

Calibration of spherical tanks for refrigerated light-hydrocarbon fluids in ships —

Part 1: Method of stereo-photogrammetry

Committees responsible for this British Standard

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- Department of Energy (Gas and Oil Measurement Branch)
- Department of Trade and Industry (National Engineering Laboratory)
- Department of Transport (Marine Directorate)
- GAMBICA (BEAMA Ltd.)
- Institute of Petroleum
- Royal Institution of Naval Architects
- Salvage Association

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National foreword

This Part of BS 7550 has been prepared under the direction of the Petroleum Standards Policy Committee. It is identical with ISO 9091-1:1991 “*Refrigerated light-hydrocarbon fluids — Calibration of spherical tanks in ships — Part 1: Stereo-photogrammetry*”, published by the International Organization for Standardization (ISO). ISO 9091-1 was prepared by Subcommittee 5, Measurement of light hydrocarbon fluids of Technical Committee 28, Petroleum products and lubricants, in which the United Kingdom participated.

It is intended that BS 7550 will consist of the following Parts.

- *Part 1: Method of stereo-photogrammetry;*
- *Part 2: Triangulation method.*

Part 2 will be identical with ISO 9091-2 which is in preparation.

Cross-references

International Standard	Corresponding British Standard
ISO 7078:1985	BS 6953:1988 <i>Glossary of terms for procedures for setting out, measurement and surveying in building construction (including guidance notes)</i> (Identical)

The Technical Committee has reviewed the provisions of ISO 8311:1989, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

CAUTION. Attention is drawn to the Health and Safety at work etc. Act 1974, and the need for ensuring that the method specified in this Part of BS 7550 is carried out with suitable precautions.

The procedure described in this Part of BS 7550 is intended to be carried out by appropriate qualified and experienced persons or other suitably trained and/or supervised personnel. Normal safety precautions should be observed throughout the use of the method. Attention is drawn to the precautions given in Annex A.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Introduction

Large quantities of light hydrocarbons consisting of compounds having 1 to 4 carbon atoms are stored and transported by sea as refrigerated liquids at pressures close to atmospheric. The liquids can be divided into two main groups: liquefied natural gas (LNG) and liquefied petroleum gas (LPG). Bulk transportation of these liquids requires a special technology in ship design and construction to enable shipborne transportation to be safe and economical. Measurement of cargo quantities in ships' tanks for custody transfer purposes has to be of a high order of accuracy. The two parts of this International Standard, together with other standards in the series, specify methods of internal measurement of ships' tanks from which tank calibration tables can be derived.

For internal measurement, liquid calibration, physical measurement, optical measurement and stereo-photogrammetry are in general use. Liquid calibration cannot be used for large spherical tanks designed to operate at near atmospheric pressure with refrigerated light hydrocarbons because the hydrostatic pressure exerted by the calibrating liquid may exceed the design pressure when filled higher than a certain level. In view of its accuracy, the last-mentioned should be adopted as the referee method if calibration by another method is in doubt. Stereo-photogrammetry consists mainly of photographing targets on the tank wall and the analytical processing of the photographs in the laboratory.

This part of ISO 9091 specifically describes the method using a universal metric camera for the photographing and analytical stereoplotter for the analysis.

1 Scope

1.1 This part of ISO 9091 describes a stereo-photogrammetric procedure for the internal measurement of spherical tanks in liquefied-gas carriers.

1.2 In addition to the actual process of measurement, this part of ISO 9091 also sets out the calculation procedures for compiling the calibration tables.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9091. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9091 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7078:1985, *Building construction — Procedures for setting out, measurement and surveying — Vocabulary and guidance notes*.

ISO 8311:1989, *Refrigerated light hydrocarbon fluids — Calibration of membrane tanks and independent prismatic tanks in ships — Physical measurement*.

3 Definitions

For the purposes of this part of ISO 9091, the following definitions apply.

3.1

absolute orientation

the procedure of final correction of the stereoscopic models formed by inner and relative orientations, in which the scale in the stereoscopic model is converted to the actual length and the inclination of the model is adjusted to the actual condition of the tank

3.2

calibration

the process of determining the total capacity or partial capacities of a tank corresponding to different levels

3.3

calibration table (main gauge table)

a table, of ten referred to as a tank table or a tank capacity table, showing the capacities or volumes in a tank corresponding to various liquid levels measured from the gauge reference point, with the ship on an even keel and upright

3.4

datum point

the south pole to which the tank table is referred

3.5

deadwood

any tank fitting which affects the capacity of a tank. Deadwood is referred to as "positive deadwood" when the capacity of the fitting adds to the effective capacity of the tank, or "negative deadwood" when the volume of the fitting displaces liquid and reduces the effective capacity

3.6
equator

the largest horizontal circumference of a spherical shell

3.7
floating mark

a mark seemingly occupying a position in the three-dimensional space formed by stereoscopic fusion of a pair of photographs and used as a reference mark in examining or measuring the stereoscopic model

3.8
gauge reference point

the point from which the liquid depths are measured

NOTE 1 In spherical tanks, this point may be either the zero of the level gauge or the south pole of the tank.

3.9
inner orientation

the process of determining, mathematically, the interior perspective of the photographs at the time of exposure in an analytical stereoplotter. The calibrated focal length, the location of the calibrated principal point and the calibrated lens distortion are the principal factors used in the calculation

3.10
list

transverse inclination of a ship

3.11
north pole

the zenith, or highest point, of a spherical tank shell (an imaginary point in most spherical tanks due to the pipe tower or other appurtenances)

3.12
pipe tower

a large-diameter pipe coaxial with the tank's north-south axis, containing pipes for loading and discharging, measuring instrumentation, the ladder, wiring and other in-tank facilities designed to protect them from the effect or sloshing of the tank contents

3.13
port

the left-hand side of a ship facing forward

3.14
relative orientation

the process of determining the relative position and attitude of a pair of overlapping photographs by mathematical analysis to create a stereoscopic model

3.15
south pole

the nadir, or lowest point, of a spherical shell

3.16
starboard

the right-hand side of a ship facing forward

3.17
stereoscopic model

three-dimensional model formed by intersecting homologous rays of a pair of overlapping photographs

3.18
stereoscopic photograph

a set of photographs of an object taken from two different positions so that they may form a stereoscopic model of the object depicting it as if it were in three-dimensional space

3.19
targets

predetermined positions distinctively marked on the inside surface of the tank for the stereo-photogrammetry

3.20
trim

longitudinal inclination of a ship

4 Precautions

This clause outlines the precautions to be taken during measurement in order to ensure that the required calibration precision is obtained.

4.1 Utmost care and attention shall be exercised in taking measurements and during photographing, and any unusual occurrence during the measurement or photographing which might affect the results obtained shall be recorded. The calibration method described in this part of ISO 9091 may be applied to ships whether afloat or in a dry dock. However, its use in a dry dock may be preferable, because trim or list, if any, will remain the same throughout the measurement. Keep trim and list of the ship unchanged while an optical level or any other levelling device is being used.

4.2 If any unusual distortions are found in the tank shell, additional measurements shall be taken to obtain sufficient data for correct calculation in the calibration table, and the calibrator's notes shall be provided in connection with such extra measurements.