Calibration Procedures adopted for Vertical Storage Tanks

1. Electro Optical Distance Ranging (EODR)

The Electro-Optical Distance Ranging (E.O.D.R.) method of tank calibration is currently the most accurate tank calibration method available. This method utilizes the latest in total station theodolite technology. Target points are set on tank walls with laser as per API MPMS 2.2D.

The latest two standards are in use, the External E.O.D.R and the Internal E.O.D.R. Both of these methods have accreditation by the International Standards Organization (ISO), ISO 7507 parts 4 & 5 or API MPMS 2.2D (Internal).

- More measurement points are taken than with traditional tank calibration techniques giving a better tank shell profile for a more accurate volumetric table.
- The tank is measured from the ground reducing the safety implications linked to the use of scaffolding.
- The measurements are recorded electronically on the theodolite's microprocessor eliminating transcription errors.
- The internal E.O.D.R. method is the only practical, accurate way for the calibration / recalibration of insulated storage tanks.
- The calibration team is self-contained and requires no support services once the permits to work are issued.
- The largest tanks can be calibrated in one day.
- The external tank calibration can be conducted in most weather conditions. The internal tank calibration is not affected by inclement weather.
- The tank capacity tables can be issued in a spreadsheet format, in hardcopy and PDF. Also issued are supplementary tables for uploading to ATG systems, linear output in centimeter measurements.
- The measurement data is also used to plot a graphical display of the tank shell distortion and to calculate the tilt. We can also make a thorough tank ovality study and settlement study along with calibration.

2. **Reference Circumference by Strapping:** First, an onsite reference circumferential strapping is done only on 1st and 2nd shell with calibrated strapping tapes and dynamometer with a tension of 5 kgf and repeated 3 times and a mean value taken. This circumference is taken roughly at a position of one-fourth from the upper or lower weld of the strake. A circumference measure at the 1st and 2nd course is chosen because there is minimum of distortion or loss of circularity at this position because the strake is welded to the annual bottom plates. An external diameter (and radius)is calculated from this circumference after applying necessary corrections like temperature, butt straps (vertical welds). We call this the reference radius or diameter. Other than this, plate thickness measure with ultrasonic thickness gauge, dip reference height & position measure, tank and course height is taken. These are done as API MPMS 2.2A, equivalent to ISO 7507 part 1

3. **Optical Triangulation Procedure:** The base length is determined by manually strapping the bottom course circumference, 20% below the horizontal weld seam. This measurement is the reference circumference.

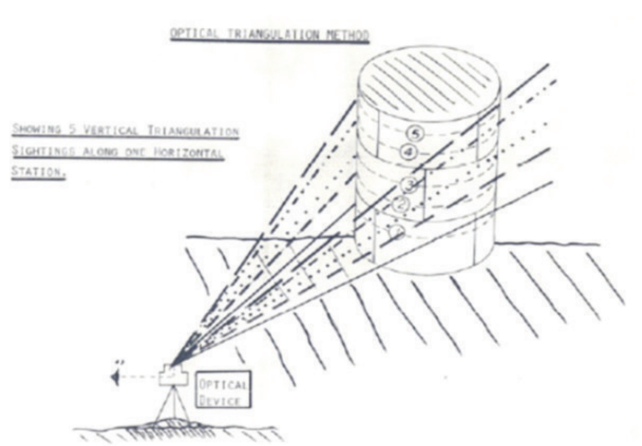
Reference circumference by strapping :

First, an onsite reference circumferential strapping is done only on 1st or 2nd shell with calibrated strapping tapes and dynamometer with a tension of 5 kg and repeated 3 times and a mean value taken. This circumference is taken roughly at a position of one fourth from the upper or lower weld of the strake. A circumference measure at the 1st or lower 2nd course is chosen because there is minimum distortion or loss of circularity at this position because the strake is welded to the annular bottom plates. An external diameter (and radius) is calculated from this circumference after applying necessary corrections like temperature, step over (vertical welds). We call this the reference radius or diameter. Other than this, plate thickness measure with ultrasonic thickness gauge, dip reference height measure, tank and course height is taken. These are done as per ISO 7507 part 1.

The tank is then sighted from the first horizontal station using a theodolite. Two sightings must be made tangentially to the tank, on the left and right from each station, recording the angle subtended between the two sightings.

The first vertical sighting should be made at the same height as the reference circumference was taken. This measurement will determine the reference angle. The theodolite is then angled upwards to sight at the next vertical station. In order to prevent any correction for tilt in the tank, the vertical angle for each pair of sightings should not be changed during the measurement.

After the angle between each pair of sightings has been recorded for all vertical stations at the first horizontal station, the theodolite is relocated to the next predetermined horizontal station. All measurements and procedures are then repeated, beginning at the first vertical station.



Therefore:

$$TZ = r \times \frac{1}{\sin\theta}$$

$$TZ = \frac{C}{2\pi} \times \frac{1}{\sin\theta}$$

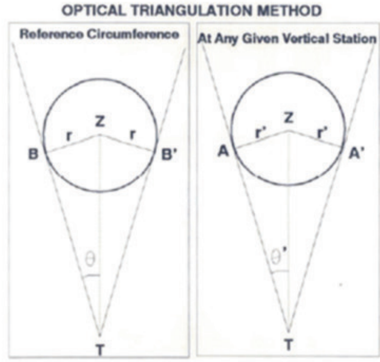
Sightings T --> A and T --> A' to any ring or vertical station give the horizontal angle θ'.

Therefore:

$$r' = TZ \times \sin\theta'$$

$$r' = \frac{C}{2\pi} \times \frac{\sin\theta'}{\sin\theta}$$

OPTICAL TRIANGULATION METHOD



Calculation :

The distance between the vertical centerline of the tank and the vertical line of any horizontal station is constant to the height of the tank. The course radii are calculated as follows:

Let T be the horizontal station site of the theodolite. The sighting T --> B and T --> B′ at the exact location of the manual strapping determines the reference horizontal angle Φ.

The arithmetic mean of all the radii (r′) for a given vertical station will determine the tank radius at that vertical station. As there will be two average radii per ring, the mean value of the two will be the average radius for that course.

4. **Internal Measurements (for empty tanks)**

Datum plate height, deadwood (manholes, pipes, beams, coils, etc.), roof structures, roof leg pin spaces are recorded. Floating roof weight and ladder weight for floating roof tanks are taken from existing references to calculate volume deduction factors in density correction tables. Bottom calibration up to datum level and subsequently up to flush point is done with water flow meter.

Volumetric Analysis and corrections on data, computation, layout of the Calibration Chart as per rules is carried out subsequently after field data consistency and quality checks. Volumetric data is also provided electronically for SAP or any other uploading.

5. **Calibration of Tank Bottom Volumes**

There are two methods that can be used to calibrate the volume below the dip-plate in a vertical tank:

The tank floor profile can be surveyed physically,using one of the following tools:

- an engineer's level or theodolite and staff.
- a laser plane and survey staff.
- a water tube or hydrostatic level tool.

The tank bottom is calibrated by filling with measured quantities of a non-volatile liquid, preferably clean water, as specified to a minimum level that covers the bottom completely, immersing the dip-plate & eliminating the effect of bottom formations or, alternatively, calibration by physical survey using a reference plane to determine the shape of the bottom.

From data obtained the volume can be calculated mathematically. The tank floor can be calibrated volumetrically, using a meter or volumetric prover and water.

FOR ANY REQUIREMENT PLEASE CALL

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