6.4 Technical Criteria for Hydrometer Laboratories[1]

6.4.1 Scope

This section outlines the specific technical requirements in accordance with which a laboratory should demonstrate that it operates if it is to be Recognized as competent to carry out calibrations of hydrometers.

6.4.2 References

[1] ASTM E 100-05: Standard Specification for ASTM Hydrometers (2005).

[2] ASTM E 126-05a: Standard Test Method for Inspection, Calibration, and Verification of ASTM Hydrometers (2005).

6.4.3 Statistical process control

6.4.3.1 All sources of variability for the hydrometer calibration should be monitored. Check standards should be used to ensure that the calibrations are carried out under controlled conditions. The laboratory should maintain statistical process control (SPC) commensurate with the accuracy levels needed for the calibration. The SPC control parameters should be based on measurements of check standards (or closure parameters) and the repeatability of multiple measurements. The frequency and number of process control checks should be appropriate for the level of uncertainty claimed for the calibration.

6.4.3.2 The laboratory should have control hydrometers that adequately span the range of materials and sizes normally calibrated by the laboratory. Every measured value of each control should be recorded and compared to its historic value to determine whether or not the process is in control. These values should be plotted on a control chart that has upper and lower control limits.

6.4.4 Accommodation and environment

6.4.4.1 The environmental conditions (i.e., temperature, atmospheric pressure and relative humidity) in the hydrometer calibration area should have no more than the maximum variations permitted, depending on the materials and the accuracy level needed for the calibration. The reference temperature for a particular hydrometer scale may vary from 15.56 °C (15.56 °C is approximately 60 °F, which is the reference temperature for petroleum products in the United States) to 20 °C. The laboratory should have the appropriate instrumentation required to measure the environmental conditions.

6.4.4.2 The density of the water used in hydrometer calibrations should be known to within 0.000005 g/cm3. Specific gravity is expressed as the ratio of the density of a liquid to the density of water at a specified temperature.

6.4.4.3 Vibration of equipment used in the hydrometer calibrations should be reduced to non-influential levels. If an obvious source of vibration exists, it should not adversely affect the laboratory's claimed uncertainty level.

6.4.4.4 Any laboratory that makes hydrometer comparisons should have an appropriate supply of calibration fluids with suitable surface tensions. Hydrometers should be calibrated in the liquids in which they are to be used.

6.4.4.5 Calibration liquids should be stored in an approved safety cabinet. Laboratories that make hydrometer comparisons should abide by all safety requirements set forth by a regulatory counsel, (e.g., chemical labeling, EPA and OSHA guidelines, etc.).

[6] This section is adapted from the NVLAP Calibration Laboratories Draft Technical Guide (NIST HB 150-2G); it is modified here for WMD application.

6.4.5 Equipment and reference materials

6.4.5.1 The laboratory should have the appropriate equipment required to perform hydrometer calibrations at the Recognized level. All equipment should be properly maintained.

6.4.5.2 The laboratory that performs hydrometer comparisons should have master hydrometers for which the calibrations are directly traceable to the appropriate national standards laboratory. The appropriate calibration corrections to these master hydrometers should be applied.

6.4.5.3 The laboratory should have the equipment needed to make auxiliary measurements of hydrometers, (e.g., balances, mass standards, knowledge of water density, etc.).

6.4.5.4 Any laboratory that makes hydrometer comparisons should abide by all safety requirements set forth by a regulatory counsel, (e.g., chemical labeling, EPA and OSHA guidelines, etc.).

6.4.5.5 The laboratory should have temperature measuring capabilities suitable to the calibration procedure. In the case of measuring the specific gravity of a liquid with a master hydrometer, temperature measurement of the liquid accurate to $\pm$ 0.01 °C is required.

6.4.5.6 A laboratory that makes hydrometer comparisons should have a ventilated chemical hood to exhaust any harmful fumes from the working area.

6.4.6 Calibration methods

6.4.6.1 The wide use of hydrometers for many different purposes has led to various stem scales for unique applications (e.g., specific gravity, percentage alcohol, degrees API, degrees Baume and Brix). The appropriate stem scale should be evaluated.

6.4.6.2 Ideally, hydrometers under test are compared directly to master hydrometers in the kinds of liquids in which they are to be used. This comparison is performed in a clear, smooth glass cylinder of suitable size. The calibration liquid should be well stirred before each comparison to minimize temperature gradient in the liquid.

6.4.6.3 The laboratory should have a manual detailing the procedures to follow for each type of hydrometers being calibrated. This manual should contain all pertinent information needed for calibration at a given Recognition level.

6.4.7 Handling of calibration items

6.4.7.1 Hydrometers should be cleaned and stored in a manner that prevents accidental contact with material that could damage the calibration surfaces. Since hydrometers are made of glass and can be easily broken, they should be handled only by an experienced operator.

6.4.7.2 Inspection should be made of all hydrometers for calibration for bent stems, twisted scales, and loose material inside the body of the hydrometer.

6.4.7.3 The hydrometer should be wiped with alcohol and dried to ensure a clean surface before it is immersed in the calibration liquid.

6.4.8 Calibration certificates and test reports

6.4.8.1 Summary sheets and data sheets should be used to document all calibrations. This documentation should be dated and initialed by the operator. A historical registry should be kept.

6.4.8.2 The uncertainty reported for the hydrometer should be derived from a model of the measurement system that includes, as applicable, the uncertainties due to:

1) master hydrometer;
2) long-term reproducibility of measurement system
3) thermal expansion; and
4) other appropriate factors.