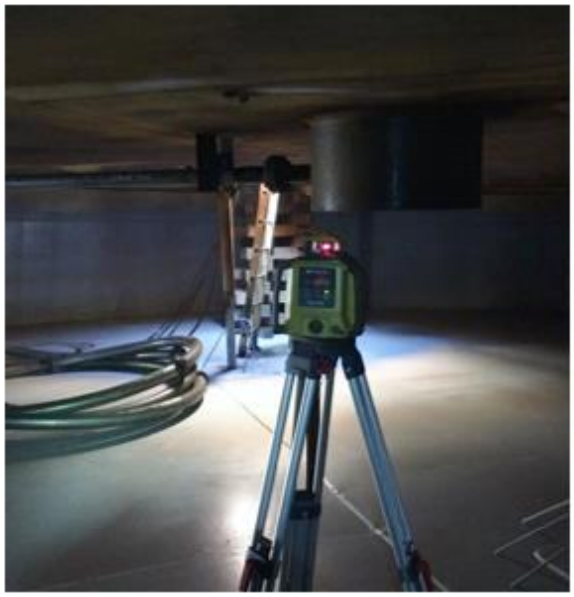
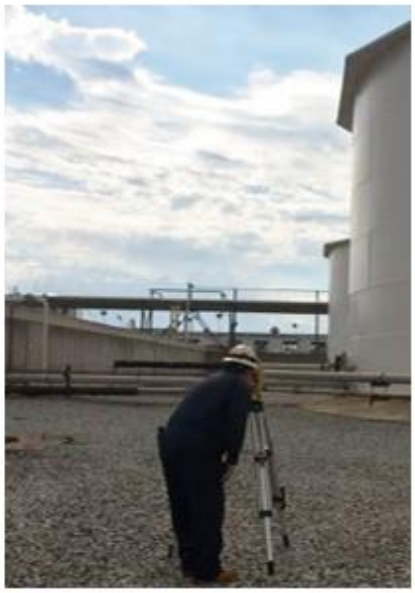
Technical Notes
#33

Exceeding Expectations

STORAGE TANK CALIBRATION

You just discharged *200,000 barrels of $86.13/bbl. crude oil* into a storage tank. Inaccurate or out of date storage tank strapping charts can negatively impact the most accurate inspection and sophisticated tank gauging systems. ***With a total product cost of $17,226,000 don't you want every gallon of this crude oil accounted for as precisely as possible?***

A = Application

The American Petroleum Institute *(API) Committee on Petroleum Measurement Standards* issues and oversees *the Manual of Petroleum Measurement Standards (MPMS).* These are the measurement standards used by the petroleum industry. *API Chapter 2 - Tank Calibration* contains the procedures used to calibrate closed storage vessels.

In order to determine the volume of product delivered or received during a transfer, the storage tank must be calibrated and have certified strapping chart.

To calibrate a tank, procedures for measurements for vertical wall roundness, shape, roof, floor and deadwood are performed. Tank capacity tables also known as strapping charts are calculated using these measurements. The tables express the volume measurement for a specific product height in the storage tank.

M = Methods

AmSpec Calibration Services personnel have many years of experience doing physical calibration of all types of storage tanks. They use the procedures in API Chapter 2, specifically 2.2C and 2.2D, laser distance techniques. Laser distance technology is more precise (accuracy of 1/16" at 600 foot) and safer than traditional methods 2.2a and 2.2b (no scaffolding required).

API Chapter 2.2A Circumferences of Tanks/Strapping Method

This method involves using a calibration tape and taking circumferences with a tape that encircles the entire tank. The measurements are taken at approximately 20% and 80% of each ring. After the ground measurements are taken, the tape is pushed up the tank to the next position by using poles. This method is very time consuming. There are also safety concerns in reading the tape at higher levels. It requires ladders or hanging over the side of a tank is a boson's chair.

API Chapter 2.2B Optical Reference Line Method

This method involves taking a circumference reading at approximately 80% height of the first ring, which will be the reference circumference. The determination of the circumferences of the other rings are done using a trolley and a millimeter scale. Poles with a pulley or a person on the top of the tank will raise and lower the trolley to approximately 20% and 80% of each ring. This determines the deviation from the reference circumference. The measurements are calculated to derive the circumferences of the other rings. The number of stations to measure depends upon the diameter of the tank.

API Chapter 2.2C Optical Reference Line Method

This method involves using a digital theodolite to determine the deviation of the shell plates. A circumference is taken at approximately 80% of the first ring. Triangulation readings are then taken at 80% of the first ring and then at 20% and 80% of each of the following rings. The measurements are calculated to derive the circumferences of the other rings. The number of station to measure depends upon the diameter of the tank.

API Chapter 2.2D Optical Reference Line Method

This method involves using a 'total station' to take radius measurements from inside the tank. The equipment is set up in the center of the tank. Two readings are taken on each ring at approximately 20% and 80% of height. The number of stations is dependent upon the size of the tank. The radius results are used to determine the diameter of the tank of each ring.

Tank Internals

Deadwood is any piping, channels, etc. that take up or add volume in a tank. All deadwood is recorded as per size, length, height, and type (i.e. channel, open pipe, closed pipe, etc.) for deduction from the charts in the area that it is at.

Tank bottom is measured by setting up a floor laser in the center of the tank. The readings start at the shell by the gauge point and are taken at intervals as prescribe by the API standard. Everything regarding height of the floating roof, overflow points, shell height as per gauging, etc. is based upon the reading taken on this point.

Tank Externals

All deadwood such as piping to the valves, manways, clean out hatches, etc. are documented.

S = Scope

Recalibration of tanks according to API 2.2A.19.10.2, "should be in any case be re-measured and calibrated under the following conditions:

a. When restored to service after being disconnected or abandoned.
b. When disassembled and re-erected or when moved bodily.
c. When deadwood is changed, when concrete or other material is placed on the tank bottom or on the shell of the tank, or when the tank is changed in any manner which would affect the incremental or total volume."

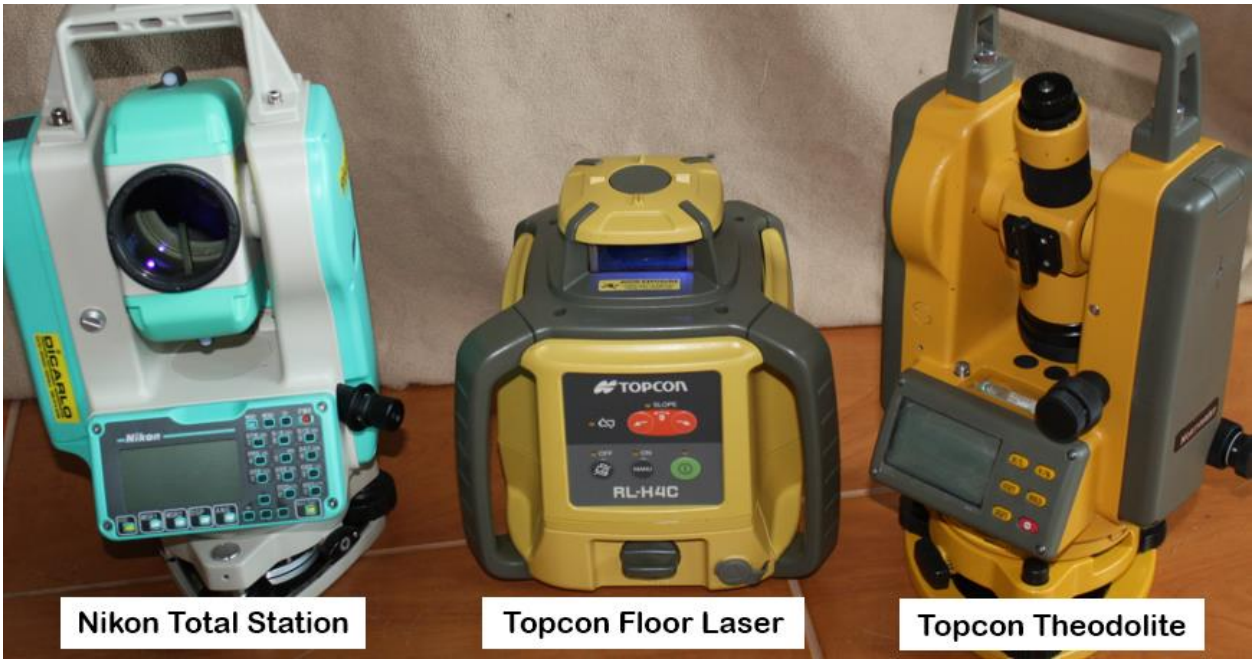
API also states for recalibration in Appendix A of Chapter 2.2A, Section A.6.3,"Tanks do change with time and service, and volume changes may not be readily identified by visual inspection or preceding verification procedures. Because of that, it is considered justifiable practice to recalibrate tanks on a periodic basis to reassure good measurement accuracy. A total recalibration at 15 year intervals for tanks in custody transfer service and at 15-20 years for others is reasonable."
A.6.1 states that for custody transfer service, verification of the bottom course diameter, bottom course thickness and tank tilt is suggested to be performed every five years. If any exceed the criteria for a predetermined variation in volume a total recalibration should considered.

Loss Control Suggestion: If you see a significant variation, the terminal or loss control should verify that the latest strapping chart is being used. If an outdated chart is found, remove it and note it as obsolete. In the case of computerized systems, check to see if there was a data entry error from when the original hard copy chart was entered into the computer system.

P = Procedure Notes

AmSpec Calibration Services use rotating lasers and slope lasers due to the accuracy and precision that these instruments offer.

The **Nikon Total Geodetic Station** does internal, external, verticality and roundness surveys in accordance with API Chapter 2.2D. It provides accuracy to a millimeter.
The **Topcon Floor Laser** is used for API Chapter 2 floor surveys.
The **Topcon Theodolite** does API Chapter 2.2C triangulation.



E = Equivalents

ISO 7507-1 = API Chapter 2.2A Manual Strapping Method
ISO 7507-2 = API Chapter 2.2B Optical Reference Line Method (ORLM)
ISO 7507-3 = API Chapter 2.2C Optical Triangulation Method (OTM)
ISO 7507-4/5 = API Chapter 2.2D Internal Electro-Optical Distance Ranging Method (EODR)

C = Cause & Effect

Tank calibration using API Chapter 2 and the tank capacity tables generated are the most accurate way to determine the true volume in a storage tank in relation to the liquid level. Inaccurate or out of date tank charts may negate even the most accurate tank gauging or sophisticated systems.

Correct tank calibrations and charts equate to more accurate measurements avoiding unexplained losses, potentially long-drawn out quantity disputes and unhappy customers.

With today's high product prices, the costs related to performing a tank calibration are minimal when compared to the potential costs of inaccurate or outdated tank charts.