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Standard Practice for Calibration of Upright Cylindrical Tanks Using the Optical Reference Line Method¹

This standard is issued under the fixed designation D 4738; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This practice has been approved by the sponsoring committees and accepted by the cooperating societies in accordance with established procedures.

¹ NOTE—Editorial corrections were made in Table 1, Fig. 3, and Fig. 4 on Jan. 5, 1990.

INTRODUCTION

The optical reference line method (ORLM) is an alternative method to tank strapping for determining tank diameter. The primary difference between ORLM and the strapping method is the procedure for determining tank diameter at shell courses other than the bottom course. The optical reference line method provides for measuring a reference diameter on the bottom course by manual strapping and measuring deviations in tank diameter at other predetermined horizontal and vertical stations by using an optical device. Other required special measurements, procedures, methods, and analytical tools for the development of a tank capacity table are identical to those stated in API Standard 2550, *Measurement and Calibration of Upright Cylindrical Tanks*.

1. Scope

1.1 This practice describes measurement and calculation procedures for determining the diameters of upright welded (lap/butt) cylindrical tanks or vertical cylindrical tanks with smooth outside surface with either floating or fixed roofs. This practice should be used in conjunction with API Standard 2550. There are a few occasions when there may be limitations to the application of the ORLM techniques described in this standard. Specifically, the use of the ORLM is not suitable for:

1.1.1 Abnormally deformed (for example, severely dented or having visible signs of damage) tanks. These tanks are excluded from this practice and should be repaired prior to calibration.

1.1.2 Outside measurement of insulated tanks. For application of ORLM, the insulation must be stripped, if possible. ORLM may be used on the interior of the tank; however, the reference circumference on the bottom course must be measured externally if possible, requiring the removal of insulation at the bottom course. This measurement shall conform to the procedures described in API Standard 2550.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is*

the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.4 The values in inch-pound units are the preferred units. The values in parentheses are for information only.

2. Referenced Document

2.1 *American Petroleum Institute Standards:*
API 2550 Method for Measurement and Calibration of Upright Cylindrical Tanks²

3. Terminology

3.1 Definitions:

3.1.1 Definitions listed in API MPMS Chapter 1, "Vocabulary" and Standard 2550 are applicable to this standard. In addition, the following definitions are relevant to ORLM:

3.1.1.1 *horizontal station*—a pre-established location in the horizontal plane at ground level along the tank circumference.

3.1.1.2 *offset*—the measurement observed through the optical device on the horizontal scale of the traversing magnetic slide at each vertical station.

3.1.1.3 *optical device*—an optical plummet or a theodolite equipped with a precision level.

3.1.1.4 *reference circumference*—the circumference of a

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² Available from American Petroleum Institute, 2201 Reed, N.W., Washington, DC 20005.

D 4738

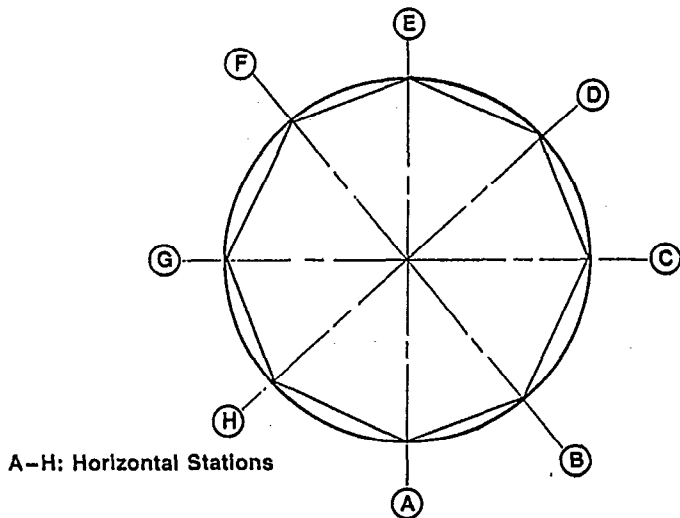


FIG. 1 Plan (Shown for Eight Stations)

tank measured by the strapping method on the bottom course very close to the reference offset location.

3.1.1.5 *reference offset*—the measurement observed on the horizontal scale of the traversing magnetic slide at the vertical station on the bottom plate.

3.1.1.6 *reference radius*—the reference circumference divided by two π where $\pi = 3.141593$.

3.1.1.7 *vertical station*—a pre-established location in the vertical plane along the tank shell corresponding to a given horizontal station.

4. Significance and Use

4.1 Accurate tank circumference/radius measurements are critical in liquid volume determinations. These measurements are influenced by both random errors associated with physical measurements and systematic errors associated with the particular device or procedure used, or both. The combination of random and systemic errors impacts the overall precision or accuracy of any measurement. The ORLM is as precise as the MTSM and can be used as an alternative method of determining tank circumferences/radii.

5. Apparatus

5.1 The apparatus required for this practice includes:

5.1.1 Equipment and apparatus as described in API Standard 2550.

5.1.2 *Optical Device* (see 2.1.1.3), mounted on a tripod or equivalent supporting device fixed to the tank shell by a magnetic clamping arrangement. The device should have a perpendicular line of vision (90° line of sight). The device should have leveling fixtures along three different axes. The perpendicularity of the optical ray (or the vertical reference line) shall be within 1 in 20 000 over the tank height.

5.1.3 *Traversing Magnetic Trolley* with a horizontal graduated scale (0.01-ft (1 mm) increments) used to measure offsets at different vertical stations. The magnetic trolley shall maintain its contact with the tank shell wall during the entire vertical traverse. The trolley shall be in good mechanical working order, and the zero on the scale shall be located closest to the tank shell. The numerical values etched on the

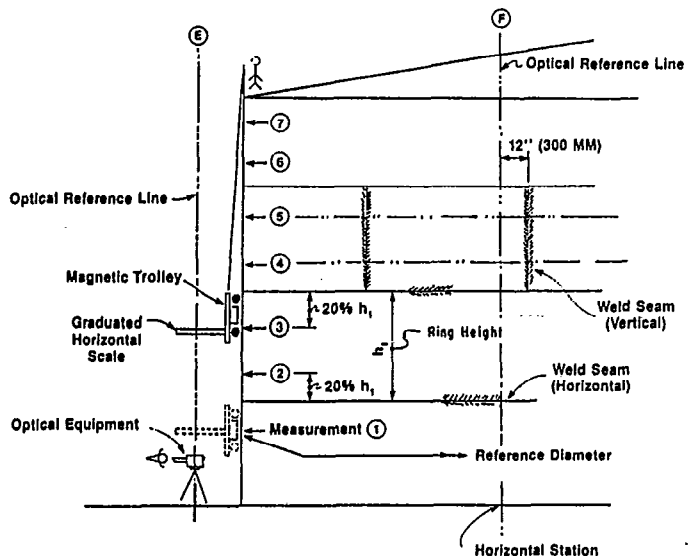


FIG. 2 Tank Elevation

scale shall be readable through the optical device. The scale accuracy shall be verified against the standard strapping tape. The combined resolution of the scale and the optical device shall enable the operator to read the offset measurement reading to the nearest 0.005 ft (1 mm) at any given vertical station. (Since the minimum resolution of the scale is 1 mm in the metric system, this system lends itself to better overall combined resolution.)

6. Optical Calibration Procedure

6.1 The step-by-step procedure described in 5.1.1 through 6.1.4 may be followed to measure deviations in the tank radius of vertical storage tanks using the optical reference line method.

6.1.1 Preparation:

6.1.1.1 Select the minimum number of horizontal stations in accordance with Table 1:

6.1.1.2 An even number of stations shall always be chosen. Additional stations, beyond the minimum specified in Table 1, may be chosen. The horizontal stations shall be spaced as near to equidistant circumferentially as possible. An example of the horizontal spacing is illustrated in Fig. 1.

6.1.1.3 The horizontal stations shall be chosen to ensure that the vertical traverse of the trolley along the shell at any given station shall be at least 12 in. (300 mm) away from the vertical weld seam. At any given horizontal station, traverse the trolley to ensure that there is no interference with the vertical weld seam. Should there be an interference, relocate the horizontal station enough to eliminate this interference.

TABLE 1 Tank Diameters and Horizontal Stations

Tank ft	Diameter m	Minimum Number of Stations
50	15	8
100	30	12
150	50	16
200	70	20
250	85	24
300	100	28
350	120	32