TANK CAR GAUGING INSTRUCTIONS

General Service Tank Cars without Magnetic Gauging Devices

This Service Bulletin provides a basic guide to some of the more common gauging methods for general service tank cars. Accurate gauging of tank cars is critical to optimize the tank car loading capacity, comply with minimum federal outage requirements, facilitate freight rate calculations, and prepare and verify customer invoices. A knowledge of the fundamental terms is required for all personnel involved in the gauging of tank cars.

Shell Full Capacity
The amount of product in a tank car when the tank shell is completely filled.

Shell Innage
The depth of the product in the tank car measured from the bottom of the tank up to the liquid level of the product, dimension B.

Shell Outage
The unfilled portion of the tank car measured from the inside top of the tank shell down to the level of the product, dimension A.

All tank cars that operate and carry hazardous materials and/or operate in interchange service are required by federal regulations to have a minimum outage at the time of loading. The minimum outage requirements provide for thermal expansion of the product during normal operations. The minimum outage is defined in the Code of Federal Regulation - CFR 49-173.24b. For most liquids, the minimum outage is 1% at a reference temperature of 115°F for non-insulated tank cars and 105°F for insulated tank cars.
OUTAGE REFERENCE POINTS

Loading tank cars to the maximum allowable level is facilitated by a variety of marking or gauging devices, the most common being the 2% outage marker. In some cases, the minimum outage for a given product may be greater than the 2% minimum specified for the tank. These are some of the factors that can affect the minimum outage requirements for a given product:

1. The rate of expansion can vary with different products. Therefore, it is necessary to calculate the minimum outage of each product, based on the requirements defined in CFR 49-173.24b.

2. The specific gravity for the product may require a greater minimum outage so that the gross weight rail limit is not exceeded.

3. If the accuracy of the outage marker is in question, contact the owner or builder of the tank car for assistance.

DOT-111A tank cars provide for expansion in the tank and manway area. These cars are generally equipped with an inverted T-shape outage marker indicating 2% outage. The top of the horizontal T-bar is the reference point for the 2% outage.

In some cases, general service tank cars can be found equipped with a tell-tale device which, when set at the same level as the outage marker, squirts liquid when the loading level is reached. Due to environmental concerns, these devices are not permitted for use with many commodities and are generally not considered acceptable for use.

METHODS OF GAUGING

Several methods are currently used to determine the amount of product in a tank car:

1. Scale Weighing — When a railroad scale is available, the weight of the lading can be determined by subtracting the car’s lightweight from the loaded scale weight. The lightweight is determined by an additional weighing, or the lightweight stencilled on the car below its reporting marks may be used. A volume measurement is obtained by dividing the weight measurement by the product’s weight per gallon and using the appropriate temperature correction factor.

B. Long Pole Method — Pole Measurement is Shell Innage

1. Using An Innage Table — Read the innage in gallons to the right of the shell innage measurement in the gauge table.

   **Example**
   
   Shell innage measurement = 82 1/2 in.
   
   From Table No. 557, 82 1/2 in. corresponds to the measured volume of 9,923 gal.

2. Using An Outage Table — Subtract the shell innage measurement from the measurement at the end of the outage table. The resulting measurement and corresponding reading in the table reflect the car’s shell outage. Subtract the gallons of outage from the stencilled capacity to obtain the measured volume.

   **Example**
   
   Shell innage measurement = 70 3/4 in.
   Stencilled capacity of car = 11,173 gal.
   Measurement at end of outage table = 85 in.
   Less shell innage measurement = 70 3/4 in.
   Equals a shell outage of 14 1/4 in.
   From Table No. 558, an outage of 14 1/4 in. corresponds to 1,208 gals. of outage.
   
   Stencilled capacity of car = 11,173 gal.
   Less shell outage = 1,208 gal.
   Equals measured volume = 9,965 gal.

Notes
1. Always be sure that the gauge table being used is the correct one for the car being gauged.
2. If the stencilled capacity of the car is illegible, the gauge table shell full capacity figure may be used as an approximation.
3. Care must be taken when gauging cars with sloping bottoms, dual diameter tanks or interior heater coils, because the gallons per inch of the diameters of these tanks do not present symmetrical volumes per inch of tank diameter in the gauge tables. Therefore, it is necessary to determine the volume of lading in the tank using the gauge table, whether innage or outage type, assigned to the car.
4. When volume comparisons are made, measured gallons must be converted to gross gallons at 60°F, or other comparable basis, using the appropriate temperature and specific gravity information.
2. Metering — The amount of product can be determined by loading or unloading through a metering system. This is the recommended method for gauging slope-bottom tank cars.

3. Liquid Level Measurement — In this method, the product level in the tank is measured manually by using a gauge pole. A gauge table is used to convert this measurement into a volume measurement. This method lacks accuracy when used with slope-bottom tank cars.

**Using Gauge Poles and Gauge Tables**

Two methods employing gauge poles can be used to calculate the amount of lading in a tank car by measuring the product level. When using either of these methods, care should be taken to see that the tank car is on a level track. Instructions for each, and for the corresponding use of gauge tables, are given on the following pages.

**Short Pole Method**

This method employs a short pole gauge stick to measure a car’s shell outage. Knowing this dimension, it is possible to calculate the volume of innage gallons in the tank using either the outage or innage tables assigned to the particular car.

The recommended short pole is 36 inches long and graduated in 1/8 inch divisions, with the “0” mark 12 inches from one end. A metal angle is attached to the pole at a point 3/8 inches above the “0” mark to allow for the nominal shell thickness, so that all measurements start from the underside of the tank shell.

**Positioning and Reading the Short Pole**

Positioning and reading the short pole to gauge the contents of a car will vary depending upon the type of car being gauged. In each case, however, the objective is the same - to measure the distance from the underside of the top of the tank shell to the level of product in the car; i.e., the shell outage measurement. Keeping this objective in mind simplifies understanding the following typical positionings of the short pole.

**DOT-111A Cars** — Compute the manway nozzle height in the same manner described above for the dome height. Insert the short pole straight down into the tank, resting the angle on the gauge marker (Figure 1). Measure the total outage from the top of the manway nozzle; that is, take a reading at the top of the nozzle, withdraw the pole and take a reading at the point where the liquid cuts the pole. The distance between the two readings is the total outage measurement. Finally, compute the shell outage by subtracting the manway nozzle height from the total outage measurement.

An alternate and preferred method is to position the pole so that the “0” mark coincides with the inside top of the tank shell. The reading taken at the point where the liquid cuts the pole is the shell outage measurement.
LONG POLE METHOD

This method employs a long pole gauge stick to measure a car’s shell innage. Knowing this dimension, it is possible to compute the volume of innage gallons in the tank using either the innage or outage tables assigned to the particular car.

The recommended long pole is 10 feet long and graduated in 1/8 inch divisions. The long pole is primarily used for measuring the amount of sediment or liquid in the lower part of the tank. It is also, however, an effective tool for gauging the contents of a fully loaded tank car.

Positioning And Reading The Long Pole

The method of using and reading a long pole is the same for all types of non-pressure tank cars. The pole is inserted through the manway at the top centerline of the tank. Caution must be taken that the pole is held vertically, and that the end of the pole rests on the bottom of the tank and not on a heater coil or other internal appurtenance. Withdraw the pole and note the point where the liquid cuts the pole. This reading is the shell innage measurement (Figure 2).

Gauge Tables

ARL cars are water gauged, using the most accurate methods available and approved by the American Petroleum Institute. Water is incrementally transferred from several overhead storage tanks with certified capacities into the tank car. The shell full water capacity is determined for each car and is stencilled on each end of the tank. Data accumulated in water gauging is used to prepare gauge tables for each lot of tank cars. Two types of gauge tables are prepared:

1. Innage Table — Calibrated from the bottom of the tank upward, this table indicates the number of gallons in a tank at quarter-inch increments.

2. Outage Table — Calibrated from the top of the tank downward, this table indicates the number of gallons out of a tank at quarter-inch increments.