National Conference on Weights and Measures / National Type Evaluation Program

Form 15: Proposal to Amend NIST Handbooks, NCWM Guidance Documents, Bylaws, or Publication 14

Submit proposals by August 15, 2021. See meeting dates at www.ncwm.com/meetings. If the item is deemed by a region to have merit, the region will forward the item to NCWM for national consideration. For more information on the Form 15 process, visit www.ncwm.com/standards-dev.

Submit in Microsoft Word Format to the NCWM Executive Director via email at don.onwiler@ncwm.com for review and dispersal to selected regions.

GENERAL INFORMATION			
1. Date: 08/15/2021	**2. Regional Association(s):** (Not applicable for proposals to the Board of Directors or NTEP Committee) _X_ Central (CWMA) X __ Northeastern (NEWMA) _X_ Southern (SWMA) _X_ Western (WWMA)		
3. Standing Committee: _X_ Laws & Regulations __ Specifications & Tolerances __ Professional Development __ Board of Directors __ NTEP Committee			
4. Submitter's Name: **Ronald Hayes**	**Submitter's Organization:** **Retired**		
5. Address: **133 Opie Rd**			
6. City: Olean	**7. State: MO**	**8. Zip Code:** 65064	**9. Country:** USA
10. Phone Number: 573-694-4776	**11. Fax Number:**	**12. Email Address:** hydrocarbonmixture@hotmail.com	

PROPOSAL INFORMATION
13. Purpose: Concise statement as to the intent or purpose of this proposal, such as problem being fixed. **(Do not include justification here.)**
Allow the use of digital density meters for package checking testing of viscous and non-viscous liquids.
14. Document to be Amended:
__ Handbook 44 __ Handbook 130 _X_ Handbook 133 __ NCWM Guidance Document __ NCWM Bylaws __ NTEP Administrative Policy
15. Cite portion to be Amended: Please file a separate Form 15 for each code, model law or regulation to be amended.
Section: Section 3 Paragraph: Amend by adding new sections.
16. Proposal: Please use ~~**strikeout**~~ to show words to be deleted and **underline** to show new words. **(Do not use track changes.)**

NET-xx.1 D Recognize the Use of Digital Density Meters

Source:
Ronald Hayes

Purpose:
Allow the use of digital density meters for package checking testing of viscous and non-viscous liquids .

Item Under Consideration:
Amend NIST Handbook 133 as follows:

3.X. Volumetric Test Procedure for Viscous and Non-Viscous Liquids by Portable Digital Density Meter

3.X Scope

Use these procedures to determine the net contents of package goods labeled in fluid volume.

This test method is suitable for measuring the density of homogenous liquids including dairy products such as milk and half and half petroleum products such as fuel, motor oil, transmission fluid and paint thinner, brake fluid, diesel exhaust fluid, automotive coolant, , pulp-free juices, wine, distilled spirits, water, mouth wash, alcohol, syrups, cooking oils, solvents, cleaning supplies, chemicals, as well as other viscous and non-viscous liquids.

This test method shall not be used for liquids with suspended solids such as orange juice with pulp, buttermilk, liquids requiring "shake before use" (paint), or carbonated products (soda, beer, etc.) and all products tested should be free of suspended gas, air, sediment, suspended mater, or substances not approved by the digital density meter manufacturer.

This test method may be used as a substitute for the volumetric flask test procedures or testing viscous fluids that cannot be tested properly by the volumetric headspace procedure due to non-rigid containers such as motor oil and transmission fluids in in oblong plastic containers.

Prior to using the method in official testing, the official's metrological laboratory should perform a comparison between the densities obtained between the HB 133 methods (sections 3.2 and 3.3) and the density meter prior to authorizing the inspector to use it for official enforcement actions.

This test method can be used for prescreening to allow the inspector to use the density from the meter to audit the product to see if there is a possibility that it is short measure and thus saving time and labor.

3.X.1. Test Equipment

- **A scale that meets the requirements in Chapter 2, Section 2.2. "Measurement Standards and Test Equipment."**

  Note: To verify that the scale has adequate resolution for use, it is first necessary to determine the density of the liquid; next verify that the scale division is no larger than MAV/6 for the package size under test. The smallest graduation on the scale must not exceed the weight value for MAV/6.

Example:

Assume the inspector is using a scale with 1 g (0.002 lb) increments to test packages labeled 1 L (33.8 fl oz) that have an MAV of 29 mL (1 fl oz). Also, assume the inspector finds that the weight of 1 L of the liquid is 943 g (2.078 lb).

Density: 1 L = 943 g (2.078 lb)

MAV: 29 mL (1 fl oz)

Convert Density into mL and fl oz:

943 g ÷ 1000 mL= 0.943 g/mL (2.07 8 lb ÷ 33.8 fl oz = 0.061 4 lb/fl oz)

Convert MAV from Volume (mL/fl oz) to Weight:

29 mL × 0.943 g/mL = 27.347 g 1 fl oz × 0.061 4 lb/fl oz = 0.064 lb)

MAV in Weight/6

27.347 g ÷ 6 = 4.557 g 0.064 ÷ 6 = 0.010 lb

In this example, the 1 g (0.002 lb) scale division is smaller than the MAV/6 value of 4.557 g (0.010 lb) so the scale is suitable for making a density determination.

lb) i

- **Air pump, low pressure– an aquarium air pump (to dry out measuring cell)**
- **Syringe, glass or plastic with Luer fitting (5mL or larger) - Note: Plastic syringe should be free of any lubricating substances**
- **Stopwatch (optional)**
- **Distilled or deionized water**
- **Cleaning agents (See Table 3.X4. Cleaning Agents)**
- **Waste container**
- **Barometer (optional), or other device for obtaining the prevailing barometric pressure, with an accuracy of ±3.0 mmHg – Note: smart phones with a barometer application that uses the phone's pressure sensor, have a typical accuracy of ±0.2 mmHg** ***(comment: barometer is not necessary if prevailing barometric pressure or altitude is known)***
- **Thermometer for measuring air temperature with a tolerance of ±1°C (2°F)**
- **Portable digital density meter meeting a minimum requirement of:**

Measuring Range	
Density	0 – 3 g/cm^3
Temperature	0 – 4 °C (32 – 104 °F)[a]
Viscosity	0 – 1000 mPa·s
Accuracy[b]	
Density	0.001 g/cm^3
Temperature	0.2 °C (0.4 °F)
Repeatability s.d.	
Density	0.0005 g/cm^3

Temperature	0.1 °C (0.1 °F)
Sample Volume	2 mL
Sample Temperature	max. 100 °C (212 °F)
footnotes **[a] Filling at higher temperatures possible.** **[b] Viscosity < 100 mPa·s, density < g/cm^3**	

3.X.2 Test Procedure

1. **Follow Section 2.3.1. "Define the Inspection Lot." Use a "Category A" sampling plan in the inspection. Select a random sample.**

2. **Bring the sample packages and their contents to a temperature between the reference temperature and ambient temperature.**

   Note Shaking liquids, such as flavored milk, often entraps air that will affect volume measurements, so use caution when testing these products. Often, less air is entrapped if the package is gently rolled to mix the contents.

3. **The instrument must at ambient temperature. Avoid causing condensation within the unit. Condensation could cause instrument malfunction and harm.**

4. **Validate the digital density meter per the manufacturer's calibration instructions. Instrument shall calibrate within allowable density range (±0.0005)**

5. **Ensure the digital density meter is clean prior to testing. Any residual liquid should be drained and the unit should be flushed with a small amount of the sample to be tested.**

6. **Follow the manufacturer's instructions to select the correct method, when using a meter with built in correction factors, and measure the density of the sample using the built-in pump or syringe. Fill sample gently. If gas or air bubbles are present drain sample and refill. Note: a syringe may be desirable to allow sample specimen to achieve ambient temperature prior to introduction of specimen into testing cell and for viscous specimens.**

7. **Once digital density meter has stabilized (maintained reading ±0.2°C (±0.5°F) for 10 seconds) record density and temperature as indicated on instrument.**

8. **Apply coefficient of expansion (Alpha) also known as the volume correction factor, to correct to the reference temperature. See Table 3-X1. Reference Temperatures of Liquids. If the Alpha correction is not known then factor can be calculated using the below formula. Note: Some digital density meters may be programmed to automatically apply this correction.**

   Calculating the Temperature Coefficient Alpha

   Temperature coefficient Alpha = $\left|\frac{\rho^1-\rho_2}{T^1-T_2}\right|$

   ρ_1 ….*density at temperature* T_1
   ρ_2 …. *density at temperature* T_2
   T_1 …. *temperature at initial measurement*
   T_2 …. *temperature at second measurement*

9. **Apply viscosity correction if viscosity > 85 centipoise at 21°C (70 °F) by adding the value in Table 3.X. Density Measurement to your density measurement. After this correction, this value is the density of the substance in Vacuo at the prescribed reference temperature.**

Note: Some units may be programmed to automatically apply. See Table 3.X. Approximate Viscosities of Common Materials for viscosity correction.

10. **Apply the apparent density correction by multiplying the density by 0.999 or for higher accuracy, by multiplying the density by the Apparent Mass Factor from Table X.2 The table was derived from the following procedure and may be used in lieu of values in the table: Calculate the Conventional Mass using the formula below to correct density to apparent density. to correct density to apparent density of product at prevailing atmospheric pressure or for higher accuracy calculate apparent density by using the following formula (terms as defined in NIST Standard Operating Procedure SOP 2 "Recommended Standard Operating Procedure for Applying Air Buoyancy Corrections. After application of this factor, the new value is density of the substance in air**

3.2.3. Calculate the Conventional Mass[6] of S_c, CM_{Sc}.

$$CM_{Sc} = \frac{M_{S_c}\left(1 - \frac{\rho_n}{\rho_{Sc}}\right)}{\left(1 - \frac{\rho_n}{8.0}\right)}$$

https://www.nist.gov/pml/weights-and-measures/laboratory-metrology/standard-operating-procedures

11. **Drain the instrument and repeat Steps 6–10 on a second specimen of the same package for verification of first measurement.**

12. **Compare the two readings, they must agree within 0.0003 g/cc. Calculate the average density of the two specimens from the sample. If the difference of two readings is greater than 0.0003 g/cc, discard results and repeat testing of sample. Air or undissolved gas will cause erroneous measurement errors. The user of the test method shall always visually inspect for undissolved gas in the measurement tube for a valid test.**

13. **Repeat testing for the second (or subsequent) package(s) of the lot.**

14. **Calculate the average of sample 1 and sample 2; the two results must agree within 0.0003 g/cc. If the difference between the densities of the two packages exceeds 0.0003 g/cc, use the volumetric procedure in Section 3.3. "Volumetric Test Procedure for Non-Viscous Liquids." for non-viscous liquids.**

15. **Convert the unit of the average density back to the unit of measure specified on the package label i.e. pounds/fluid ounce, etc.**

16. **The digital density meter must be stored clean. After final use of the day or extended period of time, the instrument should be drained and cleaned following the manufacturer's recommended cleaning procedures. Two cleaning agents should be used. The first cleaning liquid removes sample residue and the second cleaning liquid removes the first cleaning liquid. See Table 3.X. Cleaning Agents for examples of cleaning agents recommended by a particular digital density meter manufacturer.**

    NOTE: If the unit will be immediately used to measure another sample of similar composition, the unit may be drained and flushed with new sample three times before next analysis.

17. **Connect digital density meter to a low-pressure air source , such as an aquarium air pump, to dry the unit's measurement cell.**

3.X.3. Evaluation of Results

Follow the procedures in Section 2.3.7. "Evaluate for Compliance" to determine lot conformance.

Table X.1			
Notice: This Table is currently under review. Do not use without validation.			
Product	**alpha/°C**	**Typical Density at 20°C, kg/L**	**Reference Temperature, °C**
Petroleum Products			
Benzene	0.00125	0.989	15.56
n-Heptane	0.00124	0.684	15.56
Gasoline	0.00095	0.74	15.56
Kerosene, jet fuel	0.00099	0.81	15.56
Oil (unused engine oil)	0.0007		15.56
Paint Thinner			15.56
Paraffin oil	0.000764		15.56
n-Pentane	0.00158		15.56
Toluene	0.00108		15.56
Generalized Petroleum Products (ASTM D1250 Table 54B)			
Distilled Spirits			15.56
Other liquids and Wine			
Acetic acid	0.0011		20
Acetone	0.00143	0.799	20
Alcohol, ethyl (ethanol)	0.00109	0.789	20
Alcohol, methyl	0.00149	0.792	20
Ammonia	0.00245		20
Aniline	0.00085	1.022	20
Ether	0.0016		20
Ethyl acetate	0.00138		20
Ethylene glycol	0.00057	1.115	20
Isobutyl alcohol	0.00094		20
Glycerine (glycerol)	0.0005	1.261	20
Olive oil	0.0007		20

Sulfuric acid, concentrated	0.00055		20
Turpentine	0.001		20
Water	0.00018	0.9982	20
Diesel Exhaust Fluid	0.00022	1.08805	20
Dairy Products	**alpha/°C**	**Typical Density at 4°C, kg/L**	**Reference Temperature, °C**
Homogenized milk	0.00025	1.033	4
Skim milk, pkg	0.00019	1.036	4
Fortified skim	0.00019	1.041	4
Half and half	0.00044	1.027	4
Half and half, fort.	0.00044	1.031	4
Light cream	0.00056	1.021	4
Heavy cream	0.00088	1.008	4

Table X.0. Density Measurement

Calculate the density of air at the temperature of test using the following equation:

d_{air}, g/mL = 0.001293[273.15/T][P/760]

where:

T = temperature, K, and

P = barometric pressure, torr.

°C	mmHg	d_{air}, g/mL
15.56	760	0.001223314

Table X.2. Approximate Viscosities of Common Materials

Material	Viscosity in Centipoise	Correction
Water	1 cps	
Milk	3 cps	
SAE 10 Motor Oil	85–140 cps	0.0003
SAE 20 Motor Oil	140–420 cps	0.0006
SAE 30 Motor Oil	420–650 cps	0.0007

SAE 40 Motor Oil	**650–900 cps**	**0.0007**
Castrol Oil	**1,000 cps**	**0.0008**
Karo Syrup	**5,000 cps**	**0.0008**
Honey	**10,000 cps**	**0.00085**

Table X.3 Apparent Mass Factor					
Elevation, ft	sea level	1500	3000	4500	6000
Barometer, mmHg	760	**720**	680	640	600
density, g/cc	**Apparent Mass Factor**				
0.500	0.9977	0.9979	0.9980	0.9981	0.9982
0.600	0.9981	0.9982	0.9983	0.9984	0.9985
0.700	0.9984	0.9985	0.9986	0.9987	0.9988
0.800	0.9986	0.9987	0.9988	0.9989	0.9989
0.900	0.9988	0.9989	0.9989	0.9990	0.9991
1.000	0.9989	0.9990	0.9991	0.9991	0.9992
1.100	0.9991	0.9991	0.9992	0.9992	0.9993
1.200	0.9991	0.9992	0.9992	0.9993	0.9993
1.300	0.9992	0.9993	0.9993	0.9993	0.9994
1.400	0.9993	0.9993	0.9994	0.9994	0.9994
1.500	0.9993	0.9994	0.9994	0.9994	0.9995
Elevation or prevailing barometric pressure at the location of measurement.					

Table 3.X4. Cleaning Agents		
Commodity	**Cleaning Liquid 1**	**Cleaning Liquid 2**
Petroleum products	**Toluene, petroleum naptha, petroleum ether, n-nonane, cyclohexane**	**Ethanol**

Battery acid	**Tap water**	**Ultra-pre (bi-distilled or deionized) water**
Liquid soap & detergent, shampoo	**Tap water**	**Ultra-pre (bi-distilled or deionized) water**
Salad dressing, mayonnaise	**Petroleum naptha, dish washing agent in water**	**Ethanol**
Sun tan lotion	**Tap water**	**Ethanol**
Spirits	**Tap water**	**Ultra-pre (bi-distilled or deionized) water**
Grape juice, syrup	**Warm tap water**	**Ultra-pre (bi-distilled or deionized) water**
Milk*	**Tap water, enzymatic lab cleaner**	**Ultra-pre (bi-distilled or deionized) water**

***Do not introduce ethanol or other alcohols into instrument without first flushing all milk products from instruments.**

Referenced Documents

ASTM D7777 Standard Test Method for Density, Relative Density, or API Gravity of Liquid Petroleum by Portable Digital Density Meter

ASTM D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

ASTM D5931 Test Method for Density and Relative Density of Engine Coolant Concentrates and Aqueous Engine Coolants by Digital Density Meter

OIML Guide G 14 Density measurement g014-e11.pdf (oiml.org)

(71) Manual to Digital Density Measurement - YouTube

17. Justification: Please include national importance, background on the issue, and reference to supporting data or documents.

Current test procedures are slow and awkward due to the need of using borosilicate glassware for package checking. Digital density meters are fast, use small samples size (2 ml) and have built in thermometers.

Fast and accurate.

Using digital density meters equipped with built-in API density tables will not require the cooling samples to 60 F.

No need to "wet down" volumetric flasks before each measurement

Most non-food products may be recovered without contamination.

Only small sample size (2 ml) of the product is needed for testing.

No need for partial immersion thermometer or volumetric flasks.

Current method in "Section 3.4 Volumetric Test Procedures for Viscous Fluids – Headspace" does not work for plastic oblong bottles often used for motor oil.

Eliminates the entrapment of air in testing viscous fluids (i.e. motor oil, DEF, antifreeze, syrups, etc.)

18. Possible Opposing Argument's: Please demonstrate that you are aware and have considered possible opposition.
No opposition expected
19. Requested Action if Considered for NCWM Agenda:
_X_ Voting Item ___ Developing Item ___ Informational Item ___ Other (Please Describe):
20. List of Attachments: Proposal in document form. Links to vender YouTube…see end of section 16.