A Guide To

Selecting the Right Magnetic Level Indicator

July 2003
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**Magnetic Level Indicators**

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Preface

Magnetic Level Indicators

Introduction

Companies in the process industry need the ability to visually monitor liquid levels in vessels (boilers, storage tanks, processing units, etc.). Traditionally, armored glass sight gauges have been used. However, many companies want an alternative to sight gauges to avoid problems such as breakage, leaks, or bursting at high pressures and extreme temperatures. In addition, the visibility of the sight glass can be poor and often affected by moisture, corrosion, or oxidation.

Magnetic level indicators (MLIs) do not have the shortcomings of glass sight gauges and are suitable for a wide variety of installations.

Organization

This handbook describes the configuration and operation of MLIs and provides information about their key components and features. Use this handbook as a resource when selecting the right MLI for a specific application.

Chapter 1 – Introducing the MLI
Provides an introduction to MLIs, describes the components, discusses the advantages of an MLI over a glass sight gauge, and offers some general questions to ask when selecting an MLI.

Chapter 2 – Indicator Types and Seals
Discusses principles of operation, MLI shuttle and flag indicator types, advantages and disadvantages of both indicator types, and guidelines for selecting an indicator for a specific application.

Chapter 3 – Floats and Chambers
Discusses the function of the MLI float and chamber, materials of construction and properties, and guidelines for selecting appropriate MLI floats and chambers.

Chapter 4 – Magnets
Provides an overview of magnets including properties, advantages and disadvantages; discusses the functions of magnets in an MLI; and provides guidelines to use when appraising magnets.
Chapter 5 – Transmitters
Describes the types of MLI transmitters available, presents an overview of the principles of operation for each type of transmitter, discusses the benefits and shortcomings of each, and provides guidelines for selecting an appropriate transmitter.

Chapter 6 – Accessories
Discusses typical accessories used with MLI devices and presents an overview of the operation of each accessory.

Chapter 7 – Orion MLIs
Describes the features of magnetic level indicators engineered and manufactured by Orion Instruments, presents information on various configurations of MLIs, discusses the benefits and limitations of each configuration, and provides guidelines for selecting the correct MLI configuration for a specific application.
Overview

The magnetic level indicator (MLI), also called a magnetically coupled liquid level indicator or a magnetic level gauge, is in widespread use throughout the process industries. Originally designed as an alternative to glass sight gauges, MLIs are now commonly used in new construction and plant expansions.

Typical applications include:
- Alkylation units
- Boiler drums
- Feedwater heaters
- Industrial boilers
- Oil-water separators
- Process vessels
- Propane vessels
- Storage tanks
- Surge tanks
- Wastewater tanks

Principle of Operation

Magnetic level indicators use the principle of magnetic field coupling to provide fluid level information, to activate a switch, or to provide continuous level data. Magnetic coupling allows an MLI to measure levels without direct contact between the indicator and the fluid in the vessel.

A magnetic field consists of the lines of flux surrounding a magnet. The field acts on other objects (magnets or ferromagnetic materials). When a magnetic field acts upon another object with sufficient force to move the object, the magnet is said to be magnetically coupled with that object.
In an MLI, the magnets within a float and an indicator are magnetically coupled. The float, located inside a chamber, tracks the surface of the liquid. A magnet or magnet assembly inside the float creates a magnetic field, which penetrates the chamber wall to couple with the magnetic field created by the magnets in the indicator flags that display the fluid level.

**MLI Mounting Styles**

There are three primary MLI mounting styles, each with slightly different mechanics:
- Side mount
- Top mount
- Top-in, bottom-out mount

**Side Mount**

The side-mount MLI in its simplest configuration has two process connections, a fluid-filled chamber with flanges and/or caps on the top and bottom, a float, and an indicator.

The float, equipped with a magnet assembly, is weighted to operate accurately at the specific gravity of the fluid to be measured. The float moves in a non-magnetic chamber as the fluid inside rises and falls with the level of the liquid in the vessel.

A column containing a glass tube or window is attached to the external wall of the float chamber. Inside the glass is a highly visible indicator (shuttle or flags). The indicator is always magnetically coupled to the float so that it indicates the exact level of the fluid in the vessel.
Introducing the MLI

When the fluid level in a vessel changes, the corresponding level in the chamber changes as liquid moves through the process connections located at the top and bottom of the desired indication range. Any change in the chamber liquid level affects the position of the magnetic float. As the float moves, the magnetic field surrounding the float moves, and directly affects the position of the shuttle or flags in the indicator.

Top Mount

The top mount MLI in the simplest configuration has a chamber with a single flange at one end and a machined cap at the other, a float assembly that hangs below the chamber, and an indicator column. The float assembly consists of a magnet at the top of a guide rod and a float at the bottom. The float assembly is weighted to operate at the specific gravity of the fluid to be measured. A float guide tube, also called a stilling well, is often used within the vessel to prevent bending of the rod during operation when stirring, agitation, or when processing turbulence may be present in the vessel.

As the fluid level changes in the vessel causing the float to move, the magnet, attached to the end of the rod, travels up and down within the chamber. As the magnet moves, the surrounding magnetic field directly affects the position of the shuttle or flags in the indicator and the display represents the fluid level in the vessel.
Top-In, Bottom-Out Mount

This configuration has flanges at the top and bottom of the chamber, which are connected to the vessel. The indicator column is attached to the chamber, and its display represents the fluid level in the vessel.

The top-in, bottom-out mount is commonly used in capsule and spherical-shaped vessels that are filled at the top and emptied from the bottom of the vessel. The chamber usually spans the entire height of the vessel and does not require additional space above the vessel like a top-mounted unit.

Two-Layer Level Measurement

In vessels containing two liquids, MLI devices are able to measure the total fluid level in the vessel as well as the level of the interface between the two liquids. The location of the interface can be determined if the depth of the upper layer is great enough to allow a second float to operate in the chamber and the specific gravities of the two layers are sufficiently different to allow for proper design of the lower float.
Introducing the MLI

One float is weighted to operate at the specific gravity of the upper media and the second float is sized and weighted to submerge to and track the interface between the upper and lower media. Shuttle 1 is magnetically coupled to float 1 and shuttle 2 is magnetically coupled to float 2. Shuttle 1 indicates the position of the total level in the vessel and shuttle 2 indicates the position of the interface layer. The floats move in the chamber independently as the two fluids rise and fall with the levels of the two media in the vessel.

Advantages of the MLI

A magnetic level indicator is often used in applications where a glass sight gauge is unsafe, environmentally risky, or difficult to see. Typical shortcomings of sight glass gauges include:

- High pressures, extreme temperatures, and toxic or corrosive materials may cause a risk of fugitive emission of dangerous substances.
- Some chemical materials within a process vessel or storage tank can attack the glass, causing discoloration of the sight gauge, thus decreasing level visibility.
- Liquid-liquid interfaces can be very difficult to read in a sight glass particularly if the fluids are of similar color. Clear liquids are also difficult to see in a sight glass.

The key reasons for selecting an MLI over a sight glass are:

- Improved safety
- Reduced maintenance
- Increased visibility
- Easier initial installation and addition of transmitters and switches
- Lower long-term cost of ownership

Safety

The obvious safety benefit of the MLI over a sight glass is reduced chance of breakage. If the process fluid is under extreme pressures or temperatures, the likelihood of sight glass breakage increases. The pressure boundary of an MLI is made of robust metal, frequently the same as the vessel piping, making MLIs as safe and strong as the vessel. The indicators, transmitters, and switches are all mounted externally and, therefore, are unaffected by toxicity, corrosiveness, or other process fluid characteristics.

Another safety benefit is that the chemical compatibility with the fluid in an MLI indicator is restricted to only three components, the metallic chamber, gaskets and float. With glass sight gauges, the process fluid may have chemical compatibility issues with any of the wetted materials—glass, metal, or sealants.
Magnetic Level Indicators

Maintenance

MLIs are virtually maintenance free once installed, because the indicator never touches the process fluid. With sight glasses, the gauges must be periodically checked for leaks and cleaned. Scale and build-up on the glass from the process fluid can cause the sight glass to become unreadable.

Visibility

Visibility of the fluid level from long distances is another major reason for selecting an MLI over a sight glass gauge. Sight gauge level indicators are intended to be viewed at maximum distances of around 10 feet (3 m). However, the bright contrasting colors of the flags or a fluorescent shuttle on an MLI permit visible level indication at distances up to 100 feet (30 m).

Installation and Flexibility

Installing an MLI is much simpler than installing a sight glass gauge. In many cases sight glass gauges are only available in 12 inch (305 mm) lengths, due to glass weakness. Therefore, when a range of 30 inches (762 mm) is needed, three glass sights are required. If the required visible indication length is increased, additional sight gauges are needed and the potential risk for leak points increases. This setup requires complicated fittings, and at least six isolation valves. A single MLI can replace this assembly as shown in the following illustration.

Once installed, a glass level gauge is often difficult to set up, add to, or change. However, the indicators in the Orion Atlas and Gemini MLIs can easily be rotated, even after installation, by simply loosening the straps, repositioning the indicator, and retightening the straps.
Glass level gauges provide only visual level indication so additional devices (e.g., indicators, switches, or transmitters) are often needed to increase visibility or for remote monitoring. The sight glass gauges require long process stoppage and complicated dismantling and reconfiguring to add these items. MLIs can provide higher visible level indication and permit the simple addition of equipment like switches or transmitters at any time, because they are externally mounted and magnetically operated by the float.

Selecting the Right MLI

Selecting the appropriate MLI for a specific application is important. Use these questions to review your requirements and establish a set of criteria for selecting the right MLI for the application. The remaining chapters in this guide provide key information about the components of an MLI to help you make informed MLI decisions.

What is the process fluid?
- specific gravity
- operating temperature
- operating pressure
- total, interface or dual-level detection

What are the gauge body details?
- material of construction
- maximum pressure requirement
- necessary level range (fluid fluctuation—often the vessel height)
- vent and drain connections

What are the process connection details?
- size
- type
- rating
- orientation/position

What type of indicator is preferred?
- flag (orange/black, yellow/black, red/white)
- shuttle
- color(s)

What measuring scale is required?
- level (inches, feet, meters)
- volume (gallons, liters, custom)
- percent
What accessories are necessary?

- switch function and type
- level transmitter
- frost extension (required for cryogenic applications)
- heat trace
- high or low-temp insulation
- magnetic traps
- gauge glass

Notes
This chapter provides information on the operation of shuttle and flag indicators and the importance of indicator sealing methods. It also provides guidelines for selecting the right indicator for your application.

**Indicators**

The indicator is the part of an MLI that visually displays the level measured by the float inside the column. The indicator is located on the outside of the chamber and is magnetically coupled to the float. The indicator may be a glass tube or a metal channel with a flat glass front. The float follows the surface of the process fluid and follows the level of the fluid. The indicator must be positioned close to the chamber so that the magnetic field of the float and the indicator can be coupled, but not so close that process conditions affect the indicator adversely.

The chamber minimizes the effects of turbulent process conditions within the vessel that can adversely affect the float or indicator. Where process level is turbulent due to mixing, filling or emptying of the vessel, the chamber minimizes these actions, keeping the float from violent vertical movement and erratic indication.

**Types of Indicators**

There are two main types of indicators—shuttles and flags.

**Shuttle**

The shuttle (bullet or follower) indicator consists of a follower with an imbedded magnet, or piece of ferromagnetic material, that moves freely in a glass column attached to the vessel.

The glass column is isolated from the MLI chamber that contains the process fluid. Therefore, the shuttle is not in contact with the process fluid. When the fluid level in the vessel changes, the level in the attached chamber also changes.

The shuttle is magnetically coupled to the magnet in the float. As the float moves up or down with level, it drags the shuttle along in its magnetic field. The shuttle is brightly colored so that it can be seen from great distances.
The shuttle level indicator is often used in lower cost configurations and must be used in dual-level units. It provides a visual indication that is suitable for many applications, except where flashing or extreme turbulence occurs within the process vessel. These sudden changes can cause the float to become magnetically decoupled from the shuttle. The shuttle must then be reset to ensure proper level indication. The reset process involves raising the shuttle with an external magnet to recouple the shuttle to the magnetic field of the float.

**Flag**

The flag indicator gets its name from a system of small strips of material with contrasting colors on opposite sides. As the float moves up or down with the fluid level in the vessel, each flag rotates to display a color that corresponds to its orientation with respect to the magnetic field of the float. Flags above the float magnet will be oriented with the front of flag visible, while the flags below the float magnet will have the back of flags visible in the indicator.

Flags, also called flappers, can be made of plastic or metal with each flag containing a small magnet or other magnetic material. The magnet may be an embedded vertical magnet, a less expensive flexible style magnet, or embedded magnetic particles.

The flags are mounted on pivots and are equally spaced inside the column. As the magnetic field of the float moves up or down when the fluid level in the vessel changes, the flags affected by the magnetic field of the float rotate to display a contrasting color representative of the liquid level.

Flag indicators are more robust than shuttle indicators. The metal channel with the flat glass window is extremely durable. Also, the flags will stay coupled to the float’s magnetic field during sudden and rapid level change that may result in decoupling of a shuttle indicator.
Selecting the Right Indicator

When deciding whether to use a shuttle or a flag indicator for a specific application, consider the cost, durability, visibility, and maintenance requirements.

Usually a shuttle indicator is a more cost-effective item and can be adapted to show the overall liquid level and the fluid interface level on the same indicator. The flag indicator is easy to see from a distance, operates effectively at higher temperatures, and does not suffer from decoupling.

<table>
<thead>
<tr>
<th>Indicator Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shuttle</td>
<td>Lower cost</td>
<td>Risk of decoupling during flashing or sudden fluid level changes</td>
</tr>
<tr>
<td></td>
<td>Can show overall level and fluid interface level on same indicator using two shuttles</td>
<td>Less durable tubular glass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited to lower temperature service</td>
</tr>
<tr>
<td>Flag</td>
<td>Reduced risk of decoupling</td>
<td>Higher cost</td>
</tr>
<tr>
<td></td>
<td>Metal rail with flat glass front provides additional strength and security</td>
<td>Larger seal area</td>
</tr>
<tr>
<td></td>
<td>Easy to read from greater distances</td>
<td>Plastic flags can warp or stick</td>
</tr>
<tr>
<td></td>
<td>Metal flags allow operation at higher temperatures</td>
<td></td>
</tr>
</tbody>
</table>

Orion Indicators

Orion MLIs are available with shuttle or flag indicators.

The shuttles in Orion indicators are brightly colored so they can be seen from a distance of 100 feet (30 m). Fluorescent orange with a black line to mark liquid level is standard. To reduce the occurrence of magnetic decoupling, the shuttles in Orion MLIs contain very highly charged magnets, and the floats make use of a flux ring configuration which enhances the float magnetic field.

In Orion flag indicators, high-quality, embedded vertical magnets are used in the flags instead of the less reliable alternatives. The flags incorporate a locking mechanism to prevent accidental flipping due to vibration or other motions.

Orion flags and pivot axes are always made of identical materials to prevent any binding that might result from different thermal expansion rates. Compared to plastic flags, metal flags are of higher quality and are more reliable because metal-to-metal contacts yield less pivot resistance, can withstand higher temperatures (up to +1000°F [+538°C]), and are more resistant to twisting or warping.
Indicator Sealing Methods

MLI indicators may be sealed or unsealed. In some situations, a valve-sealed MLI may be the appropriate choice.

Unsealed

Unsealed indicators are less expensive, but ambient conditions can affect or damage the indicator. Unsealed indicators should not be used outdoors or in a location where moisture or freezing temperatures may exist. Indicators with an unsealed column may accumulate moisture and freeze, restricting the movement of the shuttle or preventing the flags from rotating on their axes.

In some environments, moisture or oxidation can cloud the glass of the indicator column and reduce visibility. Deposits may build up on the inside of the glass and block the view of the shuttle mark or the flag's flip point. In addition, foreign material or damage from ambient corrosives may impair the pivot action of the flags.

Sealed

Sealed indicators are not affected by environmental conditions. However, oxidation within the indicator may still cause glass or indicator discolorations over time, particularly at high temperatures.

Valve-Sealed

Valve-sealed indicators have an evacuation valve at the bottom of the indicator that allows oxygen and moisture to be removed, and a low, positive pressure of inert gas to be inserted. The inert gas eliminates problems such as reduced visibility and responsiveness caused by oxidation. In addition, pressurization with an inert gas solves most flag sticking problems because moisture and debris in the column are eliminated.
Indicator Types and Seals

Selecting the Right Indicator Seal

Cost and operating environment are two important considerations when deciding whether to use an unsealed, sealed, or valve-sealed indicator. Although the unsealed column is the lowest cost option, it exposes the indicator to the surrounding environment. If cold temperatures, high moisture, or corrosive conditions are present, a sealed or valve-sealed indicator is the better choice.

<table>
<thead>
<tr>
<th>Indicator Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsealed</td>
<td>Less expensive than sealed or valve-sealed</td>
<td>Ordinary environment may damage or affect the indicator; Glass clouding may occur due to oxidation or moisture</td>
</tr>
<tr>
<td>Sealed</td>
<td>Less expensive than valve-sealed</td>
<td>Moisture may cause lock-up of flag indicators at low temperatures; Oxidation may occur at high temperatures</td>
</tr>
<tr>
<td>Valve-sealed</td>
<td>Oxygen is replaced with inert gas to reduce oxidation; low positive pressure minimizes the presence of moisture</td>
<td>More expensive than sealed or unsealed</td>
</tr>
</tbody>
</table>

Orion Sealed Indicators

All Orion MLI indicators are sealed and purged with an inert gas to prevent condensate buildup and discoloration due to direct sun exposure. The indicator rail/glass assembly is sealed with the unique, Insta-seal™ valve method.
Notes
This chapter describes the function of the float and chamber in the operation of a magnetic level indicator. It also discusses the types of floats and chambers available and provides guidelines for selecting the appropriate MLI float and chamber.

**Float**

The float is a strong canister that is engineered for the temperature and pressure conditions of an application and designed to operate in the specific gravity of the fluid to be measured. The float rides on the surface of the process fluid and follows the level of the fluid.

The float interacts magnetically with an indicator on the outside of the chamber to show the fluid level inside. Transferring the fluid level information using the float’s magnetic field isolates the level indicator from the pressure and corrosive properties of the process media allowing for longer-lasting, error-free operation of the MLI. The interaction between the float and the indicator differs in a side- or top-mounted configuration.

In a side-mounted configuration, the float is located inside a chamber connected to the vessel. The float contains a system of magnets that form a strong magnetic field, which couples with a shuttle or set of flags in the indicator to transmit the position of the float to the fluid-level indicator. (See Chapter 2, Indicators and Column Seals, for more information.)

In a top-mounted configuration, the float is located inside the vessel and does not contain magnets. Instead, it is mechanically connected by a rod to a magnet in a chamber on top of the vessel. As the float moves up or down within a guide tube, the magnet attached to the top of the rod moves, and like the side-mounted magnetic connection, the indicator displays the fluid level.
Selecting the Right Float

The float must be designed to function at the maximums of the temperature and pressure ranges of the process fluid in the vessel. Further, it must be manufactured to provide accurate indication for the specific gravity of the application. If the specific gravity of the process fluid varies, it may be necessary to calibrate the float for the minimum specific gravity and calculate the variance in float levels with changes in specific gravity so that a level-measurement error can be determined.

The materials and design chosen for a float depends on cost, the process conditions and media properties, such as temperature, pressure, and corrosiveness. Many MLIs are installed in extreme environments, so the materials and design of the float can affect level indication performance.

Orion Floats

Orion floats are made from a wide range of strong alloys including stainless steel, titanium, Hastelloy C-276, Inconel, Alloy 20, fiberglass and various durable plastics. These materials allow for use in a wide range of pressure requirements. Orion's high-pressure ball float can be used in applications up to 5000 psig (345 bar) in a non-vented design. The metallic floats are precision welded by a pulse TIG or electron beam process. Specific gravity and serial number data are engraved onto every float to ensure accuracy. Floats may be TFE coated for slip resistance.

Orion floats feature a retainer ring that precisely aligns the vertical magnets. The 360° vertical placement of the magnets ensures proper magnetic coupling with the flag or shuttle of the indicator, even as the float turns within the chamber. A flux ring ensures a constant, long-lasting, gauss rating even at temperatures of +1000° F (+538° C).

Float Projection vs. SG

Length of float below liquid level

<table>
<thead>
<tr>
<th>S.G.</th>
<th>Float Projection, in (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.60</td>
<td>10.00 (25)</td>
</tr>
<tr>
<td>0.70</td>
<td>9.00 (23)</td>
</tr>
<tr>
<td>0.80</td>
<td>8.00 (20)</td>
</tr>
<tr>
<td>0.90</td>
<td>7.00 (18)</td>
</tr>
<tr>
<td>1.00</td>
<td>6.00 (15)</td>
</tr>
<tr>
<td>1.10</td>
<td>5.00 (13)</td>
</tr>
<tr>
<td>1.20</td>
<td>4.00 (10)</td>
</tr>
</tbody>
</table>

Float Curve

The float rides with the magnet ring at the liquid surface, and about 2/3 or more of the float is submerged. The amount of submergence, and the buoyancy safety factor vary with S.G., as you can see from the float curve below. Orion floats are typically designed for a buoyancy safety factor of 75 grams (2.6 oz) to ensure reliability.
Buoyancy can be determined using Archimedes principal. (S.G. x submerged float volume in CC) – float weight in grams. A sufficient buoyancy safety factor helps ensure reliability despite friction or light build up that may occur under some conditions.

**Chamber**

The chamber guides and protects the float. In a side-mounted MLI, the chamber is located outside the process vessel. In a top-mounted MLI, the chamber is located on the top of the vessel and guide rods provide protection to the rod attached to the float.

The chamber is constructed of a non-magnetic material that can withstand the temperature and pressure ranges of the process fluid being measured. Typically, the chamber is made of the same materials as the process vessel and piping.

Caps or flanges are built into the top and bottom of the chamber, and are usually made of the same material as the chamber. The flanged version consists of a flange welded to the end of the chamber and a blind flange bolted to it. A plugged vent or drain connection is provided in the cap or flange. Dome caps and flanges often contain shock springs to prevent float damage during rapid level movement. Flanges allow for cleaning and float removal or replacement.

**Selecting the Right Chamber**

The design and materials for chambers are chosen based on cost, the required process temperatures and pressures, and the cleanliness and corrosiveness of the process fluid. The construction and interaction of both the float and chamber affect level indication performance. Chambers must withstand the same conditions as the vessel and still allow for adequate level indication.

The chamber should be made of non-magnetic materials so that hysteresis (the transfer of magnetic properties from one metal to another through rubbing) does not occur between the float magnet and chamber. The chamber, connected to the vessel by isolation valves, should be installed with a vent plug and a drain valve that comply with the plant piping standards.
Often, dome caps are used at the top of the chamber. Flanges are typically used at the bottom of the chamber to allow for cleaning or float removal. Whether dome caps or flanges are installed, the chamber should contain shock springs at the top and bottom to prevent float damage during rapid movement.

**Orion Chambers**

Orion metal chambers are constructed of corrosion resistant, NACE MRO 175 conforming materials with hardness values below required levels. Orion uses its in-house Rockwell Hardness Tester to assure NACE compliance. This testing is standard on all NACE units and performed by Orion technicians. Most other companies subcontract this testing.

The chambers are made of non-magnetic materials that always conform to ASME B31.1 and B31.3 standards and may have optional vent and drain ports installed. Flanges are available instead of caps. All chambers have shock springs on the top and bottom for added protection for the float during shipment, normal operation, and particularly during chamber filling.

**Notes**
Magnets in an MLI

Magnets in MLI devices are located within the float and as part of the indicator. The magnets in the float are positioned at the process fluid level. The float’s magnetic field conveys the level information through the chamber wall to either a shuttle or a system of flags in the indicator. This transfer of fluid level measurement using the magnetic field isolates the column’s level indicator from possible harsh properties (e.g., temperature, pressure, corrosiveness, turbulence) of the process fluid in the vessel.

A stable, high-gauss field is critical to reliable operation. A series of magnets, precisely aligned around the inside diameter of the float, creates a 360° field. A magnetic flux ring adds rigidity and strength to the design and enhances the magnetic field.

In MLIs that use flags, magnets are placed within each flag to couple it with the magnet in the float and flip the flag to indicate fluid level. In addition, the flag magnets prevent erroneous movement of the flags that might result from vibrations or other motions of the process vessel. Flags below the float are magnetically locked into the flipped position. If a problem does occur and the flags do not pivot with the change in level, the flags within the column can be reset using an external magnet.
Types of Magnets

Man-made magnets have been in use for two centuries. Over the last 100 years, special alloys have been developed to increase magnet performance. Modern magnets are made of a wide range of materials. In industrial applications, the most commonly used materials are grouped into four classes:

- Aluminum-nickel-cobalt (alnicos)
- Strontium-iron (ceramics)
- Thermoplastic (flexibles)
- Neodymium-iron-boron and samarium-cobalt (rare earths)

Each of these materials has various strengths and weaknesses when processed into a magnet. No single magnet type is perfect for all MLI applications.

Alnico

Alnico, one of the first magnet materials to be developed, was commercially available in the early 1900s. Alnico is an alloy of aluminum, nickel, and cobalt. These magnets are generally made by casting, although the powder metallurgy sintering process is most suitable for the smaller magnets of an MLI.

The advantages of an Alnico magnet include excellent thermal stability, high corrosion resistance, and ease of magnetization. Alnico magnets can be magnetized even after the float is manufactured, which is important because the manufacturing process, especially first welding of the float, can affect magnetic properties.

The disadvantages of an Alnico magnet are the high cost of the base alloy and its inability to hold its magnetization when it interacts with other strong magnetic fields.

Ceramic

Ceramic magnets made of strontium-iron are also known as hard ferrites. They have a natural black color and the cost of the raw material is relatively low.

The advantages of a ceramic magnet in an MLI are its good magnetic performance and ability to withstand high temperature (up to +750° F [+399° C]) without demagnetizing. The main disadvantage of ceramic magnets is the manufacturing cost. Expensive diamond wheels must be used to cut and size each piece before it is magnetized.
Magnets

**Flexibles**

Flexibles are magnetic materials made from a thermoplastic product. They are dark brown in color and are the only magnets that can be bent and flexed without a loss of magnetic performance.

The advantages of a flexible magnet in an MLI are the ability to conform to the contour of a surface and the ease of magnetization. The main disadvantage of these magnets is an inability to hold magnetization at high temperatures.

**Rare Earth**

Rare earth magnets include samarium-cobalt (SmCo5) and neodymium-iron-boron (NdFeB) magnets. SmCo5 magnets were developed in the 1960s. They provide increased energy and coercive force over existing magnets and have resulted in new applications for magnets. In 1983, NdFeB magnets were developed, and they doubled the magnetic capabilities of the previous rare earth magnets. These magnets are produced by a powder metallurgy process and magnetization is done during processing.

The main advantage of rare earth magnets is that they hold their magnetism and provide higher coercive force. The primary disadvantage of rare earth magnets is that they are susceptible to breakage and normally limited to operating temperatures below +300° F (+149° C).

**Selecting the Right Magnet for an MLI**

When selecting a magnet for an MLI, consider the process conditions under which it will be used. Selecting the right magnet is not as simple as using the magnet with the greatest field strength. Good engineering practice requires balancing the magnetic field strength against the application. If too high a field strength is used, significant hysteresis may result due to excessive friction between the float and the chamber wall, causing reduced float life. In addition, the buoyancy safety factor of the float may lower due to its strong coupling to the shuttle or flag magnet.

Consider the following:

- **Operating temperature**
  What is the maximum temperature the magnet will encounter in the intended media process?

- **Magnetic field strengths**
  Can the field reliably activate the indicator through the chamber wall?

- **Magnet lifetime**
  Will the magnet become demagnetized or remagnetized during use?
**Temperature**

High temperatures can greatly affect the magnetic field of a particular magnet. Alnico 5 offers the highest temperature capabilities (+1000°F [+538°C]) of all the permanent magnet materials. A rare earth magnet, such as Neodymium 30, is more difficult to demagnetize than alnicos, but has a normal operating temperature of only +175°F (+79°C).

**Field Strength**

When evaluating magnets for an MLI, it is important to remember that stronger is not necessarily better. The strength of the magnetic field can be too great and cause excessive wear to the chamber and float, as well as put greater stresses on the flags or bullet. Also significant hysteresis, due to chamber/float rubbing, may shorten the life of float magnets. In some applications, a strong field may be necessary due to thick chamber walls or heavy external insulation. In this case, a rare earth magnet can be used, as long as the temperature is not too high and the material strength is sufficient for the application.

**Magnetic Lifetime**

Modern magnets have long magnetic lifetimes. For example, experimentation has shown that the SmCo5 magnet loses less that 1% of its magnetic field over a period of 10 years. Most magnets, when stored away from heat, humidity, radiation, electric currents, power lines, and other magnets, will retain their magnetism for well over 100 years. However, the alnico group of magnets can be affected by external magnetic fields at higher temperatures, thus accelerating the loss of magnetic field strength.

The following table compares the magnetic field strengths and the operating temperatures for various magnetic materials commonly used in MLI devices.

**Properties Table**

<table>
<thead>
<tr>
<th>Magnet Class</th>
<th>Magnet Material</th>
<th>Maximum Energy Product (BH)</th>
<th>Residual Flux Density (Gauss)</th>
<th>Coercive Force (Oersteds)</th>
<th>Maximum Operating Temperature (°F/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alnicos</td>
<td>Sintered 2</td>
<td>1.7</td>
<td>7100</td>
<td>560</td>
<td>1000/538</td>
</tr>
<tr>
<td></td>
<td>Sintered 5</td>
<td>3.9</td>
<td>10900</td>
<td>620</td>
<td>1000/538</td>
</tr>
<tr>
<td></td>
<td>Sintered 8</td>
<td>4</td>
<td>7400</td>
<td>1500</td>
<td>1000/538</td>
</tr>
<tr>
<td></td>
<td>Cast 5</td>
<td>5.5</td>
<td>12800</td>
<td>640</td>
<td>1000/538</td>
</tr>
<tr>
<td></td>
<td>Cast 8</td>
<td>5.3</td>
<td>8200</td>
<td>1650</td>
<td>1000/538</td>
</tr>
<tr>
<td>Ceramics</td>
<td>Ceramic 1</td>
<td>1</td>
<td>2300</td>
<td>1860</td>
<td>750/399</td>
</tr>
<tr>
<td></td>
<td>Ceramic 8</td>
<td>3.5</td>
<td>3900</td>
<td>2950</td>
<td>750/399</td>
</tr>
</tbody>
</table>
For many applications, alnico is the best choice because it is rugged and it can withstand elevated operating temperatures (1000° F [538° C]). The disadvantages are the relative high cost of the base alloy and the ease of demagnetization, particularly if other strong magnetic fields interact with it.

Alternatively, where the magnetic field must penetrate thick pipe walls and heavy external insulation, a rare earth magnet with properties of high energy and a high flux field is a good choice. The tradeoffs for selecting a rare earth magnet are reduced operating temperature and reduced lifetime.

Although NdFeB magnets are lower in cost and have a higher energy, there are many times when SmCo magnets are a better choice due to their higher temperature performance and better corrosion resistance.

**Orion Magnets**

Orion can recommend the right magnet for a specific MLI application.

For high temperature applications, Alnico is the best choice. Orion has a great deal of confidence in this type of magnet and uses it most frequently for their float magnets.

Orion has an in-house magnetizer. Therefore, Orion has the advantage of being able to weld de-magnetized magnets in place, then magnetize the float after fabrication.
Notes
Transmitters provide continuous signals that allow the user to remotely monitor process fluid levels without direct exposure to the liquid. A transmitter can be used together with a magnetic level indicator to provide an electronic output in addition to visual indication of the liquid level.

**MLI Transmitters**

Combining a transmitter with a magnetic level indicator provides level-measurement redundancy. In addition to the visual readouts displayed on the shuttle- or flag-type indicator, a transmitter can be added to provide level measurement as well as remote monitoring of process vessel fluid levels.

The transmitter sends a signal that is proportional to the fluid level in the vessel to a computer, PLC, or other output device. Depending on the type of transmitter used, the level is sensed directly from the fluid level in the chamber (which is the same as the level in the vessel) or the level is sensed from the position of the float in the chamber.

**Transmitter Types**

Three transmitter types often are used with MLIs:

- Reed chain
- Magnetostrictive
- Guided wave radar

**Reed Chain Transmitter**

The reed chain transmitter consists of a series of point level control devices (switches) along a resistor chain. As the MLI float moves up or down with the change in fluid level in the vessel, the magnetic field of the float magnet closes reed switches across fixed resistors. A closed reed switch changes the resistance in the circuit. The total measured resistance is proportional to the liquid level. The resistance is converted to a 4–20 mA signal. Since the signal is incrementally based on resistor length, the reed chain transmitter is limited in resolution when compared with other continuous level measurement devices such as a guided wave radar transmitter.
In short lengths, the reed chain transmitter is less expensive than other options. It is externally mounted and can be added or removed at any time without interrupting the process. Typically, the reed chain transmitter attaches to the MLI float chamber using field adjustable clamps. Because the analog transmitter is activated by the float’s magnetic field, it is non-invasive and allows for years of maintenance free service.

**Magnetostrictive Transmitter**

A magnetostrictive transmitter operates on the time-of-flight principle. A low-energy pulse from an electronic head assembly is sent down the sensor along a magnetostrictive wire. When the pulse intersects the magnetic field of the MLI float, a small distortion is produced in the wire. This distortion causes an acoustic signal to return to the electronic assembly. This return signal is detected by the acoustic sensor located within the MLI’s electronics housing. A timer precisely measures the elapsed time between the generation of the pulse and the return of the mechanical or acoustic signal.

The time it takes for the signal to reach the receiver is measured and is converted into a 4–20 mA signal that is proportional to the process fluid level. The signal can be sent to a remote display, a local indicator, or an analog input channel. At the remote display, an operator can view the actual liquid level as the percentage of level, height of level, or other signal value. The magnetostrictive transmitter is also mounted using clamps to the outside of the MLI chamber.
Guided Wave Radar Transmitter

Guided wave radar (GWR) transmitters also operate on the time-of-flight principle that combines time domain reflectometry and equivalent time sampling. The GWR consists of a transmitter-receiver and a probe or waveguide. The probe, which is in contact with the fluid in the chamber, directs and controls the radar signal. It offers an efficient path for the signal to travel down to the surface of the fluid and back.

The probe can be a single rod, twin rods, or a coaxial waveguide. MLIs with only one chamber use a coaxial-type probe in the same chamber as the MLI float. MLIs with the twin-chamber design can use a single rod, twin rod, or coaxial probe in either chamber design. The GWR is internal and detects the media level directly. It offers a redundant level output that is independent of the float and indicator.

The transmitter sends radar signal pulses down the probe. The signal pulses reflect from the surface of the liquid in the float chamber and return back along the probe to the receiver. The level of fluid in the vessel is calculated from the time it takes for a pulse emitted from the transmitter at the top of the probe to reflect from the surface of the liquid and be detected by the receiver.

Selecting the Right Transmitter

When selecting a transmitter to use with an MLI, consider the cost, accuracy, range of level measurement, and process conditions under which it will be used. Specifications of Orion reed chain, magnetostrictive, and guided wave radar transmitters that can be used with MLI devices is summarized in the next section. The advantages and limitations of these transmitters are discussed below.

Reed Chain Transmitter

The reed chain transmitter is typically the least expensive and the least precise, as it can only measure the level to the nearest 1/2 inch. Resolution is limited by the distance between the switches in the chain. The resistance of the resistor chain changes in increments, so precise measurements are not possible.
Reed chain transmitters can be used in large vessels because the length of the standard reed chain is 20 feet (6.096 m). The reed chain transmitter is not immersed in the process fluid and, therefore, is not exposed to process pressures and media. This transmitter has a minimum operating process temperature of 40°F (-40°C) and a maximum operating process temperature of approximately +500°F (+260°C).

**Magnetostrictive Transmitter**

The accuracy of the magnetostrictive transmitter is better than the reed chain transmitter (up to ±0.015 inch [±.381 mm]).

The advantage of the magnetostrictive transmitter is that the probe is not immersed in the process fluid and, therefore, is not exposed to process pressures and media. It also avoids interacting with process fluids that may be incompatible with the sensor.

This transmitter has a low-end operating temperature of -40°F (-40°C) and a maximum operating temperature of approximately +160°F (+71°C) and approximately +800°F (+427°C) when the transmitter is protected and there is sufficient separation of probe and electronics.

**Guided Wave Radar Transmitter**

The GWR transmitter is accurate (±0.1 inch [±.254 mm]) and usually is the most expensive of the three transmitters considered. The GWR transmitter is internal and detects the fluid level directly. It offers level measurement completely independent of the float. For applications requiring redundancy and transmitters with no moving parts, the GWR transmitter is an ideal choice.

**Orion Transmitters**

Orion produces a complete range of transmitters including the Magnetrol Eclipse® Guided Wave Radar transmitter. Since the company is responsible for the manufacture of its entire line of transmitters, Orion takes responsibility for the performance of each instrument. This total-control concept differs from many other MLI suppliers who purchase and private label their magnetostrictive or reed transmitters.

Specifications of the reed, magnetostrictive, and GWR transmitters used in Orion MLIs follow.
### Transmitters

#### Reed Chain Transmitter

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>24 VDC</td>
</tr>
<tr>
<td>Maximum Range</td>
<td>240 inches (610 cm)</td>
</tr>
<tr>
<td>Resolution</td>
<td>± 0.50 inch (12.7 mm)</td>
</tr>
<tr>
<td>Output</td>
<td>4–20 mA</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40° F (-40° C) to +500° F (+260° C)</td>
</tr>
<tr>
<td>Enclosure Rating</td>
<td>NEMA 4X/7/9/IP 67</td>
</tr>
<tr>
<td>Sensor Material</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Enclosure</td>
<td>Aluminum or Stainless Steel</td>
</tr>
</tbody>
</table>

#### Jupiter Magnetostrictive Transmitter

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>24 VDC</td>
</tr>
<tr>
<td>Range</td>
<td>6 to 420 inches (15 to 1066 cm)</td>
</tr>
<tr>
<td>Display</td>
<td>2-line × 8 character LCD - standard</td>
</tr>
<tr>
<td>Resolution</td>
<td>Analog: 0.01 mA</td>
</tr>
<tr>
<td></td>
<td>Digital: 0.01 units</td>
</tr>
<tr>
<td>Output</td>
<td>4–20 mA</td>
</tr>
<tr>
<td></td>
<td>4–20 mA w/ HART 5.0 w/ univ. commands</td>
</tr>
<tr>
<td></td>
<td>NAMUR NE 43 compliant with 3.8 to 21.5 MA useable range</td>
</tr>
<tr>
<td>Response Time</td>
<td>0.1 second</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40° F (-40° C) to +800° F (+427° C) with insulation</td>
</tr>
<tr>
<td>Enclosure Rating</td>
<td>NEMA 4X/7/9/IP 66/67</td>
</tr>
<tr>
<td>Sensor Material</td>
<td>316 Stainless Steel</td>
</tr>
<tr>
<td>Enclosure</td>
<td>Aluminum or Stainless Steel</td>
</tr>
<tr>
<td><strong>Eclipse GWR Transmitter</strong></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>24 VDC</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>6 to 240 inches (15 to 610 cm)</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>2-line x 8 character LCD</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td></td>
</tr>
<tr>
<td>Analog:</td>
<td>0.01 mA</td>
</tr>
<tr>
<td>Digital:</td>
<td>0.01 units</td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td>4–20mA (HART optional)</td>
</tr>
<tr>
<td><strong>Response Time</strong></td>
<td>Less than 1 second</td>
</tr>
<tr>
<td><strong>Temperature Range</strong></td>
<td>-40° F (-40° C) to +750° F (+399° C)</td>
</tr>
<tr>
<td><strong>Enclosure Rating</strong></td>
<td>NEMA 4X/7/9/IP 67</td>
</tr>
<tr>
<td><strong>Sensor Material</strong></td>
<td>Stainless Steel, Hastelloy C, Monel</td>
</tr>
<tr>
<td><strong>Enclosure</strong></td>
<td>Aluminum or Stainless Steel</td>
</tr>
</tbody>
</table>
MLIs can be fitted with a variety of accessories to enhance process control operations, protect the MLI from extremes of pressure or temperature, or enhance the MLI’s scale for a specific application. Accessories include switches, high/low level switches, heat tracing devices, insulation blankets, and magnetic traps.

**Magnetic Level Switches**

Electric snap, pneumatic relay, or reed level switches can be added to an MLI. These switches, used to sense and/or control high, low, or high/low levels, are activated by the magnet assembly in the float.

Just as the MLI float and indicator are magnetically coupled, the float and a magnetic switch couple. When the float moves up or down with the level in the vessel, the float’s magnetic field, which extends through the chamber wall, opens or closes a switch.

**Selecting a Magnetic Switch**

Since there is no physical contact with the process, magnetic coupling eliminates the need for seals, diaphragms, and gaskets common to other level switching devices. Magnetic coupling also eliminates process connections to the switch and, therefore, no valves are required to block off the switch for maintenance. The result is a level alarm or control system that is more reliable and easier to maintain than conventional switches.

**Orion Switches**

Orion level switches are generally encased in aluminum or stainless steel and attach to the outside of the chamber with a clamp which allows for field adjustments. The switch types are electric snap, pneumatic relay, or reed.

<table>
<thead>
<tr>
<th>Enclosure Material</th>
<th>Electric Snap (10A DPDT)</th>
<th>Pneumatic Relay 15–100 psig (clean air or gas)</th>
<th>Reed 1A SPDT (hermetically sealed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cast Aluminum w/ two 0.5 inch NPT conduit entries</td>
<td>Stainless Steel Single 1/8 inch NPT</td>
<td>Stainless Steel w/mounting tabs ½” M.N.P.T.</td>
</tr>
</tbody>
</table>
Heat Tracing

Heat tracing is used to prevent freezing of the liquid, maintain process temperature requirements, or keep the process fluid temperature elevated to ensure it does not become viscous. Steam and electric heat tracing are the most common forms.

Many MLIs have steam or electric connections preinstalled to permit easy commissioning in the field or addition of heat tracing at a later date. Steam connections are standard and controlled by thermostatically-operated valves. The two common electric heat tracing configurations are the fixed-point thermostatic switch and the adjustable bulb-type thermostatic switch. Both come with a wiring harness or junction box for field wiring.

Selecting Heat Tracing

Steam is most often selected for heat tracing applications since steam costs less than electricity for equivalent heating. If electric tracing is used, the temperature requirements and the area electrical classification must be specified.

Orion Heat Tracing

For Orion MLIs, steam or electric heat tracing is available as a factory-installed option. For MLIs with steam tracing, the unit has two tube connections that are ready for direct connection to the plant steam supply. For MLIs with heat tracing, the unit is available with a preinstalled insulation blanket.
Insulation Blanket

Insulation blankets have three parts—filler, jacket, and liner. Insulation is typically a removable blanket for high temperature applications or for freeze protection. The jacket and liners are made of weather resistant silicone cloth and sewn with fire retardant Teflon thread. For cryogenic blankets, the jacket is made of polyurethane and the liner is made of aluminum sheeting.

Selecting Insulation Blankets

Insulation blankets are available for all types of MLI configurations. The blanket maintains the required temperature of the processing fluid. The insulation blankets may be for high temperatures (up to +1000° F [+538° C]) or for low temperatures (down to -320° F [-195° C]). The blankets have different thickness (0.5 to 4 inches [13 to 102 mm]) based on the required temperature specifications.

Orion Insulation

Orion offers high-temperature and low-temperature insulation fabricated specifically for each application:

- Cryogenic insulation from +32° F (0° C) to -320° F (-195° C), which is suitable for liquidified gases and media that vaporize at ambient temperature, such as liquid natural gas and liquid petroleum gas.

- High-temperature insulation fabricated to specific customer requirements for product media that must be maintained at elevated temperatures up to +1000° F (+538° C).

Orion high temperature blankets are made of a needled fiberglass mat. They are attached to the MLI using Velcro® straps. All seams in the insulation and in the jacket are sealed with special vapor barriers to prevent moisture from entering. Quilting pins and cross-stitching ensures blanket integrity.

Frost Extension

Orion offers custom designed frost extensions engineered to specific application requirements. Orion frost extensions are hermetically sealed and manufactured of polymers that prevent frost accumulation while ensuring the high degree of readability for the user.
**Magnetic Traps**

Magnetic traps are used to prevent ferromagnetic particles in a vessel from entering the MLI chamber and interfering with the movement of the float. The trap is installed at the bottom process connection. The permanent magnet in the trap ensures the clean and effective removal of ferrous contaminating materials. Several models are available designed to operate within the specific requirements of an application such as pressure, temperature, sanitary or nonsanitary.

**Gauge Glass**

Although MLI’s are often used to replace gauge glasses, there are certain circumstances which may require a site glass. Boiler codes still require that a site glass be installed and functional at the time of boiler start-up. But, as previously discussed, site glasses are often not a desirable form of indication. An MLI can be equipped with a site glass in order to comply with code but once start-up is complete, the site glass can be valved off to prevent potential problems.
Orion Instruments produces the Atlas, Aurora, and Gemini models of magnetic level indicators in a wide variety of chamber styles and configurations. Each design is compatible with a complete range of level switches and level transmitters, including the Eclipse® GWR transmitter.

Features

Orion MLIs are precision engineered and manufactured to indicate liquid levels accurately, reliably, and continuously. They are sealed chambers that do not require periodic maintenance and eliminate vapor or liquid emission problems common with sight gauge glasses.

Orion MLIs’ features include:

- Fabricated, non-magnetic chamber assembly, manufactured in a wide range of metal and plastic materials
- A wide selection of process connections
- Precision manufactured floats, with internal magnets and magnetic flux rings, that have a 5-year warranty
- Flag or shuttle type indicators, with an optional stainless steel scale that reflects height, volume, or percentage of fluid level.
- Insta-Seal™ valve to maintain inert gas pressure in indicator
- Durable metal flags able to withstand rigorous high temperatures
- Local LCDs on some models enable the user to view configuration parameters, error messages, and live process variable data

In addition to Orion’s broad range of materials of construction, custom products are available. Orion can fabricate MLIs from a wide array of plastics, such as PVC, CPVC, Kynar, fiberglass, or polypropylene to ensure material compatibility with corrosive, acidic, or caustic process media.

Configurations

Orion offers three models of magnetic level indicators:

- Atlas
- Aurora
- Gemini
Selecting the right configuration for an application depends on factors such as the pressure and temperature of the process fluid in the vessel, the size and shape of the vessel, the type, material, and strength of the process connections, joints, and piping, and the style of the chamber.

**Atlas**

The Atlas, Orion's standard, high-performance, single chamber MLI, is available in a wide variety of mounting configurations. It is the ideal replacement for sight glass gauges and satisfies the highest pressure and temperature level measurement demands.

Atlas is available in a wide range of metal alloys and plastics including 304/304L SS, 316/316L SS, Inconel, Hastelloy, Alloy 20, PVC, CPVC, and Kynar fiberglass. The Atlas is offered in a broad range of pressure ratings, styles and sizes with a variety of process connections. Top and bottom float stop springs are standard.

The Atlas MLI can be equipped with shuttle- or flag-type indicators, level transmitters and switches, blankets, steam or electric heat tracing, frost extensions, and stainless steel scales.

### Atlas

<table>
<thead>
<tr>
<th>Chamber Diameter</th>
<th>2, 2.5, or 3 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Accessories</td>
<td>Switches, insulation blanket, scale</td>
</tr>
<tr>
<td>Primary Advantage</td>
<td>Less expensive, robust, and highly visible level monitoring device</td>
</tr>
</tbody>
</table>
Aurora

The Aurora, designed and engineered by Orion, combines the MLI technology of the Atlas with a premiere guided wave radar (GWR) level measurement transmitter. Aurora has a single chamber that is larger than the Atlas to accommodate both the float and Magnetrol’s Eclipse GWR with coaxial-style probe.

Inside the chamber, the coaxial probe mounts securely against the inside wall of the pipe, 180 degrees from the visual indicator without any impedance of float travel. The coaxial probe is not used as a guide for the float. An angled plate is mounted inside the Aurora chamber to ensure optimal and unimpeded travel of the float. The baffle’s perforated design allows free product flow through the entire chamber.

This combination provides for two independent, accurate, level measurement systems. The Eclipse, with coaxial style probe set in an Aurora, makes it the preferred MLI for applications where true redundancy is required and a single chamber is preferred.

Aurora has a range of side-mounted configurations and can be constructed of many materials. Top and bottom MLI float stop springs are standard. Aurora MLIs may be equipped with switches, blankets, steam or electric heat tracing, frost extensions, flag/shuttle indicators, and stainless steel scales. Aurora is offered in a broad range of pressure ratings, styles, sizes and a choice of various process connections.

<table>
<thead>
<tr>
<th>Aurora</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber Diameter</td>
</tr>
<tr>
<td>Common Accessories</td>
</tr>
<tr>
<td>Primary Advantage</td>
</tr>
</tbody>
</table>

Aurora Model
Gemini

The Gemini MLI has a twin-chamber design for use on applications where redundant level measurement is critical. Gemini combines MLI technology with a GWR, magnetostrictive or other type of direct insertion transmitter installed in the secondary chamber. It provides precise visual measurement and reliable level data transmission to a remote display or controller.

Gemini is available in a wide variety of configurations and is offered in a broad range of pressure ratings, styles, sizes and choice of process connections. Top and bottom MLI float stop springs are standard in the primary MLI chamber. The secondary chamber houses the transmitter sensor and allows the GWR or magnetostrictive transmitter to provide a backup or remote level measurement.

<table>
<thead>
<tr>
<th>Gemini</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber Diameter</td>
</tr>
<tr>
<td>Primary Chamber</td>
</tr>
<tr>
<td>Secondary Chamber</td>
</tr>
<tr>
<td>Common Accessories</td>
</tr>
<tr>
<td>Primary Advantage</td>
</tr>
</tbody>
</table>