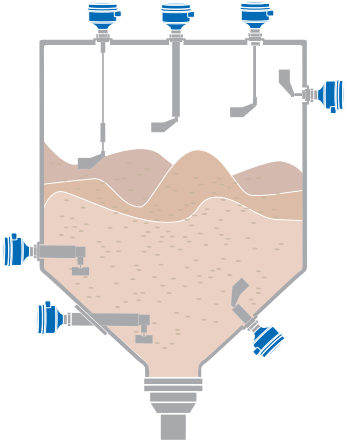
Advantages

- High filling and emptying speeds
- Enhanced signal strength for more reliable and robust measurements with Direct Switch Technology
- Handles long ranges and low DC down to 1.1 with Probe End Projection
- Signal Quality Metrics will aid in detection of dirty probes

Limitations

- Pull force dependent
- Wear on probe
- Inferred level/volume from one single point

Solids Level Switch - Rotating Paddle



Designed For All Kinds Of Solids

The simple electromechanical measuring principle withstands heavy loads and extreme temperatures, and is suitable for full, demand, or empty detection for all bulk media in all types of vessels. It is a simple, robust, and reliable technology that is insensitive to dust, electrical charge, adhesion, extreme temperature, and pressure.

Typical Applications

- Particularly suitable for small process vessels and most bulk solids
- Solids applications with high temperatures
- Solids applications with heavyweight media

Mounting Considerations

Simple and reliable measuring principle, easy and fast installation.

Positioning

- Vertical, horizontal, and oblique installation

Application Considerations

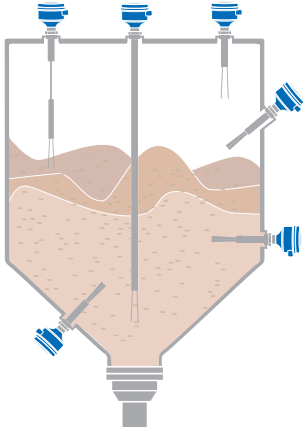
Advantages

- Self diagnoses – device fault alarm
- Adjustable switching delay prevents false switching
- Patented mechanical hysteresis for extended product lifetime
- Unaffected by dust, electrostatic charging, and caking
- Withstands heavy loads and high temperatures
- Rotatable electronics housing for easy installation
- Mechanically stable shaft-bearing design
- Robust die-cast housing with IP66 protection

Limitations

- Only measures level at one specific point

Solids Level Switch - Vibrating Fork



Level Measurement Of Solids Or Sediments In Liquids

Vibrating fork technology is suitable for fine-grained and powdered media in storage and process vessels where high sensitivity is needed. It is a robust technology with high sensitivity and is easy to operate. It has flexible options via configurable specifications for different applications. With an adjustable switching delay, false switching can be prevented.

Typical Applications

- Widely used in storage silos and process vessels/containers with limited space
- Materials with light product density, fine-grained, and powdered products
- Applications requiring pneumatic filling storage and process vessels where high sensitivity is required

Mounting Considerations

Simple and reliable measuring principle, easy and fast installation.

Positioning

- Vertical, horizontal and oblique installation

Application Considerations

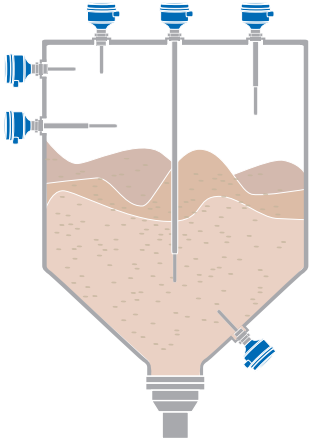
Advantages

- Able to withstand high mechanical loads due to short extension length
- Adjustable sensitivity
- Adjustable switching delay prevents false switching
- Approvals suitable for use in hazardous/ explosive, and dusty environments
- Reliable, simple, and maintenance free measurement principle
- All wetted parts made from stainless steel
- Robust die-cast housing with IP66 protection

Limitations

- Only measures level at one specific point
- Bridging if larger particles get stuck between forks

Solids Level Switch - Vibrating Rod



Reliable For Light Bulk Media And Powders

Vibrating rods are particularly suited for full, demand, and empty detection of fine grains and powders in storage and process vessels. They handle light solids and powders with ease and are suitable for use in hazardous and dusty environments. The simple design makes them reliable, maintenance-free, and less prone to clogging.

Typical Applications

- Widely used in storage silos and process vessels/containers with limited space
- Materials with light product density, fine-grained, and powdered products
- Applications requiring pneumatic filling. Full, demand, and empty detection of fine-grained and powdered materials
- Suitable for installation in hazardous/ explosive and dusty environments

Mounting Considerations

Simple and reliable measuring principle, easy and fast installation.

Positioning

- Vertical, horizontal, and oblique installation

Application Considerations

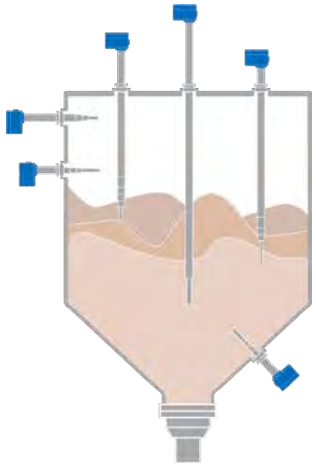
Advantages

- Not affected by grain size
- Not affected by bridging
- Approvals suitable for use in hazardous/ explosive and dusty environments
- All wetted parts made from stainless steel
- Good resistance to caking and clogging; reliable and maintenance free
- Reliable, simple, and maintenance-free measurement principle
- Small process connections
- Robust die-cast housing with IP66 protection

Limitations

- Only measures level at one specific point

Solids Level Switch - Capacitance Probe



Suitable For All Bulk Materials In All Applications

Operates by measuring the capacitance between the probe and container wall. It is robust and suitable for all bulk media in all types of vessels. It can be used for full, demand, or empty detection and is designed for low dielectric media and extreme conditions such as high temperatures, high mechanical stress, and high tensile forces.

Typical Applications

- Bulk solids in all applications, particularly suitable where there is risk of coating or if high vibration is present
- Ideal for sand, cement, and mining applications
- Suitable for use in extreme conditions, such as high temperature 932 °F (500 °C) and pressure applications

Mounting Considerations

Simple and reliable measuring principle, easy and fast installation.

Positioning

- Vertical, horizontal, and oblique installation

Application Considerations

Advantages

- Protects against media build-up or caking to ensure complete reliability
- Approvals suitable for use in hazardous/ explosive and dusty environments
- Withstands heavy loads and high temperatures
- Simple, automatic calibration via push button
- Continuous self-diagnostic probe function
- Easy to access parameters via local display and buttons
- Electronics housing made of plastic or die-cast aluminium, protection class IP67
- Measurement of low dielectric values (from 1.5)

Limitations

- Only measures level at one specific point

Technology Specifications

		Guided Wave Radar	Non-contacting Radar
Measurements	Unaffected by dust generation	●	●
	Unaffected by density	●	●
	Single point measurement	●	●
	Multiple point level measurement		●*
	Beam angle	NA	4.5-18°
Output	4-20 mA	●	●
	4-20 mA with HART®	●	●
	MODBUS®	●**	
	HART© Wireless	●	●
Performance	Maximum measuring range	164ft/50m	131ft/40m
	Reference accuracy	±0.1in/3mm	0.08in/2mm
Features	Air-purging		●
	Signal Quality Metrics	●	●
	Probe End Projection	●	NA
	Historian Event Log		●
Applications	Large warehouses, silos, domes etc.		●
	Small to mid-size silos	●	●
	Rapid level changes	●	●
	Inventory management		●
	Open air		●
	Control management	●	●
Process Temperature	-40 to 302 °F (-40 to 150 °C)	●	●
	-76 to 482 °F (-60 to 250 °C)		●

● Available
Using several devices
** Available for viewing information

		Rotating Paddle	Vibrating Fork	Vibrating Fork*	Vibrating Rod	Capacitance Probe
Measurement	Single point measurement	●	●	●	●	●
	Unaffected by dust generation	●	●	●	●	●
Output	Relay DPDT	●	●		●	●
	Relay SPDT	●		●		
	3-wire PNP		●		●	
Process Temperature	-40 to 302 °F (-40 to 150 °C)	●	●	●	●	●
	-40 to 932 °F (-40 to 500 °C)	●				●
	-40 to 2012 °F (-40 to 1100 °C)	●				

● Available
High sensitivity model

Recommended Technology - Continuous Level

Recommended solution for:	Grain Storage	Steep Tank	Corn Surge Bin	Gluten Meal Storage	Dextrose Storage	Starch Storage
Non-contacting Radar	●	●	●	●	●	●
Guided Wave Radar		●	●	●		●

Recommended Technology - Point Level

Recommended solution for:	Grain Storage	Steep Tank	Corn Surge Bin	Gluten Meal Storage	Dextrose Storage	Starch Storage
Rotating Paddle	●		●	●	●	●
Vibrating Fork	●			●		●
Vibrating Rod	●			●		●
Capacitance Probe	●	●	●	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Cocoa Bean Storage	Separated Shell Storage	Nib Storage	Alkalizer Storage	Cocoa Powder Storage
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar	●	●	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Cocoa Bean Storage	Separated Shell Storage	Nib Storage	Alkalizer Storage	Cocoa Powder Storage
Rotating Paddle	●	●	●	●	●
Vibrating Fork	●		●	●	●
Vibrating Rod	●		●	●	●
Capacitance Probe	●	●	●	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Wheat Storage	Temper Silos	Bran Storage	Germs Storage	Flour Storage
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar		●	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Wheat Storage	Temper Silos	Bran Storage	Germs Storage	Flour Storage
Rotating Paddle	●	●	●	●	●
Vibrating Fork	●		●	●	●
Vibrating Rod	●		●	●	●
Capacitance Probe	●	●	●	●	●

Recommended Technology - Continuous Level

Technology	Green Coffee Bean Storage	Roasted Coffee Beans	Ground Coffee	Instant Coffee
Non-contacting Radar	●	●	●	●
Guided Wave Radar	●	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Green Coffee Bean Storage	Roasted Coffee Beans	Ground Coffee	Instant Coffee
Rotating Paddle	●	●	●	●
Vibrating Fork		●	●	●
Vibrating Rod	●	●	●	●
Capacitance Probe	●	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Seed Storage	Hull Storage	Bleaching Storage
Non-contacting Radar	●	●	●
Guided Wave Radar		●	●

Recommended Technology - Point Level

Recommended solution for:	Seed Storage	Hull Storage	Bleaching Storage
Rotating Paddle	●	●	●
Vibrating Fork	●	●	●
Vibrating Rod	●	●	●
Capacitance Probe	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Grain Storage	Temper Silos	Sugar Storage	Spices and Flavoring	Cereal Storage
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar		●	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Grain Storage	Temper Silos	Sugar Storage	Spices and Flavoring	Cereal Storage
Rotating Paddle	●	●	●	●	●
Vibrating Fork	●		●	●	●
Vibrating Rod	●		●	●	●
Capacitance Probe	●	●	●	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Lime Silo	Sugar Beet/ Cane Storage	Waste Silo	Sugar Storage Silos	Packaging Silos
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar	●			●	●

Recommended Technology - Point Level

Recommended solution for:	Lime Silo	Sugar Beet/ Cane Storage	Waste Silo	Sugar Storage Silos	Packaging Silos
Rotating Paddle	●		●	●	●
Vibrating Fork			●	●	●
Vibrating Rod			●	●	●
Capacitance Probe	●		●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Flour Storage	Sugar Storage	Dough Mixer	Additives Storage
Non-contacting Radar	●	●	●	●
Guided Wave Radar	●	●		●

Recommended Technology - Point Level

Recommended solution for:	Flour Storage	Sugar Storage	Dough Mixer	Additives Storage
Rotating Paddle	●	●	●	●
Vibrating Fork		●	●	●
Vibrating Rod	●	●	●	●
Capacitance Probe	●	●	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level			
Recommended solution for:	Raw Grain Storage	Malted Grain Storage	Malting Silo
Non-contacting Radar	●	●	●
Guided Wave Radar	●	●	●

Recommended Technology - Point Level			
Recommended solution for:	Raw Grain Storage	Malted Grain Storage	Malting Silo
Rotating Paddle	●	●	●
Vibrating Fork			
Vibrating Rod	●	●	●
Capacitance Probe	●	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Stacker Positioning Monitoring	Raw Coal	Coal Storage	Coal Silos	Salt Bin
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar					●

Recommended solution for:	PAC Silo	ESP Hopper	Fly Ash Silo	Gypsum Bin	Lime Silo
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar	●	●	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Grain Storage	Corn Surge Bin	DDG Storage
Non-contacting Radar	●	●	●
Guided Wave Radar	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Grain Storage	Corn Surge Bin	DDG Storage
Rotating Paddle	●	●	●
Vibrating Fork	●	●	
Vibrating Rod	●	●	
Capacitance Probe	●	●	●

● Good ● Application dependent

Recommended Technology - Point Level

Recommended solution for:	Stacker Positioning Monitoring	Raw Coal	Coal Storage	Coal Silos	Salt Bin
Rotating Paddle		●	●	●	●
Vibrating Fork					●
Vibrating Rod					●
Capacitance Probe		●	●	●	●

Recommended solution for:	PAC Silo	ESP Hopper	Fly Ash Silo	Gypsum Bin	Lime Silo
Rotating Paddle	●	●	●	●	●
Vibrating Fork	●				
Vibrating Rod	●			●	
Capacitance Probe	●	●	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Wood Chips/ Wood Pellets/Sawdust
Non-contacting Radar	●
Guided Wave Radar	

Recommended Technology - Point Level

Recommended solution for:	Wood Chips/ Wood Pellets/Sawdust
Rotating Paddle	●
Vibrating Fork	
Vibrating Rod	●
Capacitance Probe	●

Recommended Technology - Continuous Level

Recommended solution for:	Cement Silos	Aggregate Silos	Mixer
Non-contacting Radar	●	●	●
Guided Wave Radar	●	●	

Recommended Technology - Point Level

Recommended solution for:	Cement Silos	Aggregate Silos	Mixer
Rotating Paddle	●	●	●
Vibrating Fork	●	●	
Vibrating Rod	●	●	
Capacitance Probe	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Polypropylene Storage	Polyethylene Storage
Non-contacting Radar	●	●
Guided Wave Radar	●	●

Recommended Technology - Point Level

Recommended solution for:	Polypropylene Storage	Polyethylene Storage
Rotating Paddle	●	●
Vibrating Fork	●	●
Vibrating Rod	●	●
Capacitance Probe	●	●

● Good ● Application dependent

Recommended Technology - Point Level

Recommended solution for:	Limestone Storage	Clay Storage	Pre-homogenizing Hall	Iron Ore and Sand Silo	Coal Storage
Rotating Paddle	●	●	●	●	●
Vibrating Fork				●	
Vibrating Rod				●	
Capacitance Probe	●	●	●	●	●

Recommended solution for:	ESP Hopper	Clinker Storage	Additives Storage	Cement Storage
Rotating Paddle	●	●	●	●
Vibrating Fork			●	●
Vibrating Rod			●	●
Capacitance Probe	●	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Limestone Storage	Clay Storage	Pre-homogenizing Hall	Iron Ore and Sand Silo	Coal Storage
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar				●	

Recommended solution for:	ESP Hopper	Clinker Storage	Additives Storage	Cement Storage
Non-contacting Radar	●	●	●	●
Guided Wave Radar	●		●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Salt Storage	PVC Powder	PVC Resins
Non-contacting Radar	●	●	●
Guided Wave Radar	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Salt Storage	PVC Powder	PVC Resins
Rotating Paddle	●	●	●
Vibrating Fork	●	●	●
Vibrating Rod	●	●	●
Capacitance Probe	●	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Polypropylene Storage	Polyethylene Storage
Non-contacting Radar	●	●
Guided Wave Radar	●	●

Recommended Technology - Point Level

Recommended solution for:	Polypropylene Storage	Polyethylene Storage
Rotating Paddle	●	●
Vibrating Fork	●	●
Vibrating Rod	●	●
Capacitance Probe	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Underground Ore Pass	Underground Storage Bins	Stationary Stacker	Rotary Stacker	Grizzly Bar Protection
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar					

Recommended solution for:	Crusher	Fine Ore Storage	Burnt Limestone Storage	Coal Storage	Sinter Ore Storage
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar		●		●	

Recommended solution for:	Powdered Metal Storage	Bentonite Clay Storage	Limestone Storage	Final Product Silos	Final Product Warehouse
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar	●				

Recommended Technology - Point Level

Recommended solution for:	Potassium Chloride Raw Material Silo	Crusher	Production and Sizing Bins	Storage Domes and Large Silos	Collection Warehouses
Rotating Paddle	●	●	●	●	●
Vibrating Fork					
Vibrating Rod	●		●	●	●
Capacitance Probe	●	●	●	●	●

● Good ● Application dependent

Recommended Technology - Point Level

Recommended solution for:	Underground Ore Pass	Underground Storage Bins	Stationary Stacker	Rotary Stacker	Grizzly Bar Protection
Rotating Paddle	●	●			●
Vibrating Fork					
Vibrating Rod					
Capacitance Probe	●	●			

Recommended solution for:	Crusher	Fine Ore Storage	Burnt Limestone Storage	Coal Storage	Sinter Ore Storage
Rotating Paddle		●	●	●	●
Vibrating Fork					
Vibrating Rod					
Capacitance Probe		●	●	●	●

Recommended solution for:	Powdered Metal Storage	Bentonite Clay Storage	Limestone Storage	Final Product Silos	Final Product Warehouse
Rotating Paddle	●	●	●	●	●
Vibrating Fork					
Vibrating Rod					
Capacitance Probe	●	●	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Crushed Limestone Silo	Sizing Screen Bins	Dust Collection Bins
Non-contacting Radar	●	●	●
Guided Wave Radar		●	●

Recommended solution for:	Quicklime Storage	Slacked Lime Powder
Non-contacting Radar	●	●
Guided Wave Radar	●	●

Recommended Technology - Point Level

Recommended solution for:	Crushed Limestone Silo	Sizing Screen Bins	Dust Collection Bins
Rotating Paddle	●	●	●
Vibrating Fork			●
Vibrating Rod		●	●
Capacitance Probe	●	●	●

Recommended solution for:	Quicklime Storage	Slacked Lime Powder
Rotating Paddle	●	●
Vibrating Fork		
Vibrating Rod	●	●
Capacitance Probe	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Ore Warehouse	Milled Ore Silos	Sizing and Storage Bins	Concentrated Talc Pellets Silo	Talc Powder Storage
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar		●	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Ore Warehouse	Milled Ore Silos	Sizing and Storage Bins	Concentrated Talc Pellets Silo	Talc Powder Storage
Rotating Paddle		●	●	●	●
Vibrating Fork				●	●
Vibrating Rod		●	●	●	●
Capacitance Probe		●	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Potassium Chloride Raw Material Silo	Crusher	Production and Sizing Bins	Storage Domes and Large Silos	Collection Warehouses
Non-contacting Radar	●	●	●	●	●
Guided Wave Radar	●		●		

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Stock Silo	Crushed Salt	Sizing Bins
Non-contacting Radar	●	●	●
Guided Wave Radar	●	●	●

Recommended solution for:	Final Salt Storage	Underground Storage Bins	Loading Bins
Non-contacting Radar	●	●	●
Guided Wave Radar	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Stock Silo	Crushed Salt	Sizing Bins
Rotating Paddle	●	●	●
Vibrating Fork		●	●
Vibrating Rod		●	●
Capacitance Probe	●	●	●

Recommended solution for:	Final Salt Storage	Underground Storage Bins	Loading Bins
Rotating Paddle	●	●	●
Vibrating Fork	●	●	●
Vibrating Rod	●	●	●
Capacitance Probe	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Raw Coal Stacker Position	Raw Coal Stockpiles	Coal Silo	Aggregates and Rocks
Non-contacting Radar	●	●	●	●
Guided Wave Radar				

Recommended Technology - Point Level

Recommended solution for:	Raw Coal Stacker Position	Raw Coal Stockpiles	Coal Silo	Aggregates and Rocks
Rotating Paddle			●	●
Vibrating Fork				
Vibrating Rod				
Capacitance Probe			●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Coal Storage	ESP Hoppers	Coking Coal Silo	Slag Storage
Non-contacting Radar	●	●	●	●
Guided Wave Radar	●	●	●	

Recommended solution for:	Limestone Storage	Sinter Ore Storage	Iron Pellets Storage
Non-contacting Radar	●	●	●
Guided Wave Radar	●		

Recommended Technology - Point Level

Recommended solution for:	Coal Storage	ESP Hoppers	Coking Coal Silo	Slag Storage
Rotating Paddle	●	●	●	●
Vibrating Fork				
Vibrating Rod				
Capacitance Probe	●	●	●	●

Recommended solution for:	Limestone Storage	Sinter Ore Storage	Iron Pellets Storage
Rotating Paddle	●	●	●
Vibrating Fork			
Vibrating Rod			
Capacitance Probe	●	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Coke Storage	Trona Ore Storage	Salt Storage	Soda Ash Storage
Non-contacting Radar	●	●	●	●
Guided Wave Radar			●	●

Recommended Technology - Point Level

Recommended solution for:	Coke Storage	Trona Ore Storage	Salt Storage	Soda Ash Storage
Rotating Paddle	●	●	●	●
Vibrating Fork			●	●
Vibrating Rod	●		●	●
Capacitance Probe	●	●	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level

Recommended solution for:	Bauxite Ore	Alumina Powder Storage
Non-contacting Radar	●	●
Guided Wave Radar		●

Recommended Technology - Point Level

Recommended solution for:	Bauxite Ore	Alumina Powder Storage
Rotating Paddle	●	●
Vibrating Fork		
Vibrating Rod		●
Capacitance Probe	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Dry Ingredients Silo	Finished Product Silo	Rejected Recycle Silo	Production Silo
Non-contacting Radar	●	●	●	●
Guided Wave Radar	●	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Dry Ingredients Silo	Finished Product Silo	Rejected Recycle Silo	Production Silo
Rotating Paddle	●	●	●	●
Vibrating Fork	●	●	●	●
Vibrating Rod	●	●	●	●
Capacitance Probe	●	●	●	●

Recommended Technology - Continuous Level

Recommended solution for:	Raw Material Storage	Batch Silos	Metal Oxide Storage
Non-contacting Radar	●	●	●
Guided Wave Radar	●	●	●

Recommended Technology - Point Level

Recommended solution for:	Raw Material Storage	Batch Silos	Metal Oxide Storage
Rotating Paddle	●	●	●
Vibrating Fork	●	●	●
Vibrating Rod	●	●	●
Capacitance Probe	●	●	●

● Good ● Application dependent

Recommended Technology - Continuous Level				
Recommended solution for:	Wood Chip Storage	Pre-steaming Wood Chip Silo	Lime Silo	High Density Pulp Stock
Non-contacting Radar	●	●	●	●
Guided Wave Radar			●	

Recommended Technology - Point Level				
Recommended solution for:	Wood Chip Storage	Pre-steaming Wood Chip Silo	Lime Silo	High Density Pulp Stock
Rotating Paddle	●	●	●	
Vibrating Fork				
Vibrating Rod	●			
Capacitance Probe	●	●	●	●

● Good ● Application dependent