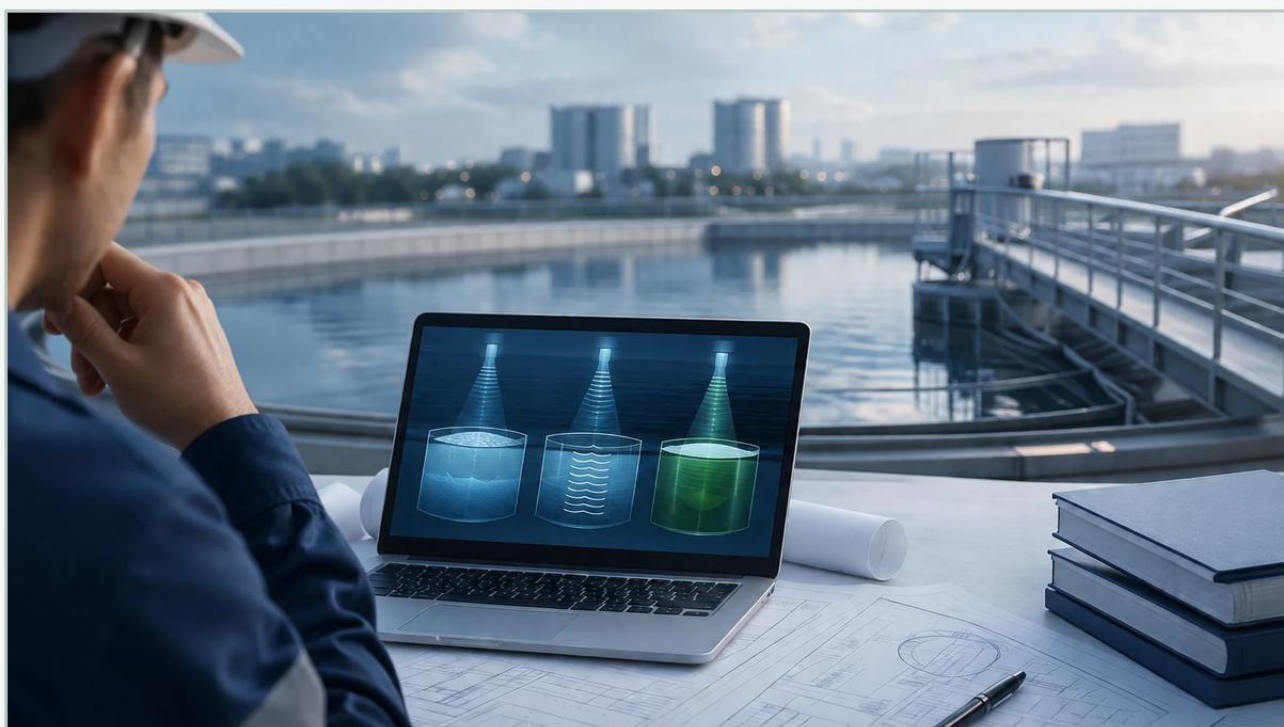


Vessel Experience Factor

A practical guide to vessel experience factor, covering the reader intent, the relationship to vessel experience factor, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



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In the global trade of liquid bulk commodities, such as crude oil, refined petroleum products, and chemicals, the precise measurement of cargo is fundamental to financial settlement and operational efficiency. However, a persistent challenge in maritime logistics is the discrepancy between the quantity measured at the shore terminal and the quantity measured on the receiving or discharging vessel. This discrepancy is addressed through a statistical tool known as the Vessel Experience Factor (VEF).

For engineers and terminal operators, understanding the Vessel Experience Factor is not merely about accounting for losses; it is about evaluating the reliability of level measurement instrumentation and the physical integrity of vessel tank calibration. This guide explores the principles of VEF, the role of advanced level sensing technology in minimizing measurement uncertainty, and practical considerations for industrial applications.

Understanding the Principles of Level and Volume Measurement

Before delving into the calculation of the Vessel Experience Factor, it is essential to understand how volume is determined on a vessel. Unlike shore tanks, which are typically stable and precisely calibrated, vessel tanks are subject to dynamic environments, including trim (longitudinal tilt), heel (lateral tilt), and structural flexing.

Ullage vs. Innage

Level measurement in marine vessels is generally performed using one of two methods:

1. **Ullage (Outage):** Measuring the empty space from a reference point at the top of the tank down to the surface of the liquid.
2. **Innage (Dip):** Measuring the depth of the liquid from the tank bottom up to the surface.

In most large-scale industrial vessels, ullage is the preferred method, particularly when using non-contact sensors like radar or ultrasonic meters. Once the level is determined, it is cross-referenced with the vessel's tank capacity tables (strapping tables) to calculate the gross volume. This volume is then corrected for temperature, density, and the vessel's trim and heel to arrive at a Total Calculated Volume (TCV).

| The Source of Discrepancy

Discrepancies arise because shore-based measurements (using high-precision flow meters or static tank gauging) and ship-based measurements rarely align perfectly. Factors contributing to this include:

Inaccurate tank calibration tables on older vessels.

Physical deformation of the vessel's hull over time.

Accumulation of sediment or "unpumpable" residues (ROB - Remaining On Board).

Calibration drifts in level measurement instruments.

| Defining the Vessel Experience Factor (VEF)

The Vessel Experience Factor is a historical ratio used to reconcile the difference between the Ship's Figures and the Shore Figures. It represents the mean deviation of a vessel's measurement over a specific number of voyages. According to the American Petroleum Institute (API) Manual of Petroleum Measurement Standards (MPMS) Chapter 17.9, the VEF is a decimal value used to adjust the ship's measurements to provide a more accurate estimate of the actual cargo quantity loaded or discharged.

| The Calculation Formula

The VEF is calculated by dividing the total shore-measured volume by the total ship-measured volume over a series of qualified voyages (usually the last 10 to 20 voyages).

$VEF = (\text{Sum of Shore Figures}) / (\text{Sum of Ship Figures})$

A VEF of 1.0000 indicates perfect agreement between ship and shore.

A $VEF > 1.0000$ suggests the ship consistently under-measures the cargo.

A $VEF < 1.0000$ suggests the ship consistently over-measures the cargo.

To ensure the VEF is statistically valid, certain voyages are excluded from the calculation, such as those involving ship-to-ship transfers, voyages where the vessel was modified, or instances where the discrepancy exceeds a specific tolerance (typically $\pm 0.3\%$).

The Role of Level Measurement Technology in VEF Accuracy

The reliability of the Vessel Experience Factor depends entirely on the consistency of the level measurements taken on board. If a vessel utilizes outdated or poorly maintained sensors, the resulting VEF will be volatile, leading to disputes during custody transfer. Modern industrial automation relies on several key technologies to stabilize these figures.

Radar Level Meters

Radar technology is the gold standard for vessel level measurement. Operating on the Time-of-Flight (ToF) principle, these devices emit microwave pulses that reflect off the liquid surface.

80GHz High-Frequency Radar: Provides a narrow beam angle, which is critical in vessel tanks where internal structural members (bulkheads, heating coils) can cause false echoes.

Non-contact Measurement: Since the sensor does not touch the medium, it is unaffected by the density, pressure, or corrosive nature of the cargo.

| Ultrasonic Level Sensors

Ultrasonic sensors use sound waves to measure the distance to the liquid surface. While cost-effective, they are generally less suitable for large vessel tanks containing volatile chemicals or hydrocarbons, as changes in vapor space composition and temperature can alter the speed of sound, leading to measurement errors.

| Hydrostatic Level Transmitters

These sensors measure the pressure exerted by the liquid column. While highly accurate for static applications, they require precise knowledge of the liquid's density, which can vary with temperature. In marine environments, they are often used as secondary systems or for ballast tank monitoring.

For those seeking to upgrade their vessel instrumentation to improve measurement reliability, you can Review product options and application support at our Main Page.

| Selection Table: Level Measurement for Marine Vessels

Choosing the right instrument is critical for maintaining a stable Vessel Experience Factor. The following table compares common technologies based on marine operational requirements.

Feature	Radar (FMCW)	Ultrasonic	Hydrostatic	Magnetic Level Gauge
Measurement Range	Up to 30m+	Up to 15m	Dependent on Pressure	Up to 6m
Accuracy	±1mm to ±3mm	±0.25% of range	±0.1% to ±0.5%	±5mm
Vapor Sensitivity	None	High	None	None
Maintenance	Very Low	Low	Moderate	Moderate
Installation	Top-mounted	Top-mounted	Side or Bottom	Side-mounted
Best Use Case	Crude, Chemicals, LNG	Water, Waste Oil	Ballast, Fuel Oil	Small Process Tanks

| Installation and Engineering Considerations

To ensure that level measurements contribute to a reliable Vessel Experience Factor, engineering teams must adhere to strict installation protocols.

1. **Reference Point Alignment:** The "Zero" point of the level sensor must be physically verified against the vessel's manual sounding pipe. Any offset must be programmed into the transmitter to ensure consistency between manual and automated readings.
2. **Stilling Wells:** In tanks where turbulence or splashing is common during loading, radar sensors should be installed within a stilling well (a vertical pipe) to provide a calm surface for measurement.
3. **Trim and Heel Correction:** Modern level systems should be integrated with the vessel’s inclinometer. If a vessel is trimmed by 2 meters by the stern, the liquid level in a forward tank will appear lower than it actually is. Automated systems apply trigonometric corrections to the level reading before calculating volume.
4. **Temperature Integration:** Volume calculation is inseparable from temperature. Multi-point temperature probes should be installed alongside level sensors to calculate the Volume Correction Factor (VCF) according to ASTM tables.

| Limitations of the Vessel Experience Factor

While VEF is a powerful tool, it is not infallible. Several limitations must be acknowledged by cargo surveyors and engineers:

Structural Changes: If a vessel undergoes significant structural repairs or is fitted with new internal equipment, the historical VEF becomes invalid, and a new factor must be established over the next 10 voyages.

Cargo Type Variability: A vessel may have a different VEF for high-viscosity fuel oil than it does for low-viscosity gasoline, primarily due to the amount of cargo that clings to the tank walls (clingage).

Human Error: Manual soundings are often used to verify automated systems. If the manual sounding technique is inconsistent, it will skew the historical data used to calculate the VEF.

| Frequently Asked Questions (FAQ)

Q: How often should the Vessel Experience Factor be updated?

A: The VEF is typically a "rolling" factor. As a new voyage is completed and qualified, it is added to the calculation while the oldest voyage is removed. This ensures the factor reflects the current physical state of the vessel.

Q: Can a VEF be used for shore-to-shore transfers?

A: No. VEF is specifically designed to reconcile the difference between a vessel's measurement and a shore measurement. Shore-to-shore discrepancies are handled through meter proving and tank calibration audits.

Q: Why is radar preferred over ultrasonic for VEF-related measurements?

A: Radar is unaffected by the gas composition in the ullage space. In many cargo tanks, the presence of hydrocarbon vapors or inert gas (IG) systems changes the speed of sound, which would cause an ultrasonic sensor to provide an inaccurate level reading.

Q: What is a "qualified voyage" in VEF terms?

A: A qualified voyage is one where both ship and shore figures are available, the vessel was fully loaded or discharged, and no ship-to-ship transfers occurred. The discrepancy between ship and shore must also be within a reasonable limit (usually $< 0.3\%$).

| Conclusion

The Vessel Experience Factor remains a cornerstone of maritime cargo accounting, providing a necessary bridge between two different measurement environments. For B2B stakeholders in the oil, gas, and chemical industries, the stability of this factor is a direct reflection of the quality of their level measurement infrastructure. By implementing high-precision radar technology and ensuring rigorous installation standards, operators can reduce measurement uncertainty, minimize financial disputes, and optimize their custody transfer processes.

For technical specifications and guidance on selecting the appropriate instrumentation for your vessel or terminal, visit our [Main Page](#) to explore our full range of level measurement solutions.