



White Paper

The evolution of the MTG™ MTG 3000 to the MTG 3012

The patented MTG™ 3012 (Multi-function Tank Gauge) is the most advanced tank gauging technology on the market with the unique capability of meeting both API (and ISO) standards for Hybrid (API 3.6) and Hydrostatic measurement (API 16.2) to custody transfer accuracy from a single instrument.

METROLOGY CERTIFICATION:

In 2005, MTG™ went through metrology testing by NMI for OIML certification and GOST for their own metrology certification. The results; MTG™ was the first tank gauge to pass OIML R-125 certification for Measuring Systems for the mass of liquids in storage tanks and MTG™ passed the GOST metrology certification for Mass Measurement. NOTE: Both standards are for measurement to custody transfer accuracy.

INSTALLATION PROBLEMS OVERCOME:

Our early field installation experience with the MTG™ 3000 was an educational experience and can't be overlooked. Lessons learned, i.e., experience has taught us how to produce the best tank gauge product on the market. Example: One customer had a costly policy of installing a second gauge well in tanks to accommodate the automatic tank gauge. While the original gauge well was used for manual hand lines and sampling. However, the readings would never match.

The problem that was discovered (documented by an independent contractor) was that when the tanks were empty the reference points between the two gauge wells matched using a manual hand line measurement. However, when the tanks were full, there was a variance between the manual hand line measurements between the two gauge wells in both full and empty conditions. The error varied by tank from +3/4" to -1/8". The error was for the most part due to bottom reference movement in the tank.

To overcome this error Gauging Systems Inc. recommends the installation of the MTG™ within the same gauge well that you are using for manual hand lines and sampling. A normal gauge well is between 6" and 10" in diameter. GSI has designed a flange with a gauge hatch for normal hand lines and sampling, but also allowing the installation of the 2" diameter MTG™. This provides a single mutual reference point between the manual and automated gauging for level, temperature, density, and water in accordance with the testing procedures within API 3.1a and API 2551 for calibration measurement.

To our knowledge the MTG™ is the only hybrid gauge that can provide a direct measurement of all variables against manual hand line, electronic hand temperature measurement, and sampling for density and water at the same reference point.



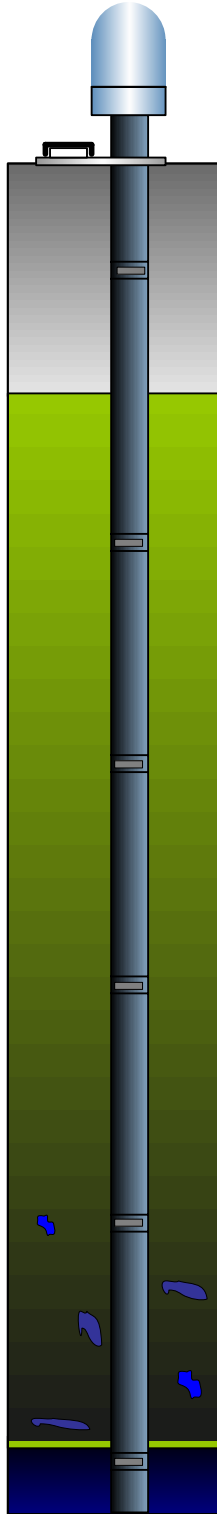
Gauging Systems Inc. also manufactures a top clamp for the MTG™ for use when a top reference point is required due to bottom reference movement (second gauge well or when customers just want to match the manual gauge line). Similar in nature to top mounted level probes, only the MTG™ is rigid and straight hanging with no moving parts (Floats, displacers, etc.).

Measurement errors can also occur between a gauge well used for automatic tank gauging and the manual gauge because of a difference between the fabrication of the gauge wells, i.e., slotted or non-slotted gauge well, the size of the slots, etc. Gauging Systems Inc. manufactures a mounting flange with well vent for equalizing the well to atmospheric pressure. The well vent is available as an option.

1. Features comparison between MTG™ 3000 (Old) and MTG™ 3012 (New)

<u>Function</u>	<u>MTG™ 3000 – Existing System</u>	<u>MTG™ 3012 – New Generation</u>
1. Number Of Sensor Modules	Up to 6 6 sensor modules allow for up to 4 density layers, up to 5 liquid and 1 gas temperature measurements, percentage of water calculation in up to 3 layers of liquid and absolute vapor pressure and temperature measurements. Data for emulsion calculation provided, which should be done in the host PC.	Up to 12 sensor modules allow for up to 10 layers of density, up to 11 liquid and 1 gas temperature measurements, percentage of water in up to 9 layers inside the tank, absolute and gauge pressure and temperature in the vapor space. Very accurate emulsion calculations for entrained water. Optional double or triple bottom sensors for redundancy. Shorter span's between sensors provide increased accuracy.
2. Static and dynamic measurements	One accurate ADC converter in the head allowed for accurate static and moderate dynamic measurements when filling and emptying the tank	Three synchronized accurate ADC converters allow for accurate static and dynamic measurements while filling and emptying the tank
3. Tank strapping table	Polynomial approximation. Excellent for cylindrical tanks and floating roof tanks above the critical zone.	Up to 1000 points of actual calibration table stored directly in the head. Critical zone correction as per API, ISO, or GOST requirements. Tanks of any shape handled.
4. API calculations directly from the Gauge Head	Level, Water Level, Total Observed Volume, Head Mass, Up to 6 spot and Average Temperature , Up to 4 density layers converted to reference temperature	Level, Water level, Total Observed Volume, Free Water Volume, Gross Observed Volume, Available Room, Head Mass, Heel Mass, Mass, Apparent Mass, Average Density. Up to 10 density layers converted to reference temperature, Up to 10 spot and Average Liquid and Vapor temperature, Volumetric Flow rate, Mass Flow rate
5. Self diagnostic	Reporting via MODBUS registers	Extensive detail with optional self correction for failed sensors
6. Temporary disconnecting of sensors	Requires minimum rewiring but involves climbing on top of the tank	Automatic or remote via MODBUS command. No rewiring necessary
7. Installation	Requires sensor wires to be cut on site after connecting all sections	Sensors with MILSPEC connectors to exact wire lengths – simplifies and shortens installation & repairs.
9. Sensor excitation	Voltage, some minimal wire effect possible.	Current, no wire effect
10. Firmware upgrade	Requires chip removal and reinstalling.	Flash programmable over RS-485 or network topology (Ethernet, Radio, Satellite, etc.).
11. Configuration and Self calibration information	Configuration transferable from board to board with a chip, but self calibration information requires minimum settings via MODBUS registers	Configuration and self calibration data are transferable via a plug in chip. They are also downloadable via the RS-485 or network topology.
12. Movement detection	Speed of movement detection depends on filter settings	More effective filtering algorithms and higher speed Analog to Digital converters allow for faster system reaction.
13. Level calculation	With the highly stratified product level accuracy may be diminished in some cases	Higher accuracy of level calculations due to increased number of sensors and more advanced algorithms of top layer density calculations
14. Water level calculation	Accuracy may decrease for stratified products	Further advancements in algorithms for bottom density stratification and improved accuracy of water calculations
15. Output units of measurement from the Gauge Head	Metric	Metric and English (Fractional , Decimal)

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2. Calibration Issues

More advanced algorithms along with the increased number of sensors and physical changes to the MTG™ design provide increased sensor self-calibration accuracy and reduce the time and effort of initial calibration. No movement of product is necessary unless the immediate measurement to custody transfer accuracy is required. Normal product movement will bring the MTG™ into calibration after the span of a couple of sensors are crossed. The more movement of product, the more self calibration that is performed.

3. Compatibility

The new electronic transmitter head is backward compatible to any installed previously installed system and sensors. Thus, the ability to upgrade any existing installations to the current product being manufactured today and in the future.

4. New sensor and housing design

The new sensor design involves units with the hermetic connectors instead of the wires protruding from the back of the sensors. This allows for quicker and easier installation and maintenance. New sensor housings as well..



5. Leak detection

The new transmitter head has enough power to support directly in the head all algorithms associated with unique MTG™ mass-based leak detection option. The simulation proved abilities to detect as low as 0.05 gal/hour leaks from 100 ft diameter tanks.

6. Installation options

A number of new accessories have been developed for the correct installation of the MTG™ in various tank and product applications. The gauge hatch flange for common reference point between manual and automatic tank gauging, installation collar for top reference point mounting, magnetic bottom anchor for sloped bottom tanks, Teflon bottom shoe for coated bottom tanks, maintenance covers for the sensor sections, additional sensors for increased span (level) accuracy or redundancy, etc.

Conclusion

The new generation of MTG™ provides better reliability and accuracy. It greatly reduces the labor and resources needed for initial installation and calibration.

The MTG™ is the only gauge in the world to meet both API and ISO standards for the calculation of volume by Hybrid or Hydrostatic measurement by a single device.

The MTG™ when installed within the gauge well provides a direct comparison be-



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tween the manual gauging & sampling for Level, Temperature, Density, and Water. It is the only gauge in the world that offers the ability to validate all data variables for volumetric measurement from the same reference point. By using the gauge well, you reduce infrastructure cost and improve accuracy.

Metrology – MTG™ is the only gauge ever certified by OIML for standard R-125 for Measuring Systems for the mass of liquids in storage tanks. MTG™ is also certified by GOST for Mass Measurement to custody transfer accuracy. MTG™ also meets API 3.6 (Hybrid) & API 16.2 (Hydrostatic) accuracy for custody transfer.

MTG™ also provides intangible data that is not normally associated directly with a tank gauging instrument, however, provides Operational, Safety, and Environmental benefits:

- Leak detection (Optional)
- Accurate free and entrained water measurement (even within emulsified product)
- Qualitative measurement and Quantitative measurement
- Measurement of hydrocarbon emission variables; Vapor pressure and Vapor temperature
- Tank over pressure or Tank vacuum
- Density stratification and Temperature stratification
- Primary and Third, fourth, fifth, etc. High Level Alarms
- Measurement redundancy; double or triple bottom sensors and double vapor space sensors

Review - Standard features of the New MTG™ 3012 includes:

- Measurement or calculation of all hybrid data variables and mass data variables; Level, Multi-point spot temperature, Multi-strata density, Free and entrained water, and Mass. On board; calculation of volume based in accordance to API, ISO, or GOST standards. On board; 1,000 strapping points per tank. All pertinent data is stored on non volatile plug-in flash memory for easy configuration.
- Self calibration (2nd generation with new transmitter card design)
- Self diagnostics (2nd generation with new transmitter card design)
- NO MOVING PARTS (No bubbles, No bearings, and No floats)
- No (second) stilling well required, only a flange (No major tank infrastructure cost)
- One tank entry (for Mass, Level, Multi-point spot temperature, Multi-strata density, etc.)
- One electrical and conduit connection (I.S. design, both signal and power within the same conduit)

NOTE: The MTG™ 3000 has a limitation on software capability due to the size of processor memory. The new MTG™ 3012 doesn't have a limitation on processor memory, therefore, many of the improvements to the unit are based around software improvements and additional algorithms.

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