Manual of Petroleum Measurement Standards, Chapter 7.1

Temperature Determination—Liquid-in-Glass Thermometers

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INTRODUCTION

This section describes how to correctly use various types of liquid-in-glass thermometers to accurately determine the temperatures of hydrocarbon liquids. Other methods, equipment, and procedures for temperature determination are described in the other sub-sections of API *Manual of Petroleum Measurement Standards (MPMS)* Chapter 7.

Temperature Determination—Liquid-in-Glass Thermometers

1 Scope

This section describes how to correctly use various types of liquid-in-glass thermometers to accurately determine the temperatures of hydrocarbon liquids. Other methods, equipment, and procedures for temperature determination are described in the other sub-sections of API *MPMS* Chapter 7.

This chapter describes the methods, equipment, and procedures for manually determining the temperature of liquid petroleum and petroleum products with liquid-in-glass thermometers. This chapter discusses temperature measurement requirements in general for custody transfer, inventory control, and marine measurements. The actual method and equipment selected for temperature determination are left to the agreement of the parties involved.

The manual method covers:

— Non-pressurized tanks and non-pressurized marine vessels

— Gas-blanketed tanks and gas-blanketed marine vessels

It does not cover hydrocarbons under pressures in excess of 21 kPa gauge (3 psi gauge) or cryogenic temperature measurement, unless equipped with a thermowell.

The requirements of this chapter are based on practices for crude oils and petroleum products covered by API *MPMS* Chapter 11.1 (ASTM D1250). Requirements in this chapter may be used for other fluids and other applications. However, other applications may require different performance and installation specifications.

2 Normative References

Manual of Petroleum Measurement Standards (MPMS)

— Chapter 1, *Terms and Definitions*

— Chapter 2, *Calibration of Upright Cylindrical Tanks* (All Sections)

— Chapter 3, *Tank Gauging* (All Sections)

— Chapter 8.1, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*

— Chapter 11.1, *Physical Properties Data, Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils*

— Chapter 12.1.1, *Calculation of Static Petroleum Quantities—Upright Cylindrical Tanks and Marine Vessels*

— Chapter 12.2, *Calculation of Petroleum Quantities Using Dynamic Methods and Volumetric Correction Factors*

— Chapter 15, *Guidelines for Use of the International System of Units (SI) in the Petroleum and Allied Industries*

— Chapter 18.1, *Custody Transfer—Measurement Procedure for Crude Oil Gathered From Lease Tanks by Truck*

RP 500, *Recommended Practice for Classifications of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*

RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

RP 3000, *Classifying and Loading of Crude Oil into Rail Tank Cars*

ASTM [1]

D1250, *Standard Guide for Use of the Petroleum Measurement Tables*

E1, *Standard Specification for ASTM Liquid-in-Glass Thermometers*

E77, *Standard Test Method for Inspection and Verification of Thermometers*

E344, *Terminology Relating to Thermometry and Hydrometry*

E2251, *Standard Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids*

OCIMF [2]

International Safety Guide for Oil Tankers and Terminals (ISGOTT)

NIST [3]

NIST Special Publication 1088, *Maintenance, Validation, and Recalibration of Liquid-in-Glass Thermometers*

NFPA [4]

NFPA 70, *National Electrical Code*

3 Terms and Definitions

For the purpose of this document, the following definitions apply. Refer to API *Manual of Petroleum Measurement Standards (MPMS)* Chapter 1 and ASTM E344 for the definition of additional terms used in this standard.

3.1
degree

3.1.1
degree Celsius (°C)
A derived unit of temperature in the International System of Units (SI).

3.1.2
degree Fahrenheit (°F)
A non-SI unit of temperature used in the U.S. Customary (USC) system of units. At any temperature, an interval of one degree Fahrenheit is the same as an interval of $^5/_9$ degree Celsius.

°F = (°C * 9/5) + 32

3.2
temperature discrimination
The ability to sense and record the actual temperature of a liquid to the specified temperature increments.

1 American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428.
2 Oil Companies International Marine Forum, 6th Floor, Portland House, Stag Place, London SW1E 5BH.
3 National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899.
4 National Fire Prevention Association, 1 Batterymarch Park, Quincy, MA 02169.

3.3
thermometer
A device that measures temperature using any of a variety of different principles. A thermometer has two important components: a temperature sensor in which some physical change occurs that is dependent on temperature, and some means of indicating and/or transmitting this physical change as a value.

3.3.1
liquid-in-glass thermometer (LIGT)
A glass thermometer containing mercury or a low-hazard liquid that indicates the temperature being measured.

3.3.2
low-hazard liquid
A liquid that is biodegradable, non-hazardous and considered non-toxic in quantities specified for the thermometer specification.

3.3.3
mercury-in-glass thermometer (MIGT)
A glass thermometer containing mercury that indicates the temperature being measured.

3.3.4
partial-immersion thermometer
A liquid-in-glass thermometer designed to indicate temperatures correctly when the bulb and a specified part of the stem are exposed to the medium being measured.

3.3.5
total-immersion thermometer
A liquid-in-glass thermometer designed to indicate temperatures correctly when just that portion of the thermometer containing the liquid is exposed to the medium being measured.

4 General Precautions

4.1 Safety

Safety shall be considered for the specification, installation and operation of all equipment. Refer to API RP 500 and NFPA 70 for guidance. When loading liquids that can accumulate static charges, refer to the precautions described in the *International Safety Guide for Oil Tankers and Terminals*, *Safety of Life at Sea*, API *MPMS* Chapter 3, and API RP 2003. Care must be taken with all liquid-in-glass thermometers to prevent breakage, which will result in a safety hazard. If the liquid in the thermometer is mercury, additional care must be taken.

4.1.1 Mercury Warning

WARNING: Mercury has been designated by the Environmental Protection Agency (EPA) and many state agencies as a hazardous material that can cause central nervous system, kidney and liver damage. Mercury or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable product Safety Data Sheet (SDS) or Material Safety Data Sheet (MSDS) for details, and the EPA website http://www.epa.gov/mercury/faq.htm for additional information. Users should be aware that selling mercury or products containing mercury, or both, in your state may be prohibited by state law.

5 Units of Measure

For custody transfer, the means of temperature determination should be agreed to among the parties involved. Temperatures referenced in this document are those defined by the International Temperature scale of 1990 (ITS-90). Temperatures may be measured and expressed in degrees Celsius or in degrees Fahrenheit. This standard presents