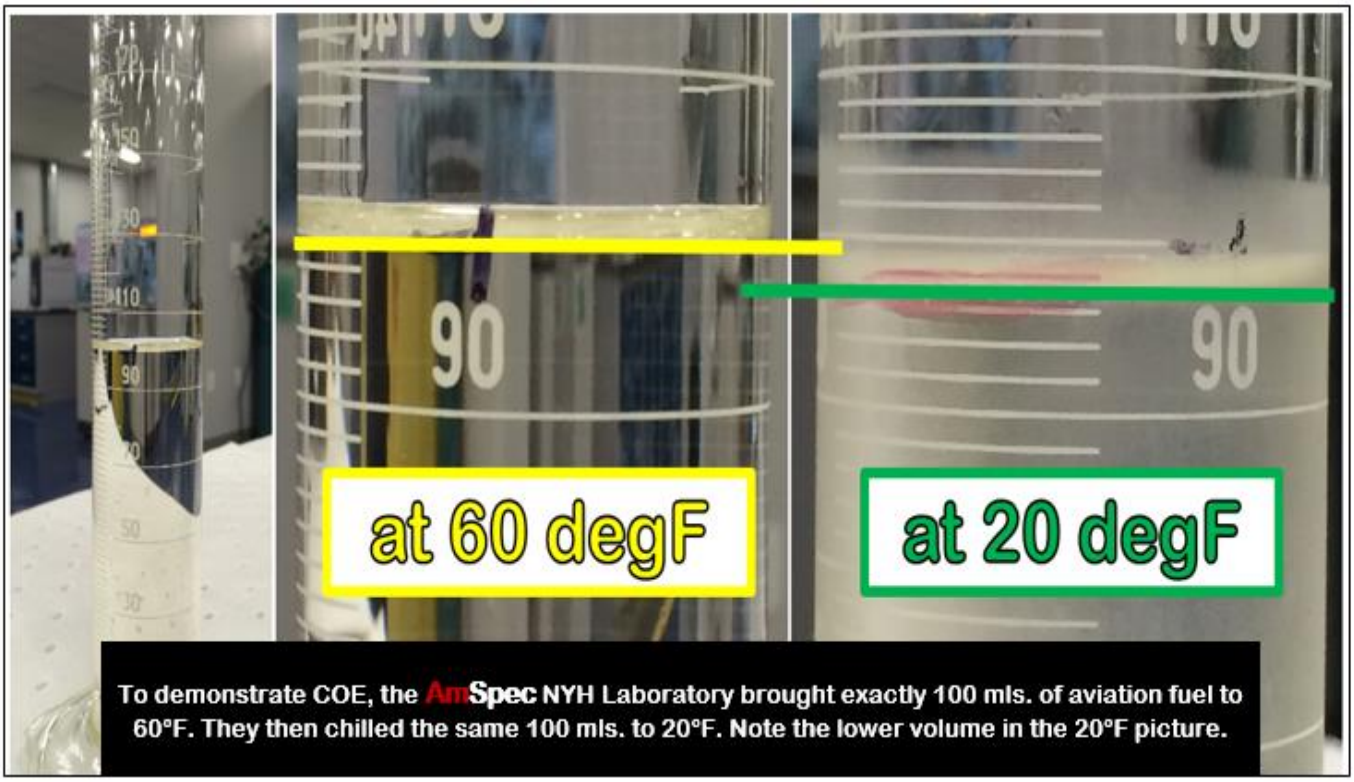
We're Going Global

THE IMPACT OF PRODUCT TEMPERATURE

Petroleum products expand when heated and contract when cooled. This rate of expansion or contraction is called the coefficient of expansion (COE).
The COE is higher for lighter substances, for example, gasoline expands with temperature at a faster rate than residual fuel oil.

Without temperature and temperature correction, we would only be dealing with observed (gross) numbers which are called Total Observed Volume (TOV) and GOV Gross Observed Volume (GOV). If we only used gross volumes, one of the parties, either the buyer or the seller would unfairly be losing barrels during the transaction.
It is impossible to compare "apples to apples" unless all numbers are corrected to the same standard temperature.

The petroleum industry uses Gross Standard Volume (GSV) in all transactions. It is the total volume of all petroleum liquids and sediment and water, excluding free water, corrected by the appropriate volume correction factor (VCF) for the observed temperature and API gravity or density, to a standard temperature of 60°F or 15°C.



History of the Temperature Correction Tables

Temperature Correction Tables are so vital to accurate accounting, they have been modified numerous times over the years for better accuracy and uniformity when accounting for the thermal expansion / contraction of liquid hydrocarbons.
Here's a history of the modifications that took place.

- **1916** The first tables were done by the National Bureau of Standards (United States).

- **1945** The Institute of Petroleum (IP) published the Tables for Measurement of Oil in British units. The compressibility standard (API Standard 1101, Appendix B, Table II) were issued.

- **1952** American Society for Testing and Materials (ASTM) and the IP joined the British and the American temperature correction factor tables to make the Petroleum Measurement Tables. These tables are commonly referred to as the 1952 Tables or "Blue Book Tables."

- **1974** API started an initiative to re-confirm the temperature correction factor tables. Until 1974, "Old" Table 6 and "Old" Table 54 were used by both importers and exporters for all cargoes, products as well as crude oil.

- **1980 to mid-1990s** Tables separated the density and volume correction tables into "A" for crude oil, "B" for refined products, and "C" for special applications. Between the initial issuance of the 1980 Tables and the mid-1990s, a number of needs arose within the petroleum industry and a number of enhancements occurred in computer technology.

- **1984** More accurate tables were introduced. Developed by the API (American Petroleum Institute) jointly with the I.P. (Institute of Petroleum). These are 6A, 6B, 6C, 6D and 54A, 54B, 54C and 54D.

- **2006** The API once again introduced new tables. They went to 5 decimal places for VCF and every 0.1 gravity and 0.5 Temperature. If the old table was approximately 300 pages – the new would need to be *11,000 pages* so it must be done electronically.

  A is used for CRUDE oils
  B is used for PRODUCTS (2oil, 6oil etc.)
  C is used for CHEMICALS
  D is used for LUBE OILS

- Tables 54A / 6A and 54B / 6B are really the same tables.
- Tables 6A and 6B are based on Fahrenheit temperatures and API gravity whereas Tables 54A and 54B are based on Centigrade temperatures and Density. Any difference is due to rounding of temperature or density.

Temperatures play such an important role in accurate accounting, the American Petroleum Institute has dedicated many chapters of its manual to this subject.

Current API Manual of Petroleum Measurement Standards
Chapter 7—Temperature Determination

The purpose of this standard is to describe methods and practices that may be used to obtain accurate measurements of temperature of petroleum and petroleum products in pipelines, storage tanks, gathering tanks, ships, barges, tank cars, pipe provers, tank provers and test measures under both static and dynamic conditions using electronic temperature measuring devices or mercury-in-glass thermometers.

Current API Manual of Petroleum Measurement Standards Chapter 12.1.1 Part 1
Calculation of Static Petroleum Quantities—Upright Cylindrical Tanks and Marine Vessels

This standard guides the user through the steps necessary to calculate static liquid quantities in cylindrical tanks and marine tank vessels.

Tanks and Marine Vessel's Tanks

10.1 Gross Standard Volume (GSV)

The GSV is calculated by multiplying the GOV by the correction for the effect of temperature and pressure on the liquid (or the volume correction factor). GSV = GOV × CTPL

10.2 Correction for the Effect of Temperature and Pressure on a Liquid (CTPL) or Volume Correction Factor (VCF)

If a quantity of oil is subjected to a change in temperature, its volume will increase as the temperature rises or decrease as the temperature falls. The volume change is proportional to the thermal coefficient of expansion of the liquid, which varies with density (API gravity) and temperature. The correction factor for the effect of the temperature and pressure on a volume of liquid is called CTPL, CTL, or VCF. The function of this correction factor is to adjust the volume of liquid at observed temperature to its volume at a standard temperature. The most common standard temperatures are 60 °F, 15 °C, and 20 °C (68 °F). These correction factors can be obtained from API MPMS Ch. 11.1, the Adjunct to ASTM D1250, or the Adjunct to IP 200. These computer programs or tables are entered with the observed average temperature and API gravity at 60 °F, a density at 15 °C, a relative density at 60 °F/60 °F, or a coefficient of thermal expansion.

Current API Manual of Petroleum Measurement Standards
Chapter 17.1 - Guidelines for Marine Inspection

These guidelines specify the policy and minimum recommended practices for the manual and automatic measurement, sampling, and accounting for bulk quantities of crude oil, petroleum products, and chemicals that are transported on marine vessels.

Current Manual of Petroleum Measurement Standards
Chapter 17.2—Measurement of Cargoes On Board Tank Vessels

To determine the quantity and quality of cargo on board marine tank vessels, it is necessary to accurately gauge, temperature, collect a representative sample, and calculate the amount of all materials contained in the vessel's lines, cargo tanks, and slop tanks. Any void spaces that may contain cargo, such as permanent ballast tanks, double bottoms, and cofferdams, must also be checked, and any volumes contained in these spaces must be calculated. This standard establishes the procedures for obtaining the level measurements of cargo, free water, and OBQ/ROB as well as taking the temperatures and samples required for the marine custody transfer of most bulk liquid petroleum cargoes.

THERMOPROBE WITH CALIBRATION CERTIFICATE

PETRO MARINE

CERTIFICATE OF CALIBRATION

Manufacturer: ThermoProbe Model: TP9 Serial # 9-01270

This is to certify that the instrument listed above has been calibrated in our laboratory. PETRO-MARINE certifies that this instrument has been calibrated using standards and instruments which are traceable either directly or indirectly to the N.I.S.T. The standards and instruments used in the calibration are supported by a system which meets or exceeds the requirements of the AMERICAN PETROLEUM INSTITUTE, Manual of Petroleum Measurement Standards, Chapter 7. Supporting documents are available for examination upon request.

Master Manufacturer: Techne – Model WSP425

Master Thermometer Serial Numbers: 9BE9A7, 9BE9A9, 9BE9A8

READING OF THIS INSTRUMENT	READING OF N.I.S.T. STANDARD
31.8 °F	31.9 °F
120.1 °F	120.1 °F
199.9 °F	199.8 °F

This instrument has been calibrated in terms of the standard maintained at this laboratory and was returned.

☒ Within API SPECIFIED ACCURACY
☐ OTHER please specify

Photo: http://www.thermoprobe.net/

"WOODBACK" CUP CASE THERMOMETER

If you would like to be removed from our distribution list or you require information on a certain subject, please let us know via return email. Also, please be advised individual / group AmSpec laboratory / operational tours can be arranged upon request.

Please visit us on our website…www.amspecgroup.com or contact us at (800) 286-2208

Thermoprobes vs. Thermometer

- Thermoprobes are more accurate (can be to 0.1F vs thermometers read to 0.5F)
- Thermometers need to be pulled out of the product to read and are subject to outside weather temperatures; probes are read while still submersed in product therefore making use of thermoprobes quicker and more accurate.
- Immersion time – According to API Chapter 7 here is a quick comparison of how the thermoprobe compares to a woodback thermometer regarding immersion times depending on the volume and whether in motion or stationary:

Gravity	Thermometer	Thermoprobe
	*Motion / Stationary	* Motion / Stationary
Over 50	5 minutes / 10 minutes	30 sec / 5 minutes
Over 40-49	5 minutes / 15 minutes	30 sec / 5 minutes
30 - > 39	12 minutes / 20 minutes	45 sec / 30 minutes
20 - > 29	20 minutes / 35 minutes	45 sec / 30 minutes
Less than 20	35 minutes / 60 minutes	75 sec / 30 minutes

*Motion means rather than letting the probe sit still in the liquid, it is repeatedly raised One foot above and below the desired depth. This prevents cold probe chilling the surrounding product.

Thermoprobes and Equipment Calibrations Checks

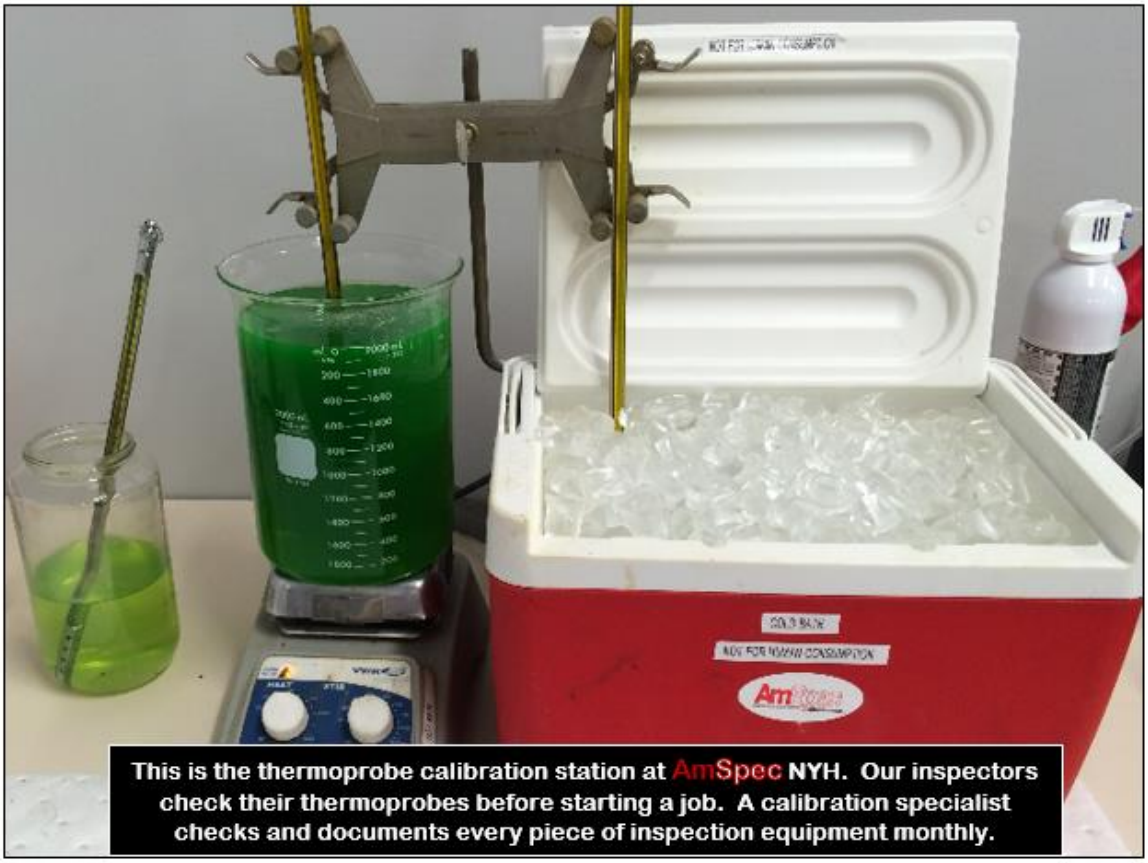
It is required that before initial use, and at least once a year thereafter, each portable electronic thermometer (PET), or also referred to as a probe, shall be re-standardized in a laboratory or other qualified calibration facility. The PET shall be compared at three or more temperature points, near the midpoint and ends of the range, with either a National Institute of Technology (NIST) certified reference thermometer or an equivalent thermometer with accuracy traceable to the NIST. The PET shall be calibrated in accordance with the manufacturer's instructions.

Field Verification

Before each use, or once per day (whichever is less frequent), PETs should be spot checked by comparing the ambient reading against an ASTM glass stem thermometer in liquid. If the reading differs by more than ± 0.5°F (0.25°C), the probe (PET) should be re-standardized before it is used for custody transfer. IFIA (International Federation of Inspection Agencies) states it must be restandardized if it is in error more than 0.2°F.

Monthly Verification and Inspection

On a monthly schedule, the probe should be checked at two or more temperatures near the ends of its range against a NIST certified reference thermometer or an equivalent thermometer with accuracy traceable to the NIST.



This is the thermoprobe calibration station at AmSpec NYH. Our inspectors check their thermoprobes before starting a job. A calibration specialist checks and documents every piece of inspection equipment monthly.

AmSpec

PORTABLE ELECTRONIC THERMOMETERS
MONTHLY TEMPERATURE UNIT VERIFICATION
AT TWO TEMPERATURES

NAME: Lenyn Acosta
LOCATION: NYH
YEAR: 2015

DATE	Model Type	Unit Number	HIGH Nist Thermometer No.	LOW Nist Thermometer No.	TEMPERATURE		VARIANCE		CALIBRATED BY
					HIGH	LOW	HIGH	LOW	
1/6/15	Thermoprobe	TP2C-0616	718445	647856	141.4	32.2	+.1	0	Kevin Krueger
1/22/15	Thermoprobe	TP5C-1252	718445	647856	143.6	32.2	+.1	-.1	Kevin Krueger
2/6/15	Thermoprobe	TP9-01270	718445	647856	144.4	32.2	0	+.1	Kevin Krueger
2/24/15	Thermoprobe	TP9-01270	718445	647856	143.2	32.2	-.1	0	Kevin Krueger
3/12/15	Thermoprobe	TP9-01270	718445	647856	145.2	32.2	-.2	-.2	Kevin Krueger
4/29/15	Thermoprobe	TP9-01270	718445	647856	144.6	32.2	-.1	-.2	Kevin Krueger
5/26/15	Thermoprobe	TP9-01270	718445	647856	136.2	32.2	0	-.2	Kevin Krueger
6/26/15	Thermoprobe	TP9-01270	718445	647856	137.0	32.2	+.1	-.2	Kevin Krueger