Manual of Petroleum Measurement Standards Chapter 17—Marine Measurement

Section 7—Recommended Practices for Developing Barge Control Factors (Volume Ratio)

FIRST EDITION, SEPTEMBER 1995

American Petroleum Institute

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Chapter 17—Marine Measurement

SECTION 7—RECOMMENDED PRACTICES FOR DEVELOPING BARGE CONTROL FACTOR (VOLUME RATIO)

17.7.1 Scope

This procedure is intended to determine a fixed barge/shore ratio which can be used either when no *reliable* Vessel Experience Factor (VEF) is available or to verify and validate an existing VEF. The resultant ratio may be used as a "Control Factor" to ascertain a corrected barge volume for comparison against future shore delivery or receipt volumes.

This procedure describes the method for determining the volume ratio of a barge relative to an accurate known volume, measured by shore tank or meter; this will be known as the Control Factor. The procedures and practices relate to action by buyers, sellers, shore terminal operations, barge owners, independent inspectors, and other parties having an interest in the measurements. If the methods stated in this procedure are followed, the measurements will form a reliable basis for comparing relative shore and barge volumes in the production of a Control Factor. The procedures contained in this method apply to a single transfer between the shore and the barge, preferably using a light or medium product or chemical with an approximate volume of at least 80 percent fill of the barge capacity. The procedure may be conducted again at a later date for added assurance or to update the factor for any structural change(s) or damage to the barge.

This method is not a substitute for, nor does it replace, barge calibration (strapping) tables or the need for recalibration.

The gauging procedures outlined herein and known as "Double Reference Gauging" may also be employed in regular inspection of barge and shore quantification as a loss control technique.

This method is intended for inland waterway barges. Ocean-going barges should use VEF method.

17.7.2 Normative References

Normative references for Section 7 include the following:

Chapter 2—"Tank Calibration"
Chapter 3—"Tank Gauging" (In preparation)
Chapter 4—"Proving Systems"
Chapter 5—"Metering"
Chapter 7—"Temperature Determination"
Chapter 8—"Sampling"
Chapter 9—"Density Determination"
Chapter 12—"Calculation of Quantities"

17.7.3 General Recommendations and Precautions

17.7.3.1 TEST CRITERIA

Before these procedures are implemented, parties responsible for the various activities should be clearly designated and should ensure that *all* procedures can be accomplished within the criteria outlined herein. Should any one of these procedures be in reasonable doubt or considered unreliable, then the test should not be conducted, or continued, until the reason for doubt is removed or corrected.

17.7.3.2 TEST CONDITIONS

Prior to testing, ensure that the conditions in this method can be met; verify that the terminal and barge equipment are capable of meeting the required procedures and that the operation facilities are conducive and in accordance with API standards and practices.

17.7.3.3 PROCEDURE CONTROL

To ensure the accuracy of the volumes, both that of the barge and of the "test" volume (shore tank or metered volume), it is necessary to adopt strict procedures to control the movement of the "test" medium and to control associated measurement techniques.

17.7.3.4 TEST MEDIUM (TYPE OF PRODUCT)

For increased accuracy of the test, it is preferable to use a light or medium oil (such as Diesel oil) or a chemical product of known fixed standard density. The product should be homogeneous. Tank mixers or circulation should be employed to avoid temperature and density measurement error.

17.7.3.5 GRAVITY/DENSITY DETERMINATION

For calculation and comparison purposes, it is usually better to use one standard density than to use separate analyses of barge and shore tank samples. If the product is uniform and from one tank, then the same reference density for both barge and shore tank calculation of quantity should be used. For the purposes of development of a B.C.F., it is assumed that the barge and the shore tank have the same standard density.

17.7.3.6 SHORE LINE INTEGRITY

All relevant shore pipelines must be checked for fullness. This should be accomplished by use of a method which determines the pipeline condition, and one which is docu-

mented as the preferred method utilized at the facility. Ideally, the product should be routed from the shore supply tank through the lines and pumps being used to the dock manifold, and returned to the same (or other) shore tank.

All branch lines leading off the line being used in the test should be isolated by closing at least two valves between the separate systems; or by fitting blanks into the branch line(s). It is preferable to use a tank that has the shortest pipeline distance to the barge.

17.7.3.7 SHORE TANK INTEGRITY

The use of a large tank will decrease the accuracy due to the gauging tolerance when a relatively small volume is transferred from a large tank. Select a tank size that is suitable for test volume. To ensure accuracy in uncertainty better than 0.20 percent of the volume, a single shore tank should be used that has sufficient volume to conduct the test: one that allows a minimum of 2 meters (about 6 feet) of tank volume to be transferred to the barge. However, the level remaining in the tank on completion of the test should be at least 2 feet above the top of the main tank outlet pipe. Preferably, the tank should be more than half full prior to the test.

The tank bottom should be stable, and have no known appreciable flexing. Flexing in excess of 15 millimeters (about ½ inch) may not be suitable for use in development of a B.C.F. Check any available records and inquire of terminal experience with variance in total gauge height.

17.7.3.8 BARGE BOTTOMS (CARGO RESIDUES)

The barge should be essentially empty prior to the test. Minor quantities and puddles may be acceptable, provided that the total does not exceed 0.10 percent (10 barrels in 10,000) of the volume to be transferred.

17.7.3.9 TRIM AND LIST CONSIDERATIONS

The barge should be on even keel (no trim) and upright (no list) when loading is completed. Where the gauging location is situated on or near to the geometric center of the compartment, a small degree of list and/or trim is permissible.

17.7.4 Metered Quantity

A Positive Displacement (PD) meter is preferred for use with this method. The meter should have been proven in accordance with the relevant API standards, preferably just prior to conducting this test (control factor). A meter factor and proving data should be available and be valid for the intended product (density range). Obtain a copy of the proving certificate to be included as part of the records for the test.

17.7.4.1 READING AND RECORDING MEASUREMENTS

All measurements should be recorded at the time the measurement is taken. A minimum of 3 measurements should be taken, gauging the product until 2 consecutive readings are the same; the readings should be recorded to an accuracy of plus or minus 1/16 of an inch. Record the measurement immediately after it is taken.

17.7.4.2 READING OF DRAFTS

If the draft marks are difficult to read, freeboard measurements should be taken.

17.7.4.3 SHORE TANK STANDPIPES (UNPERFORATED)

Tanks with unslotted standpipes should not be used for this test. If no other aperture exists for gauging of product level, do not conduct the test until a suitable replacement tank is available.

17.7.4.4 SAMPLING

Effective mixing and/or circulation is the key to obtaining a representative sample. In all cases, samples should be drawn in a manner consistent with API procedures. In addition, and if practical, line samples should be drawn at frequent intervals, sampling at approximately one sample every 500 barrels.

17.7.4.5 BARGE CAPACITY TABLES—TRIM AND LIST READINGS

In cases where trim or list exist and are not removed by internal transfer, correct using an applicable trim/list correction table or formula. However, the correction table *must* be checked for validity. If the gauging location has been changed, verify that applicable trim/list corrections are available for that location.

17.7.4.6 BARGE DECK STANDPIPES

If deck standpipes are fitted, special care should be taken when these extend into the compartment (below the deck) and into the product. In such cases it is usual for the product to "pump" within the pipe directly after filling of a compartment or when river traffic is passing.

17.7.4.7 INNAGE GAUGING

On a fixed roof tank, ascertain if there is any flexing of the roof by the weight of persons. One person only should stand in the same location relative to the gauging hatch, for both opening and closing measurements, to avoid errors.

17.7.4.8 OUTAGE GAUGING

The outage is taken in addition to the innage gauge for a double reference and as a tool in reconciliation, should a later unexplained difference be apparent.

17.7.4.9 SAMPLE HANDLING

Sampling and sample handling described in this document are limited to the need for accurate density determination only. The application is for measurement, not product quality.

17.7.5 Procedures—Barge

17.7.5.1 BARGE OBQ

Prior to loading, inspect all cargo compartments for residual water (from cleaning) or previous product. It is preferable to inspect the compartments visually as, due to barge trim and/or the gauging location, material may remain undetected in the tank. This inspection can normally be accomplished from deck level.

The cargo system (hoses, pipelines, pumps, and valves) being used for the test should be opened in order to drain residues into barge tanks for observation and measurement. Ensure that all valves in the pipeline system are opened, to prevent entrapment of residues. This includes crossovers, deck lines, and cargo riser valves. Trim corrections should not be used. In general, if there is sufficient volume remaining in a compartment in which to apply the correction, there is too much to conduct the test, and it should be removed. *The bottom of barges' compartments is the area of most imprecision and one of the main reasons that tests are necessary.*

Prior to loading, observe the standpipes (if fitted) and determine if they extend to the tank bottom. Determine and report whether or not the pipe is slotted (perforated). Measure and record the total height at both standpipe (if fitted) and ullage hatch (manway) gauging locations; this is to be compared with similar readings taken after loading is complete.

17.7.5.2 BARGE INNAGE GAUGING

After completion of product transfer (loading) and prior to gauging for level, observe river traffic for passing vessels. These will, invariably, affect the measurements. Ensure that the product level is stable (that is, no movement) when gauging for level.

Gauge the tank for product level only, using a suitable product finding paste. Probe the bottom of the tank around the full perimeter of the gauging hatch (if not a standpipe) with tape and bob to ascertain the nature of materials on the tank bottom. This may be helpful if there is a problem in later gauging.

Establish the total gauge height.

Note: Gauging for water is not necessary in establishing a control factor, unless required as part of a general inspection or loss control measure.

17.7.5.3 BARGE MEASUREMENTS

Trim and list should be checked *before* loading is complete in order to use the balance of the cargo to adjust trim, and or list, where necessary. Filling of individual compartments should be adjusted where necessary in order to complete the loading without any appreciable trim/list condition existing. However, if the barge is trimmed and/or cannot be avoided, apply the applicable correction. List can be avoided in most cases and should be eliminated if present.

17.7.5.4 TRIM CORRECTION

The calculation to check for trim correction is:

$$\frac{D \times TRIM}{LBD}$$

Where:

D = longitudinal (fore & aft) distance from gauging location to the center of the tank.
$TRIM$ = difference between the forward and aft draft marks
LBD = length between the draft marks

To determine D (distance), measure the distance from the gauging location to the closest fore or aft bulkhead (usually aft); this is referred to as Ullage distance (U).

Obtain or measure the length of the tank. (If the expansion hatch is in the same location on each tank, say 2 port and 3 port, measure the distance between these using a suitable reference, such as the ullage port (hatch), to obtain the length of the tank.) The length of the tank divided by 2 less the Ullage distance (U) is equal to D (distance).

As the expression T/LBD (trim divided by the length between drafts) is the ratio of the difference in drafts to that of the length between drafts, then it follows that any similar ratio will produce the same factor, i.e.:

Draft Forward	7' 06"
Draft Aft	9' 00"
Difference	1' 06" (1.5')

Distance between drafts 165' 00" (165.0')

Therefore:

1.5/165.0 = .0091 (factor)

Whereas:

Freeboard a)	4' 03" Fore
Freeboard b)	3' 04 ⅛" Aft
Difference	10 ⅞" (0.90625')

Distance between Freeboards 100' 00" (100.00')

Therefore:

0.90625/100.00 = 0.0091 (factor)

When applied to the formula $D \times T/LBD$ (or D/f—substituting f for T/LBD): = $D \times 0.0091$ in both cases.

17.7.5.5 LIST CORRECTION

The difference and distance between port and starboard drafts can be applied in the same manner as that for the

trim correction to produce a factor for use in the list correction.

The calculation to check for list correction is:

$$\frac{D \times F}{Breadth}$$

Where:

D = transverse (port to starboard) distance from gauging location to the center of the tank. Example 4.25 feet.

F = difference between the port and starboard freeboards or drafts.

Breadth = total width of the barge (distance between freeboards). Example 35.0 feet.

To determine *D* (distance), measure the distance from the gauging location to the closest side bulkhead. The width of the tank divided by two, less the distance from the gauging location to the bulkhead, gives the distance (*D*).

Example:

Freeboard a) 3’ 06” Port
Freeboard b) 3’ 08” Starboard
Difference 2” (0.16667’)

Breadth (distance between Freeboards) = 35’ 00”

Therefore:

Factor = 0.16667/35.00 = 0.00476

Distance to centerline bulkhead = 4’ 03” (4.25 feet)

Width of tank = 17.5’ feet

Therefore:

Distance (*D*) to center of tank = 17.5÷2 = 8.75’
8.75-4.25 = 4.50’

Applied to the formula

$$\frac{D \times F}{Breadth} = .02142\text{’ feet} = \tfrac{1}{4}\text{” (approx)}$$

Note: Rule of application: Port list/Port tank/Port hatch = negative to innage; Stbd list/Stbd tank/Stbd hatch = negative to innage. (Port/Stbd hatch means Port or Stbd of centerline).

17.7.6 Procedures—Shore

17.7.6.1 SHORE TANK MEASUREMENTS

Following the checks on the integrity of pump, lines, and tank, gauging of the shore tank should be conducted; read the automatic tank-side gauge (if fitted) at this time also. The shore tank should be gauged in accordance with the relevant API standards.

Tank bottoms that have sludge or sediments present at the gauging location may induce error; ensure a solid bottom is found when gauging.

Additional considerations in regard to tank standpipes (see 4.3) should be carefully observed to minimize error.

17.7.6.2 SHORE TANK INNAGE GAUGING

Gauge the tank for product level only using a suitable product finding paste. Ensure that the product level is stable (no movement) and that a solid bottom is found. Probe the bottom of the tank around the full perimeter of the gauging hatch with tape and bob to ascertain the nature of materials on the tank bottom. This may be helpful if there is a problem in later gauging.

Measure and record the observed gauge height. On a fixed roof tank, ascertain if there is any flexing of the roof. Only one person should stand in the same location relative to the gauging hatch, for both opening and closing measurements, to avoid errors. Note any observations regarding tank bottom and roof movement.

Note: Gauging for water is not necessary in establishing a control factor, unless required as part of a general inspection or loss control measure.

17.7.6.3 OUTAGE GAUGING

Outage gauging shall be taken using the calibration (strapping) table Total Reference Height and lowering the tape and bob to a depth of the Total Reference height less 1 foot, or, in the case of small quantities, 2 inches less than the Total Reference Height. This is often referred to as “innage by outage” or a “swing gauge.” The outage is taken in addition to the innage gauge for a double reference and as a tool in reconciliation, should a later unexplained difference be apparent.

The measurements should be accurately recorded, e.g.:

TOTAL REFERENCE HEIGHT (as stated on table)	38’ 06”
TAPE IN TANK (outage measurement)	37’ 06”
DIFFERENCE	1’ 00”
PRODUCT ON TAPE (swing gauge)	27’ 03”
INNAGE (innage by outage)	28’ 03”

17.7.6.4 TEMPERATURE MEASUREMENT

If possible, circulate the product within the tank and/or operate tank mixers if fitted. Take temperatures in accordance with API procedures, generally obtaining an upper, middle and lower, temperature.

If a standpipe inhibits accurate temperature measurement, circulate and/or mix the product and take the reading elsewhere to ensure a representative temperature is obtained (see 4.3). At least two temperature measurements should be obtained (at different locations using the same equipment) for double reference purposes. If the tank has a floating roof, a temperature (and sample) should be obtained 1 foot (or 30 centimeters) below the liquid surface. This will provide for a more accurate roof displacement correction.

17.7.6.5 SAMPLING

Samples shall be taken at the middle of the upper, mid, and lower thirds of the tank contents. Gravities shall be run on each sample prior to commencing the test, which will indicate if the product is homogeneous or if (additional) mixing or circulation of the product is required.

Where differences over 0.5 API, are found, the tank shall be resampled at every 2 feet of liquid depth. In addition, samples should be drawn at the dock manifold to obtain line content samples as well as interval samples for double reference purposes (see 4.4).

17.7.6.6 METER MEASUREMENT

Ensure that procedures for line fullness are observed (see 3.6). Read and record the pressure and temperature measurements at 30-minute intervals throughout the loading. Where necessary, apply the relevant pressure and temperature factors to the observed meter readings (refer to API Chapter 5 on metering).

17.7.7 Factor Calculation

17.7.7.1 COMMENCE TEST

Testing will commence only when all checks for integrity have been conducted and agreement that conditions are favorable. Obtain measurements as described above.

17.7.7.2 COMPUTATION

The barge loaded quantity at Gross Standard Volume (GSV), that is, the total quantity on board after loading minus any quantity found prior to loading (OBQ) corrected to standard reference temperature of 60˚F, is divided by the recorded (G.S.V.) quantity delivered by the shore tank or meter.

17.7.7.3 REPORTING TEST RESULTS

Report the relevant details of the test on a suitable form(s). Retain all measurements and volume calculations including a complete time log of events. Record the final measured volumes and the resultant ratio found between the shore figure and that of the barge.

17.7.7.4 FACTOR CALCULATION

The computed ratio (Barge Control Factor) should be expressed as a divisor, to 4 decimal places, applicable to the barge quantity, that is:

$$\frac{\text{Barge quantity 19500.00 Barrels}}{\text{Shore quantity 19422.00 Barrels}} = 1.0040$$

17.7.8 Application

17.7.8.1 USING THE BARGE FACTOR

The barge factor is a measure of the vessel's calibration variance. As such, it should be applied to loaded barge quantity. When compared to the respective shore quantity, it will show a more realistic difference and give an indication to any quantity discrepancy, should one be apparent.

17.7.8.2 APPLYING THE FACTOR

If the factor is within 0.3 percent of the barge strapping tables, the barge strappings may be used without applying the factor or, in the case of a previous barge control factor, the mean of the two may be used as the new barge control factor.

17.7.8.3 RECHECKING FACTORS

If the barge has been structurally modified, damaged or dented, or if there is any reasonable doubt as to the accuracy, rechecking the factor by conducting another test may be in order.

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