Australian Government
Australian Maritime Safety Authority

MARINE NOTICE

Marine Notice 2/2012
Supersedes 5/2006

The correct use of marine hydrometers

Two types of marine hydrometers are commonly found in the shipping industry. They are used to measure related properties but have different uses. The purpose of this marine notice is to highlight the correct usage of each type. Ships' officers, marine surveyors, draught surveyors and other persons involved in the loading of ships should be familiar with the correct usages so that no confusion arises in relation to overloading, stability calculations or draught surveys.

Load Line Hydrometers

Load line hydrometers are used to determine the displacement of a vessel at a given waterline and enable compliance with the requirements of the International Convention on Load Lines 1966. The Convention permits a vessel to load to the appropriate load line mark with a dock water allowance correction to compensate for the relative density of the water in which the vessel is floating. The Convention uses density in vacuo (i.e. mass per unit volume).

Load line hydrometers measure the relative density of a seawater sample at a standard temperature (T1) against pure water at a standard temperature (T2). Temperatures T1/T2 are usually 15º/15ºC or 60º/60ºF. In extreme cases of variation between the seawater sample temperature and the standard sample temperature a small temperature correction should be applied to compensate for the slight expansion or contraction of the hydrometer.

Draught Survey Hydrometers

Draught survey hydrometers are used to determine the apparent weight (i.e. the weight in air) of the vessel and from this the commercially accepted weight or apparent density of the cargo on board.

These hydrometers are also calibrated at standard temperatures but no temperature correction is required. A small error is introduced if the hydrometer is not at its standard temperature but this is compensated for by a change in volume of the ship. This change is due to the same temperature difference but the cubical expansion coefficient correction for steel expansion is of the opposite sign to that for glass expansion and the two differences tend to cancel each other out.

These hydrometers should not be used for load line purposes.

Relationship between hydrometers

The displacement and apparent weight of the vessel are related, as are the relative and apparent densities of the water the vessel is floating in. The difference between the relative density or specific gravity as determined by the load line hydrometer and the apparent density as determined by the draught survey hydrometer is termed the "air buoyancy correction" and corresponds to 0.002 for all usual ranges of marine related work. The correction is always added to the draught survey hydrometer reading to obtain the load line hydrometer reading ignoring any temperature corrections.

Example

The density of pure water at 15ºC is 0.9991kg/l. A seawater relative density reading of 1.025 on the load line hydrometer means that the seawater has an actual density of 1.025 x 0.9991kg/l = 1.0241kg/l. A one litre sample of seawater of this density will weigh 1.0241 kg in a vacuum.

Commercial weights are measured in air not in a vacuum and in air one litre of seawater will have a buoyancy force of 0.0011 kg. The commercial weight is therefore smaller than the weight in a vacuum by this amount. The one litre sample will weigh 1.0241 – 0.0011 = 1.023 kg in air.

For the sample of seawater the load line hydrometer shows a relative density of 1.025 and the draught survey hydrometer shows an actual density of 1.023 kg. Both are correct.

Most marine hydrometers have markings that indicate their type. Load line hydrometers are usually marked with the notation RD or Sp. Gr and the two standard temperatures, T1/T2. Draught survey hydrometers are usually marked with the units kg/l and temperature T. Like all testing equipment hydrometers should be regularly calibrated.

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6 January 2012

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File No: 007168-04