Manual of Petroleum Measurement Standards
Chapter 2—Tank Calibration

Section 8B—Recommended Practice for The Establishment of the Location of the Reference Gauge Point and the Gauge Height of Tanks on Marine Tank Vessels

FIRST EDITION, AUGUST 1995
REAFFIRMED, APRIL 2005

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

Manual of Petroleum Measurement Standards
Chapter 2—Tank Calibration

Section 8B—Recommended Practice for The Establishment of the Location of the Reference Gauge Point and the Gauge Height of Tanks on Marine Tank Vessels

Measurement Coordination

FIRST EDITION, AUGUST 1995

American Petroleum Institute

SPECIAL NOTES

1. API PUBLICATIONS NECESSARILY ADDRESS PROBLEMS OF A GENERAL NATURE. WITH RESPECT TO PARTICULAR CIRCUMSTANCES, LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS SHOULD BE REVIEWED.

2. API IS NOT UNDERTAKING TO MEET THE DUTIES OF EMPLOYEES, MANUFACTURERS, OR SUPPLIERS TO WARN AND PROPERLY TRAIN AND EQUIP THEIR EMPLOYEES AND OTHERS EXPOSED CONCERNING HEALTH AND SAFETY RISKS AND PRECAUTIONS, NOR UNDERTAKING THEIR OBLIGATIONS UNDER LOCAL, STATE, OR FEDERAL LAWS.

3. INFORMATION CONCERNING SAFETY AND HEALTH RISKS AND PROPER PRECAUTIONS WITH RESPECT TO PARTICULAR MATERIALS AND CONDITIONS SHOULD BE OBTAINED FROM THE EMPLOYER, THE MANUFACTURER OR SUPPLIER OF THAT MATERIAL, OR THE MATERIAL SAFETY DATA SHEET.

4. NOTHING CONTAINED IN ANY API PUBLICATION IS TO BE CONSTRUED AS GRANTING ANY RIGHT, BY IMPLICATION OR OTHERWISE, FOR THE MANUFACTURE, SALE, OR USE OF ANY METHOD, APPARATUS, OR PRODUCT COVERED BY LETTERS PATENT, NEITHER SHOULD ANYTHING CONTAINED IN THE PUBLICATION BE CONSTRUED AS INSURING ANYONE AGAINST LIABILITY FOR INFRINGEMENT OF LETTERS PATENT.

5. GENERALLY, API STANDARDS ARE REVIEWED AND REVISED, REAFFIRMED, OR WITHDRAWN AT LEAST EVERY FIVE YEARS. SOMETIMES A ONE-TIME EXTENSION OF UP TO TWO YEARS WILL BE ADDED TO THIS REVIEW CYCLE. THIS PUBLICATION WILL NO LONGER BE IN EFFECT FIVE YEARS AFTER ITS PUBLICATION DATE AS AN OPERATIVE API STANDARD OR, WHERE AN EXTENSION HAS BEEN GRANTED, UPON REPUBLICATION. STATUS OF THE PUBLICATION CAN BE ASCERTAINED FROM THE API AUTHORING DEPARTMENT (TELEPHONE (202) 682-8000). A CATALOG OF API PUBLICATIONS AND MATERIALS IS PUBLISHED ANNUALLY AND UPDATED QUARTERLY BY API, 1220 L STREET, N.W., WASHINGTON, D.C. 20005.

FOREWORD

The API *Manual of Petroleum Measurement Standards* (MPMS) is currently available. The manual will eventually include all subject matter now found in API measurement publications—including evaporation loss measurement—as well as new material and revised editions of existing MPMS material when revisions are completed.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any federal, state, or municipal regulation with which this publication may conflict.

Suggested revisions are invited and should be submitted to Measurement Coordination, Exploration and Production Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

CONTENTS

SECTION 8B—RECOMMENDED PRACTICE FOR THE ESTABLISHMENT OF THE LOCATION OF THE REFERENCE GAUGE POINT AND THE GAUGE HEIGHT OF TANKS ON MARINE TANK VESSELS

2.8B.0 Introduction

This document is intended to supplement the calibration procedures described in API Chapter 2.8A, "Calibration of Tanks on Ships and Ocean-Going Barges," and API Chapter 2.7, "Calibration of Tanks on Barges" of the *Manual of Petroleum Measurement Standards (MPMS)*.

2.8B.1 Scope and Field of Application

This recommended practice is intended as a guide for establishing reference gauge heights during calibration of marine tank vessels. In many cases this calibration is carried out by shipyard engineers who may not be fully familiar with petroleum measurement requirements nor the use of such measurements by petroleum inspectors and tanker operating personnel. This procedure is also for recalibration of vessels.

The importance of establishing an accurate reference gauge height for tanks on marine tank vessels cannot be overstressed. Such tanks are generally calibrated in ullages (outages) whereas in measuring quantities remaining onboard (ROB) or free water, it is frequently more convenient and accurate to measure innages. The reference gauge height is a necessity in converting ullage to innage. Also, in determining the volume of the ROB, the reference gauge height is a factor in every wedge formula, for the establishment of wedge tables.

API MPMS Chapters 2.7 and 2.8A provide three methods of calibrating the volumes of tanks on marine tank vessels: calibration by linear measurement, liquid calibration, and calibration from vessel drawings. The measurement and establishment of the reference gauge height, however, can only be determined by direct linear measurement.

2.8B.2 References

Unless otherwise specified, the most recent editions or revisions of the following standards, codes, and specifications shall, to the extent specified herein, form a part of this standard.

API

Manual of Petroleum Measurement Standards

Chapter 2.7, "Calibration of Tanks on Barges"

Chapter 2.8A, "Calibration of Tanks on Ships and Ocean-Going Barges"

DOT[1]

33 *Code of Federal Regulations*

IMO[2]

Resolution of the International Conference on Tanker Safety and Pollution Prevention

NFPA[3]

306 *Control of Gas Hazards on Vessels*

2.8B.3 Safety

Prior to entering any compartment, permission must be obtained from the vessel's master, senior deck officer, authorized shipyard official, or other responsible person in charge. This responsible person should be able to supply information regarding particular materials and conditions or the applicable Material Safety Data Sheet. Before entering the compartment, a valid marine chemist's certificate must be obtained indicating that the compartment is "Safe for Workers" and/or "Safe for Hot Work," as prescribed in National Fire Protection Association 306, *Control of Gas Hazards on Vessels*. Regulations of the U.S. Coast Guard, the Occupational Safety and Health Administration (OSHA), or other international, federal, state, or local regulations may also apply. Such testing must be made at least every 24 hours or more often when changing conditions warrant.

When entering a compartment, another person should stand watch at the compartment entrance for the duration of such entry to sound an alarm should an emergency occur. Normal safety precautions with respect to staging and ladders are to be observed.

2.8B.4 Tank Measuring Equipment

Tank measuring equipment for the establishment of the reference gauge point location and reference gauge height shall be as described in 2.8A.7.1 of API MPMS Chapter 2.8A or 2.7.7.1 of API MPMS Chapter 2.7.

2.8B.5 Measurement Conditions and Tolerances

2.8B.5.1 MEASUREMENT CONDITIONS

Measurements should be taken only after all construction, conversion, and repair activities that would affect tank or reference height dimensions have been completed.

[1]U.S. Department of Transportation. *The Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, D.C. 20402.
[2]International Maritime Organization, London, England.
[3]National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts.

The area of the tank bottom directly beneath the reference gauge point must be a clean surface and free of scale, debris, and solid or semi-solid petroleum residues.

When measurements for the reference gauge height are made, the vessel should be on an even keel with no trim or list. If this is not feasible, a correction must be applied to the measured gauge height to obtain the corrected reference gauge height as described in API MPMS Chapter 2.8A.

2.8B.5.2 MEASUREMENT TOLERANCES

Measurement tolerances shall be as described in 2.8A.8.2 of API MPMS Chapter 2.8A or 2.7.8.2 of API MPMS Chapter 2.7.

2.8B.6 Number and Location of Reference Gauge Points

2.8B.6.1 NUMBER OF REFERENCE GAUGE POINTS

In the United States, all tank vessels fitted for crude oil washing (COW) are required to have four hand gauging locations in each tank, one of which is to be located in the aftermost portion of the tank, as per U.S. Coast Guard regulations.

Note: U.S. Coast Guard Regulations 33 CFR 157.128 (b) state (in connection with design, equipment, and installation for COW), "Each cargo tank must be designed to allow the level of crude oil in the tank to be determined by: (1) Hand dipping at the aftermost portion of the tank and three other locations; or (2) Any other means acceptable to the Commandant."

This wording is taken from Section 4.4.4 of *Resolution of the International Conference on Tanker Safety and Pollution Prevention*, 1978 of the International Maritime Organization.

The regulations make no requirement that each of these hand gauging points be calibrated for the total and incremental volume of the liquid in the tanks.

Each tank on self-propelled tank vessels shall be fitted with a minimum of two principal reference gauge points, each fully calibrated for total and incremental tank volume. The additional manual gauging points are required by COW regulations. The reference gauge heights at these additional hatches may be established for flexibility in measurements, for example, quantities remaining on board (ROB) and/or onboard qualtities (OBQ). Nonself-propelled inland waterway barges may require a total of three calibrated primary reference gauge points as covered in 2.8B.6.4.

The location of the primary reference gauge points and the additional secondary (manual) gauging points are covered in 2.8B.6.2 for conventional tankships and in 2.8B.6.3 for Combination Carriers [Ore/Bulk/Oil (OBOs)].

2.8B.6.2 LOCATION OF REFERENCE GAUGE POINTS (TANK SHIPS)

The two calibrated reference gauge points referred to in 2.8B.6.1 should be located in each tank as follows.

The primary reference gauge point may be located at the geometric center of the tank at deck level. This position will eliminate the effect of trim and list on the calculation of static volumes when the vessel is in a loaded condition.

However, if a swash bulkhead or transverse web frame is fitted at the mid length of the tank, the reference gauge point must be sufficiently forward of the mid length so that the zero gauge point clears the swash bulkhead or web frame at the bottom under the normal direction of maximum trim. This location will permit obtaining an ullage for a quick close approximation of tank content volume without the necessity of applying a trim correction. For complete accuracy, a trim correction is necessary inasmuch as the gauge point has been displaced longitudinally from the geometric tank center.

The secondary reference gauge point or points on a vessel tank should be located at the aft and/or forward end of the tank, depending on the varying operating trim conditions.

Note: In the course of normal operations involving a barge that operates with trim by the bow and stern, the primary gauge point at the geometric center is not required since secondary gauge points are required at both forward and aft locations.

This gauge point should be located as close to the aft or forward bulkhead, centerline, or inboard bulkhead as possible, but again sufficiently forward of same so that a gauge tape suspended to take OBQ/ROB/free water measurements does not contact the bulkhead.

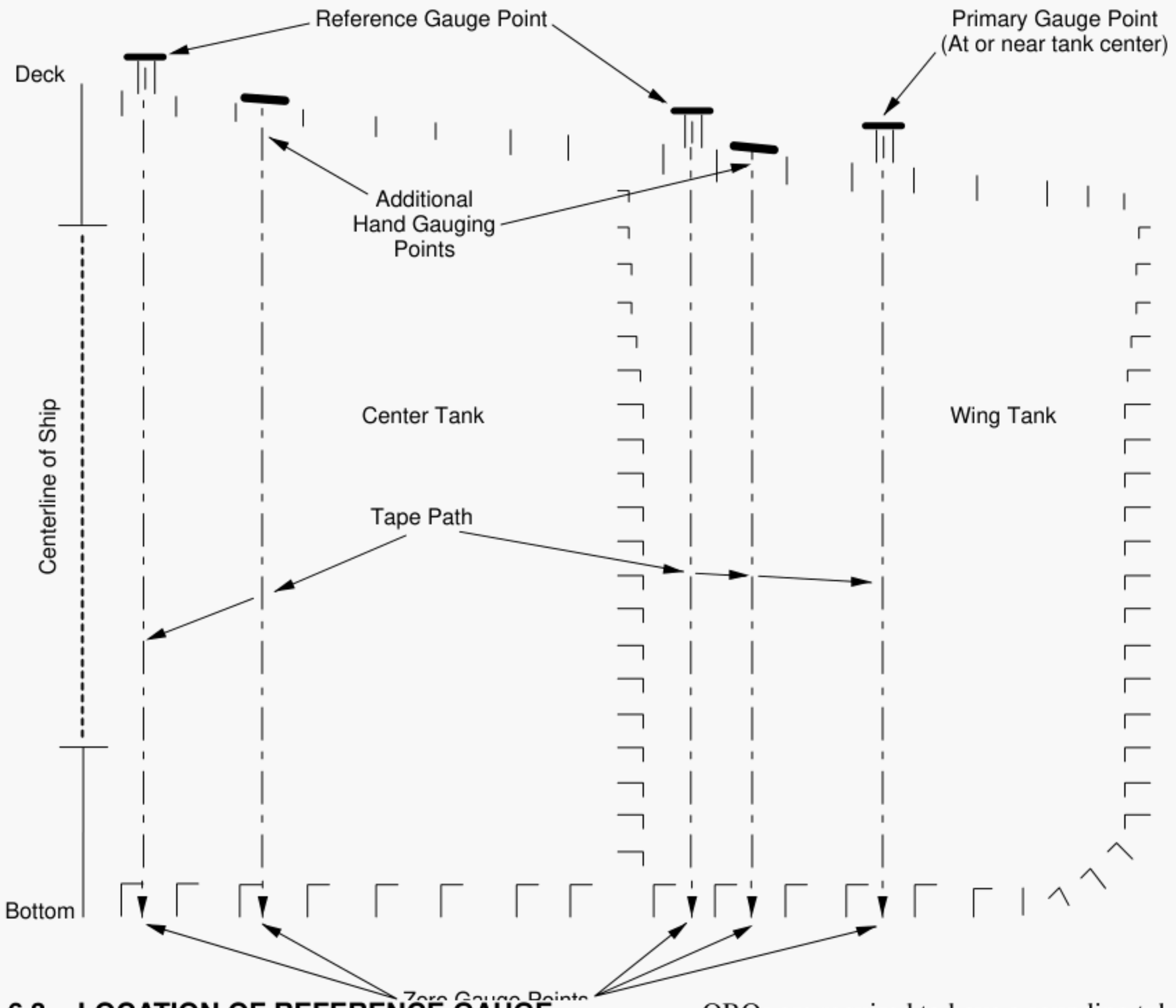
The additional manual gauge points may be fitted at any convenient location in the tank where there is a clear drop to the bottom.

The recommended fore and aft locations for the reference gauge points and the manual gauge points are shown in Figure 1. Figure 2 shows the same tank in a transverse section, indicating the necessity for clearance of the gauge point from the tank structures.

The secondary reference gauge point at the aft end of each tank should be as far in board as possible so that if deadrise is present, the volume of cargo below the zero gauge point will be minimized. This is particularly necessary for wing tanks at the forward and aft ends of the tank space.

Figure 3 indicates the recommended transverse locations for the reference and additional gauge points. With the usual configuration of tank structure, it may not be possible to locate a primary reference gauge point at the geometric center of a center tank due to the presence of the centerline deck girder and the center vertical keel at the bottom requiring the gauge point to be offset slightly to one side or the other. For the wing tanks, there is usually no problem in locating a gauge point at the mid width of the tank.

All gauge points on all types of tank vessels must have a clear path from the reference gauge point to the zero gauge point clear of all interferences throughout the expected range of trim and list. This would include, without limitation, clearances from all structural framing members as already noted, piping, ladders, heating coils, reach rods, and anodes.



2.8B.6.3 LOCATION OF REFERENCE GAUGE POINTS—COMBINATION CARRIERS (OBOs)

The same general principle for location of reference gauge points applied to conventional tankers should apply equally well to OBOs, namely one primary reference gauge point as close as possible to the geometric center of each tank, in plan view, and one secondary reference gauge point at the aft end of each tank to evaluate ROB. However, due to the wide variety of tank/hold configurations on OBOs, specific recommendations become difficult. Figures 4 and 5 depict the longitudinal and transverse sections through a representative cargo hold/tank.

For an OBO with one hatch per hold, the recommended primary reference gauge point at the geometric center of the tank can be located on the hatch cover at the mid length of the tank as shown in Figure 4. If the hatch cover is of the two panel side rolling type with a centerline joint, the primary reference gauge point must be offset slightly to one side of the mid width of the tank to clear such joints as depicted in Figure 5. The secondary reference gauge point at the aft end of the hold/tank must be kept clear of sloping bulkheads forming the lower ballast tanks.

OBOs are required to have a sounding tube for use when carrying dry bulk cargoes. This may be counted as one of the manual points required for COW. This sounding tube will be calibrated in innage; however, the gauge height should be measured and recorded for convenience in converting between innage and ullage. Sounding tubes must be slotted.

2.8B.6.4 LOCATION OF REFERENCE GAUGE POINTS (BARGES)

Barges without propelling machinery are not subject to the extremes of trim as are tankships with machinery aft. They may, however, be subject to trim either forward or aft, which would require calibrated secondary gauge points at each end of each tank to evaluate ROB.

Location of a calibrated primary reference gauge point on the exact geometric center of the tank, in plan view, may have the same problem with interference from tank structure as on tankships.

For a barge, these primary reference gauge points may be calibrated as ullages or as innages. If calibrated as innages, they may very well be as sounding tubes with strike plates. These sounding tubes must be slotted.

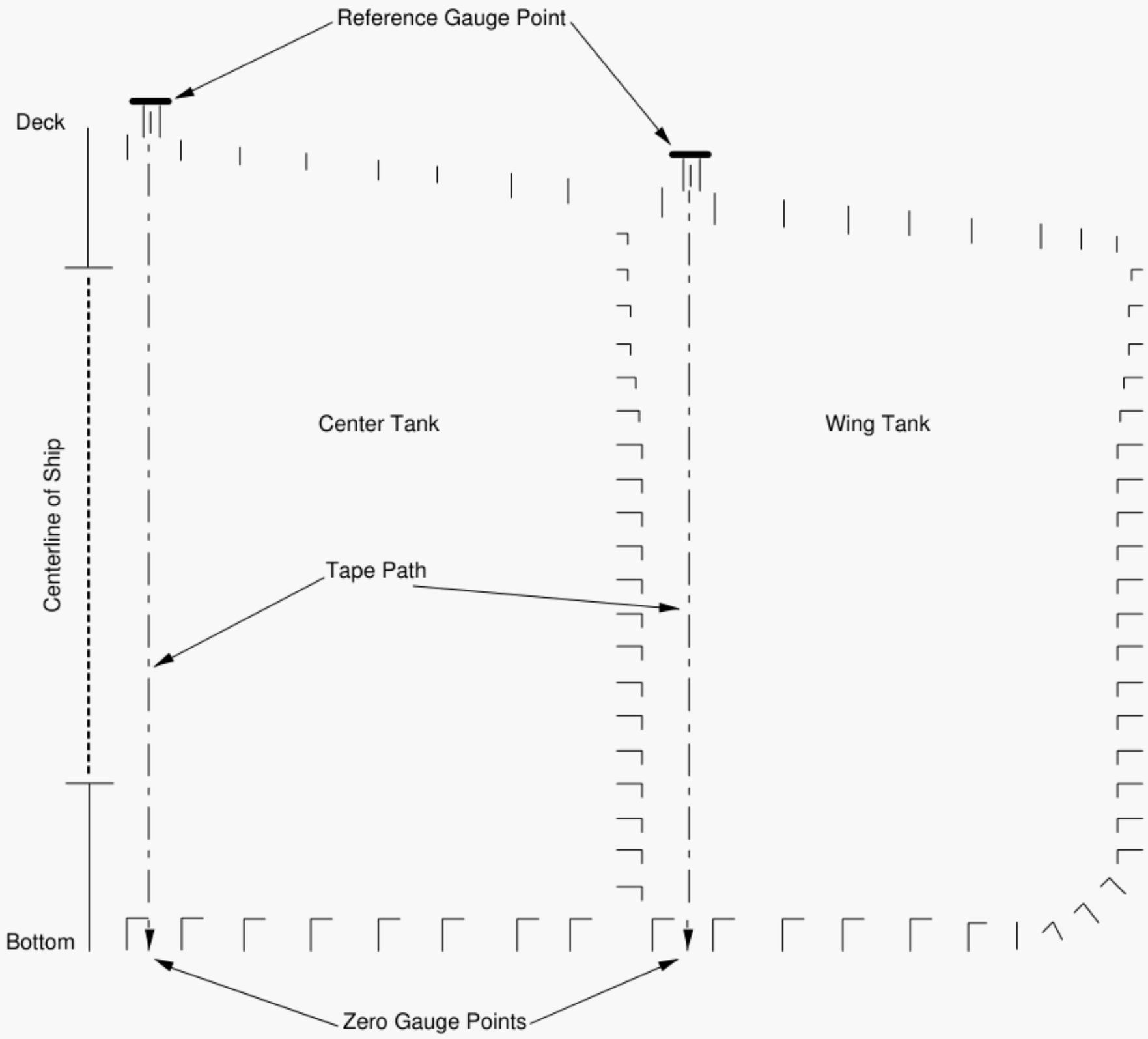


Figure 2—Transverse Section Through Typical Cargo Tank Showing Gauge Point Locations and Tape Path

Since inland waterway tank barges are not fitted for COW, additional hand dipping (hand gauging) points may not be required.

Recommended locations for reference gauge points on inland waterway tank barges are indicated in Figures 6 and 7.

2.8B.7 Gauging Hatches

2.8B.7.1 PRIMARY GAUGING HATCH

For many years, the common practice has been to fit the gauging hatch in the dome of the expansion trunk cover (access hatch cover). This introduces an error in the gauge height due to compression of the hatch cover gasket. With a 2 inch square gasket, the error may be as much as ½ inch after many openings and closings. For this reason, future installations should locate the primary gauging hatches on standpipes separate and apart from the expansion trunk cover.

The standpipe should be a length of extra heavy pipe extending from the deck to a suitable height above the deck, and at least one standpipe per tank should have an internal diameter sufficient to pass a sample container.

All reference gauge points should be calibrated for incremental tank volumes, have trim and list correction tables, and have a reference gauge height established.

The upper end of the standpipe may be fitted with a hinged dogged cover. If a hinged cover is fitted, the reference gauge point should be established as the rim of the standpipe opposite the hinge.

If the vessel is fitted with a vapor lock system on the standpipes and positive inert gas pressure must be main-

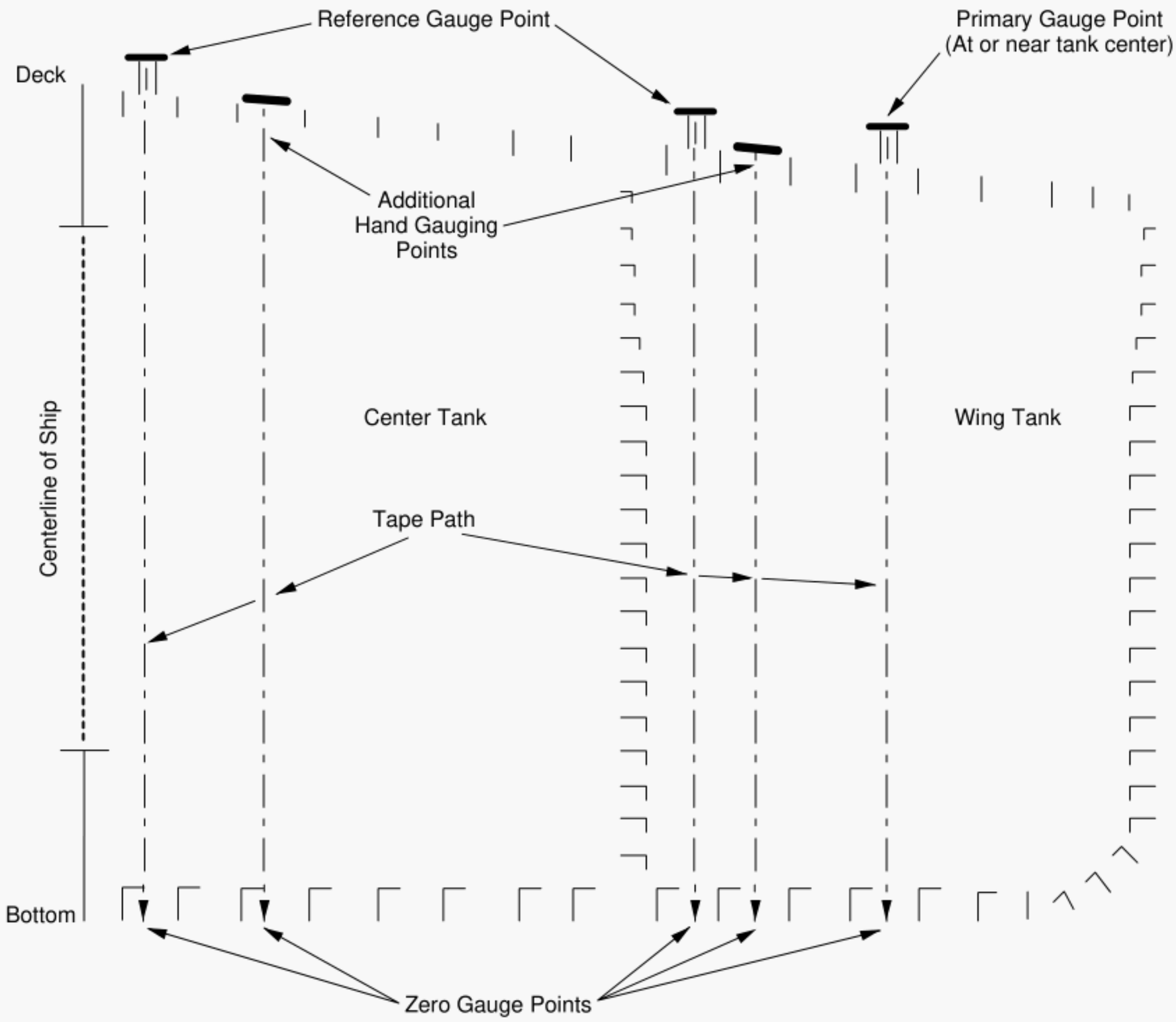


Figure 3—Transverse Section Through Typical Cargo Tank Showing Recommended Gauge Point Locations for Tankers

tained throughout the gauging process, a closed gauging device must be utilized. The reference gauge point will be to the top of the indicator bar on the gauging device. The reference gauge height will be established with the closed gauging device in operating position.

If a screw-down plug is fitted, the reference gauge point should be established to the top lip of the plug and clearly indicated by scribe marks on the deck of the vessel.

2.8B.7.2 OTHER MANUAL GAUGE POINTS

Other manual gauge points may have closures similar to those on principal gauge hatches or they may simply be a drilled and tapped opening in the deck or in the cover for a portable tank cleaning machine, closed by the pipe plug when not in use. These additional openings for manual gauging need only be calibrated for a reference gauge point.

2.8B.8 Measurement Procedures

2.8B.8.1 PRELIMINARY

Prior to boarding the vessel, the vessel's drafts should be read, fore, aft, and amidships and port and starboard, using a small boat as necessary. Vessel personnel should be contacted to ensure that there will be no change in ballast, bunkers, or cargo during the measurement process.

The presence of list should be checked by noting the difference in drafts at the midship port and starboard draft marks. If at all possible, the list condition should be corrected to zero list condition. If list is present, it should be recorded as port or starboard.

Ensure that neither hog nor sag condition exists by a comparison of the observed drafts. See API MPMS Chapter 2.8A, Appendix B for definition of these conditions.

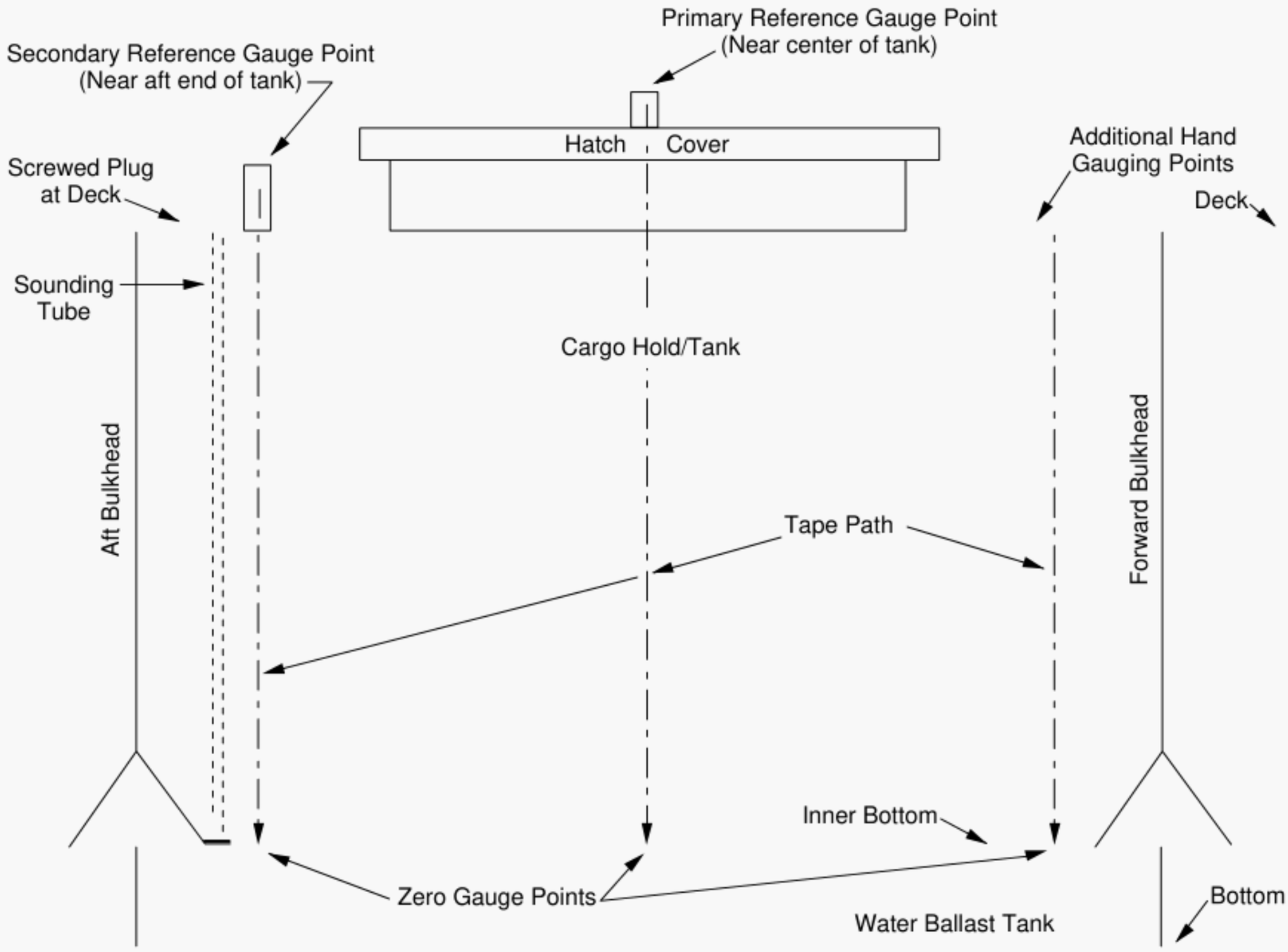


Figure 4—Longitudinal Section Through Cargo Hold/Tank of a Combination Carrier (OBO) Showing Recommended Gauge Point Locations

To correct the reference gauge heights for the vessel in an uneven keel condition, the length of the vessel between draft marks should be obtained, either from the vessel's documents or by measurement. The measurement is obtained from reading the drafts on the vessel's sides, then obtaining the distances from the draft marks to the forward and aft perpendicular as indicated in Figure 8.

At each gauge point, an innage tape should be lowered and the tape clamped in place at the reference gauge point with the bob at the zero gauge point. The tank should then be entered and the tank bottom, in way of the zero gauge point, examined for cleanliness. If the condition is not considered satisfactory, measurement procedures should be suspended until proper cleanliness is obtained.

The tape path for the full height of the tank should be carefully examined for clearances from tank internals. If it is considered that an incipient interference may occur at some condition of trim or list, a notation of such interference and specific conditions of trim and list involved should be included in the capacity tables.

2.8B.8.2 MEASUREMENT OF GAUGE POINT LOCATIONS

The location of each gauge point in the longitudinal and transverse directions shall be carefully measured from convenient longitudinal and transverse bulkheads and recorded. A sketch locating each gauge point shall be prepared similar to Figure 9. The sketch shall also indicate the type of gauge hatch fitted, whether it be on the expansion truck cover, on a standpipe with hinged cover, on a standpipe with vapor lock, on a pipe plug in the deck, or in the cover of an opening for a portable tank cleaning machine.

With more than one calibrated reference gauge point per tank, it is essential that the vessels's capacity tables be clearly specific as to which reference gauge point the table applies. It is recommended that the following terminology be used: "Center Tank No. 6 Forward," "Port Wing Tank No. 4 Mid," "Starboard Wing Tank No. 5 Aft."

Likewise, if calibration information plates are installed in accordance with 2.7.13 of API MPMS Chapter 7.2 or 2.8A.13 of API MPMS Chapter 2.8A, the designation of

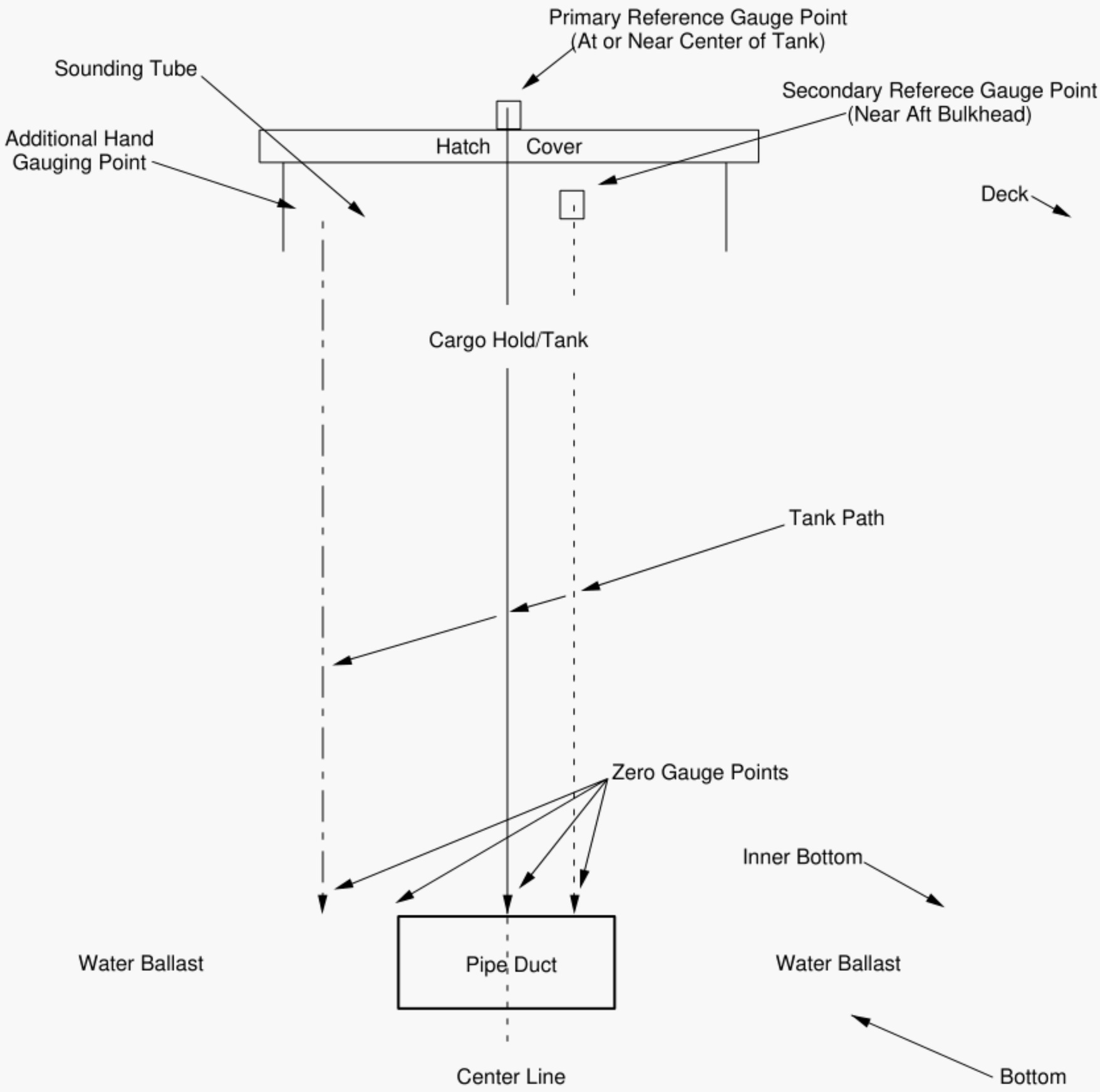


Figure 5—Transverse Section Through Cargo Hold/Tank of a Combination Carrier (OBO)
Showing Recommended Gauge Point Locations

each reference gauge point must clearly correspond with the designation in the capacity tables.

2.8B.8.3 MEASUREMENT OF REFERENCE GAUGE HEIGHT

Using a calibrated working tape for height measurement as described in 2.8A.7.3 of API MPMS Chapter 2.8A, the distance from the zero gauge point to the reference gauge point is measured for each gauging location. These are recorded as the measured gauge height and noted in the capacity tables.

2.8B.8.4 EXPANSION TRUNK COVER GASKET COMPRESSION

When measuring the reference gauge height on an existing vessel having the gauge hatch in the expansion trunk cover, the cover must be dogged down as in normal operation. With the cover in this position, a check measurement should be made from the lip of the cover to the deck. As this dimension will vary around the circumference of the expansion trunk due to the deck camber, the measurement should be taken in line (longitudinally)" with the reference gauge point as shown in Figure 10.

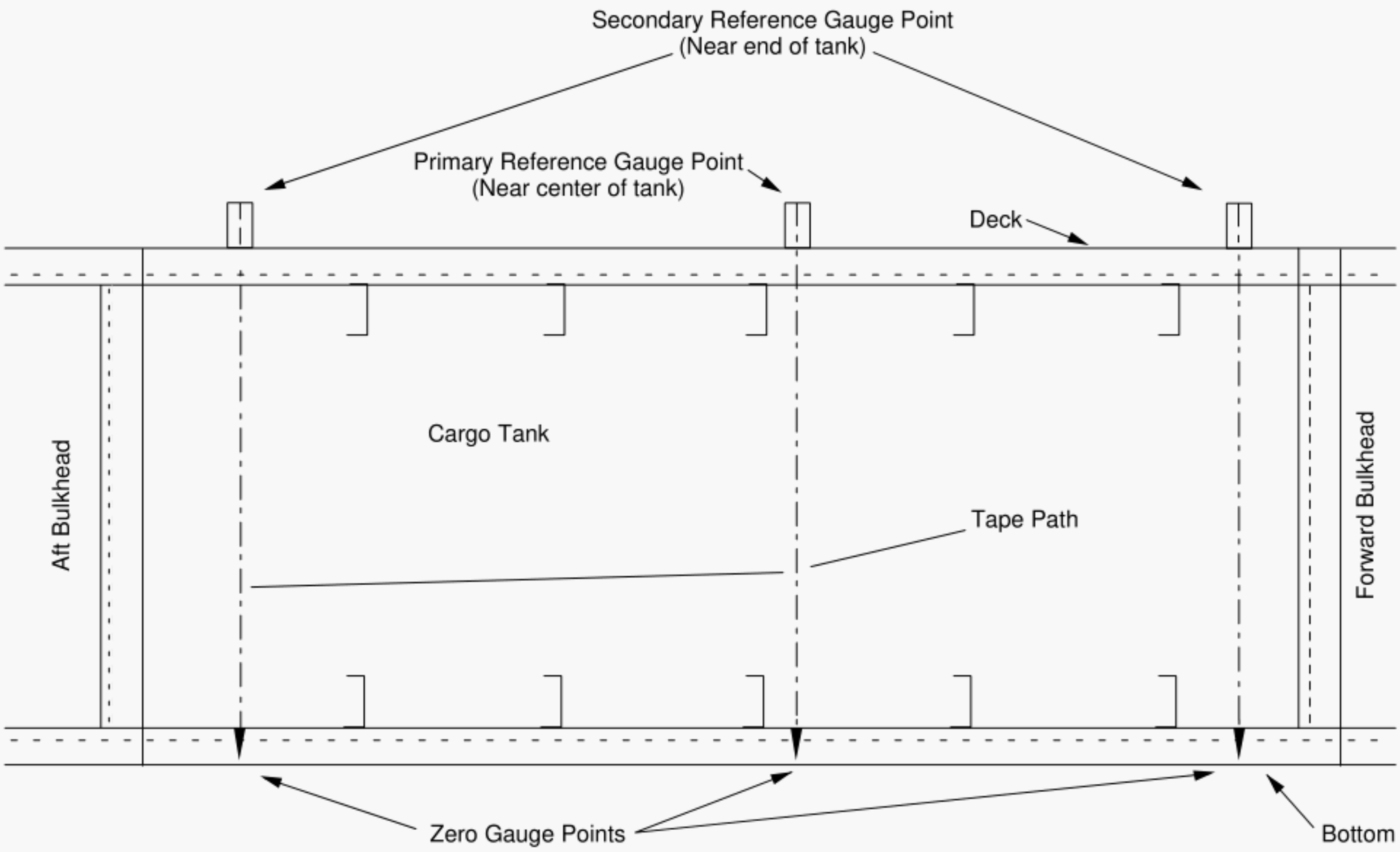


Figure 6—Longitudinal Section Through Cargo Tank of a Typical Inland Waterway Tank Barge Showing Recommended Gauge Point Locations

The measured gauge height and ullages will then be correct for that particular gasket compression, and this should be noted in the capacity tables.

As an alternative, it is recommended to attach a small horizontal plate on the expansion trunk and a second plate on the lip of the cover immediately above—the two plates being less than 6 inches (15 centimeters) apart. The plate on the cover shall have a horizontal line scribed upon it. At the time of measuring the reference gauge height, the distance from the horizontal line to the scribed line is also measured. This distance then becomes the compression distance; it is precisely measured to the nearest millimeter and recorded at the time of calibration. The measured gauge height and ullages will then be correct for that particular gasket compression, and this should be noted in the capacity tables.

2.8B.9 Calculation Procedures

If the vessel was at an absolute even keel at the time of measurement with no trim or list, then the measured gauge height is the reference gauge height and no further corrections are necessary. However, if at the time of measurement, trim, list, or both are observed, the measured reference height must be corrected for trim, list, or both using guidelines as detailed in 2.8A.10.4 of API MPMS Chapter 2.8A.

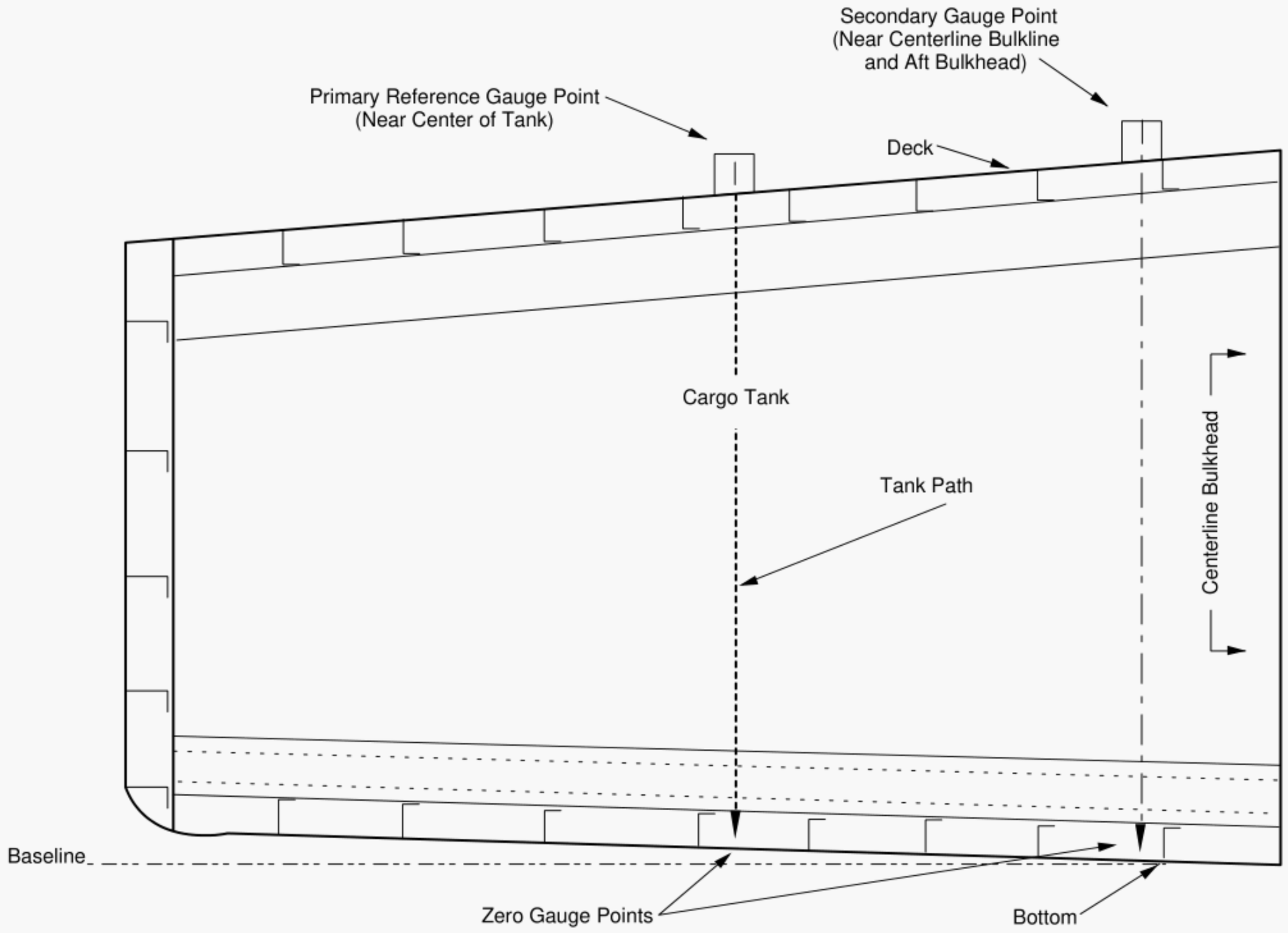


Figure 7—Transverse Section Through Cargo Tank of a Typical Inland Waterway Tank Barge Showing Recommended Gauge Point Locations

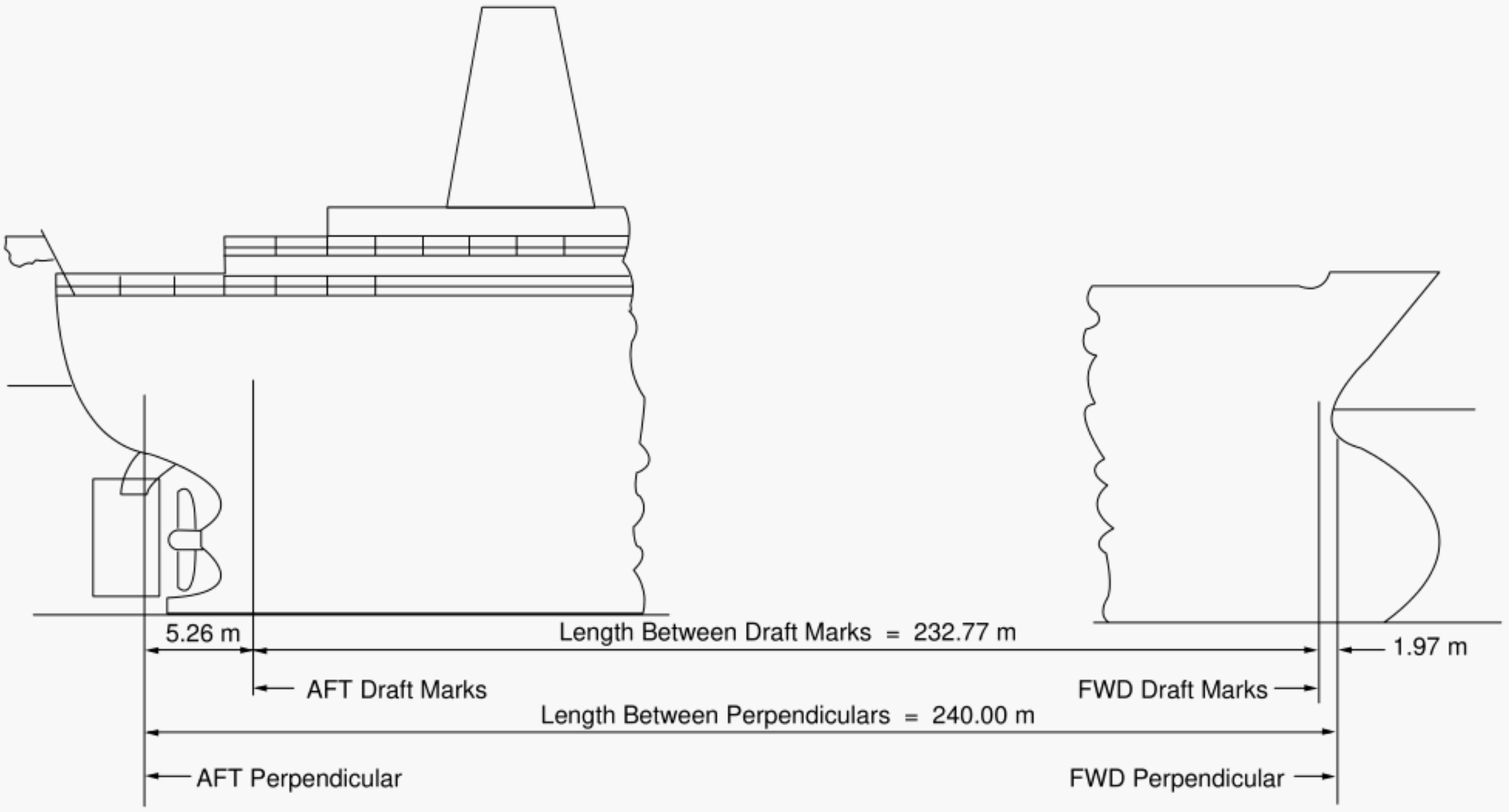


Figure 8—Illustration of Length Between Draft Marks
70,000 DWT Tanker

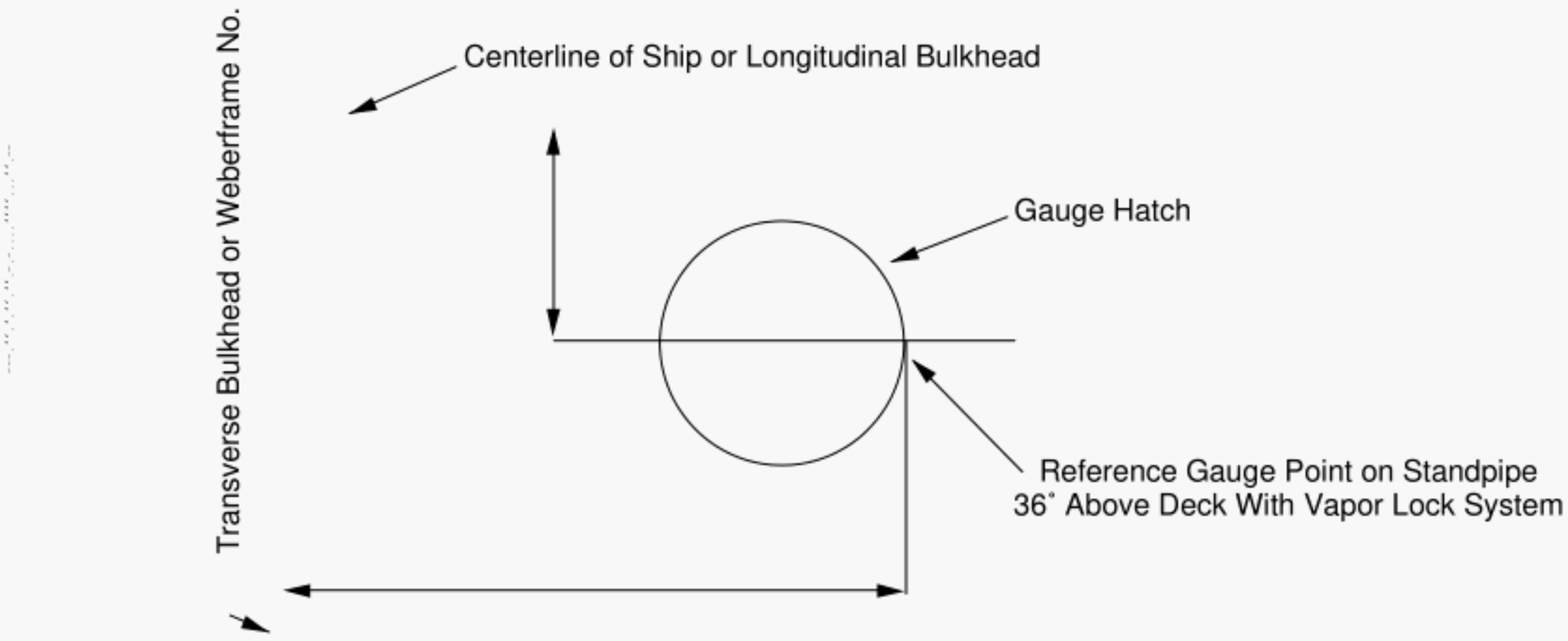


Figure 9—Sketch for Locating Gauge Point

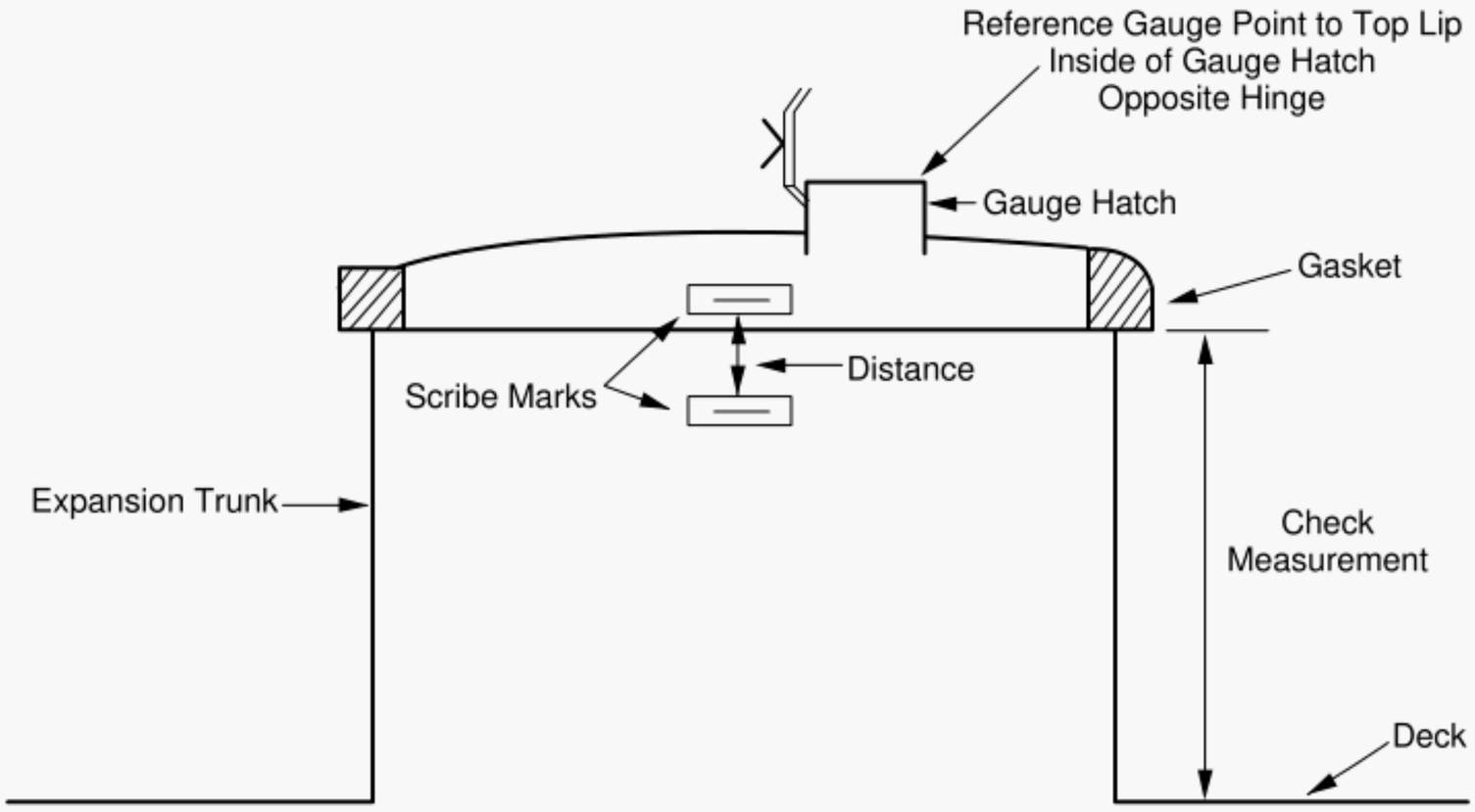


Figure 10—Check Measurement for Gasket Compression

1-01102—8/95—5C ( )

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

Order No. H028B1