# How Hydrostatic Pressure Sensors Convert Pressure Readings into Accurate Volume Data


In industrial tank management, a hydrostatic pressure sensor is one of the most reliable tools for determining liquid volume. Unlike ultrasonic or radar sensors that measure from the top down, a hydrostatic sensor (like the Whitman L95 Series ) measures the "weight" of the liquid column above it. To turn these pressure readings into accurate volume data, you must account for the fluid's density and the physical geometry of the tank.

## Step 1: How to Calculate Liquid Height from a Pressure Reading

The first step is converting the pressure measured at the bottom of the tank into a linear height. This is based on the hydrostatic pressure formula:

### Why Specific Gravity (SG) Is a Critical Input for Non-Water Fluids

If you are measuring a fluid other than water, you must adjust for its Specific Gravity. For example, hydraulic oil is lighter than water (SG approx 0.88), meaning a 10-foot column of oil exerts less pressure than a 10-foot column of water.

## Step 2: How Tank Geometry Determines the Volume Formula

Once you have the height (h), the mathematical formula to find the volume (V) depends entirely on the shape of your reservoir.

- **Vertical Cylindrical or Rectangular Tanks: Simple Linear Calculation**

These are the simplest to calculate. Because the surface area (A) is constant from bottom to top, the relationship is linear.

- **Horizontal Cylindrical Tanks: Why a Strapping Table Is Required**

These are much more complex. As the tank fills, the volume added per inch of height increases until the halfway point, then decreases. This requires a "strapping table" or a specific trigonometric formula to calculate the circular segment.

- **Spherical or Conical Bottom Tanks: Accounting for Changing Cross-Sections**

These require calculus-based volume formulas to account for the changing cross-sectional area at the bottom of the tank.


## Step 3: Scaling Pressure Signals for Volume Display in PLCs and Panel Meters

Most modern hydrostatic transmitters provide a 4–20mA or 0–10V analog signal. To display "Gallons" or "Liters" on a PLC or panel meter, you must perform a "scaling" operation.

- **Linear Scaling for Vertical Tanks -** For vertical tanks, you simply map 4mA to "0 Gallons" and 20mA to "Max Gallons."
- **Non-Linear Mapping for Horizontal Tanks -** For horizontal tanks, the PLC must use a "Look-Up Table" (LUT) or a polynomial equation to translate the linear pressure signal into a non-linear volume value.
- **Real-Time Temperature Compensation for High-Accuracy Systems -** Since liquid density changes with temperature, high-accuracy systems often use a temperature sensor to adjust the ρ value in real-time, preventing volume errors as the fluid warms or cools.


# Why Hydrostatic Sensors Outperform Ultrasonic Sensors for Industrial Volume Monitoring

- **They Ignore Foam, Vapors, and Surface Disturbances**

Unlike ultrasonic sensors, hydrostatic sensors are unaffected by surface foam, heavy vapors, or dust in the tank.

- **High Sensitivity for Precision Inventory and Leak Detection**

Sensors like the Whitman L95 can detect minute changes in level, making them ideal for high-precision inventory and leak detection.

- **Built for Permanent Submersion - Red Seal Technology and IP68 Rating**

With "Red Seal" technology and NEMA 6 / IP68 ratings, these sensors can remain submerged indefinitely without electrical failure.

# About Whitman Controls and Industrial Control Solutions

**Whitman Controls**, part of **Industrial Control Solutions**, has been manufacturing precision vacuum, temperature, pressure, and liquid level switches and sensors for over 40 years. What began as a focused instrumentation manufacturer has grown into a trusted name across some of the most demanding industries in the world - aerospace, defense, semiconductor, medical, and industrial automation.

As a **Service-Disabled Veteran-Owned Small Business**, Industrial Control Solutions was built on the same principles that define military service: tireless dedication, rigorous quality standards, and an unwavering commitment to the mission. That foundation isn't marketing language, it shapes how we engineer every product, handle every order, and support every client relationship.

We don't offer off-the-shelf compromises. Every sensor solution we build is configurable to your exact application, accounting for media environment, pressure range, temperature exposure, mounting constraints, and dozens of other specifications. If a standard product doesn't meet your requirements, we build one that does and we back it with full documentation and traceability at every step.

Every product ships with full traceability documentation under our **ISO 9001:2015 certification**, giving customers confidence that internal processes, materials, and finished products have all met the highest standards of quality and regulatory compliance.

At Industrial Control Solutions, our most loyal clients have been with us for the entirety of our 40+ years in business. That kind of partnership isn't accidental. It is the direct result of a commitment to delivering exactly what we promise; high-quality products, built to specification, backed by people who stand behind their work.

Our product portfolio spans four specialized USA-manufactured lines:

- **Whitman Controls** - Vacuum, pressure, temperature, and liquid level switches engineered for precision and durability in extreme environments
- **Load Controls** - Pump load controls, compact power sensors, fast-response load controllers, current sensors, and VFD-compatible solutions
- **Thomas Products** - Flow switches, level switches, pump controls, multi-level switches, and visual indicators
- **Duro-Sense** - High-quality platinum and noble thermocouples, RTDs, and ISO 17025 calibrated wire

# FAQs

**Q1: How does a hydrostatic pressure sensor convert pressure into volume?**
A hydrostatic pressure sensor measures the pressure exerted by the liquid column above it. This pressure is first converted into a height value using the hydrostatic formula, and that height is then applied to the appropriate tank geometry formula to calculate volume in gallons or liters.

**Q2: Why does Specific Gravity matter when using a hydrostatic level sensor?**
Specific Gravity (SG) represents how dense a fluid is relative to water. If you are measuring a fluid other than water such as hydraulic oil (SG ≈ 0.88), the sensor's pressure reading must be adjusted for that density. Without this correction, the calculated height and volume will be consistently off across the entire measurement range.

**Q3: What is a strapping table and when is it needed?**
A strapping table is a calibration reference that correlates each pressure or height value to a specific volume. It is required for horizontal cylindrical tanks, where the volume-to-height relationship is non-linear meaning equal height increments do not correspond to equal volume increments.

**Q4: Can hydrostatic sensors be used with PLCs and panel meters?**
Yes. Most hydrostatic transmitters output a standard 4–20mA or 0–10V analog signal that is compatible with virtually all PLCs and panel meters. The control system is then configured to scale or map that signal into engineering units such as gallons or liters.

**Q5: How does temperature affect hydrostatic volume measurement?**
Liquid density changes with temperature, which directly affects the pressure-to-height calculation. High-accuracy systems pair the hydrostatic sensor with a temperature sensor to adjust the density value in real time, preventing volume measurement errors as the fluid temperature fluctuates during operation.