

Technical guidance

Understanding Draft Survey

Hydrometers

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This technical guidance note clarifies the design specifications and operational requirements for Draft Survey hydrometers. Draft Survey hydrometers are engineered to specific maritime standards (the UN/ECE Code of Procedures for Draft Surveys) that differ significantly from laboratory instruments. It is imperative that ship officers and survey personnel adhere to these guidelines to avoid the common error of “correcting” readings back to laboratory standards, an action that would invalidate the final cargo weight calculation.

1. It measures “density in air,” not true density

Most standard laboratory hydrometers and digital density meters measure true density (mass per unit volume in a vacuum) or specific gravity. In contrast, your Draft Survey hydrometer is deliberately calibrated to measure density in air (often termed apparent density) in kilograms per litre (kg/l). This calibration allows a marine surveyor to calculate the actual, commercially accepted weight of the cargo simply by multiplying the hydrometer’s scale reading by the volume (in cubic metres) of the water displaced by the vessel. If you compare this reading to an instrument measuring true density, the numbers will naturally differ because the hydrometer has already factored in the buoyancy effect of air.

2. Temperature corrections must not be applied

In standard laboratory practice, operators are taught to always apply mathematical corrections to adjust their readings to a reference temperature (like 15 °C or 20 °C). However, the UN/ECE Code of Procedures for Draft Surveys explicitly warns against doing this with Draft Survey hydrometers. The official manual states: “Any attempt to correct this water density to density at 15° C, 60° F or some other standard temperature can lead to very serious errors in the weight calculation”. The reason for this rule is that while the glass hydrometer will expand or contract if the water is not exactly at 15 °C, the massive steel hull of the ship itself will also expand or contract. These volume changes are of opposite signs and naturally tend to compensate for each other. If you try to apply standard temperature correction tables to your Draft Survey hydrometer, you will artificially create an “error” that will result in an inaccurate cargo calculation.

3. Comparisons to load line hydrometers

Draft survey hydrometers must not be used for load line purposes. If you are comparing your glass hydrometer to load line hydrometers, you will see a discrepancy. Load Line hydrometers measure the specific gravity of water (relative density) rather than density in air. The difference between the relative density or specific gravity as determined by a load line hydrometer and the apparent density determined by a Draft Survey hydrometer is exactly 0.002 (termed the “air buoyancy correction”). To convert a Draft Survey hydrometer reading to a Load Line specific gravity reading, simply add 0.002 to the Draft Survey reading.

4. How to properly verify the accuracy of your hydrometer

Because of the unique characteristics outlined above, checking your Draft Survey hydrometer against a digital density meter or standard laboratory hydrometer will inevitably lead to mismatched readings. The only reliable way to check the accuracy of your hydrometer locally is by using the “comparison method” against a reference hydrometer of the exact same type and of known accuracy.

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To perform this check:

- Obtain a certified reference Draft Survey hydrometer (ideally one supplied with a UKAS, NAMAS, BSI, or equivalent calibration certificate).
- Fill a clean, transparent glass test jar with a well-mixed sample of water (sea, brackish, or fresh water).
- Float both your hydrometer and the certified reference hydrometer side-by-side in the jar, ensuring they do not touch the walls or each other.
- Once they have settled, read both instruments simultaneously at the point where the level liquid surface meets the scale.

5. Understanding calibration certificates (UKAS / NAMAS)

When sending a draft survey hydrometer to an independent laboratory (such as a UKAS-accredited lab) for certification, it is vital that the laboratory understands what the instrument is.

If the laboratory mistakenly tests and certifies the instrument as a standard g/ml density hydrometer rather than a draft survey hydrometer, the certificate will be invalid for marine use.

- A standard g/ml calibration will issue corrections designed to adjust the instrument's readings back to true density (in vacuum).
- The UN/ECE Code of Procedures for Draft Surveys strictly requires the calculations to be based on density in air.

If a surveyor applies the corrections from a standard g/ml UKAS certificate to their draft survey hydrometer, they will accidentally cancel out the built-in air buoyancy adjustment. This will artificially inflate the water density value by roughly 0.0011, leading to a serious overestimation of the cargo weight.

Always ensure your calibration certificate explicitly states that the instrument was tested for Density in Air (kg/l). If verifying the instrument locally, you must use the comparison method against a certified reference hydrometer of the exact same type.

6. Converting a standard UKAS g/ml certificate for Draft Survey use

If your hydrometer has been certified by a UKAS laboratory as a standard g/ml density hydrometer, the corrections on your certificate are designed to calculate True Density (in vacuum).

To use the hydrometer for draft surveys, you must convert these corrections to Density in Air. Because the standard air buoyancy correction for liquids in this density range is -0.0011 g/ml, you can convert your certificate using this simple equation:

Draft Survey Correction = UKAS Certificate Correction – 0.0011

Example Calculation:

- You float your hydrometer in a sample of seawater and it reads 1.0250.
- Your UKAS g/ml certificate states that at the 1.0250 mark, the correction is +0.0008.
- You apply the conversion equation: $+0.0008 - 0.0011 = -0.0003$.
- Your new Draft Survey Correction is -0.0003.
- You apply this new correction to your reading ($1.0250 - 0.0003$) to get a final Density in Air of 1.0247 kg/l, which can now be safely multiplied by the ship's displaced volume.

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(Note: If a perfectly accurate draft survey hydrometer is sent for a standard g/ml calibration, the lab will naturally report a correction of +0.0011 across the scale. Applying the equation $[+0.0011 - 0.0011 = 0]$ correctly shows that the hydrometer has zero error for draft survey purposes).

7. Compliance summary

Strict adherence to these operational parameters is mandatory to ensure that all cargo weight determinations remain in full compliance with the UN/ECE Code of Uniform Standards for Draft Surveys. Adherence to these standards provides the authoritative basis required for all commercial and regulatory maritime declarations.