



Document No.	GP 64-03
Applicability	Group
Date	27 December 2005

Guidance on Practice for Static Fluid Measurement Systems

GP 64-03

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This is the first issue of Engineering Technical Practice (ETP) GP 64-03. This Guidance on Practice (GP) is based on parts of heritage documents from the merged BP companies as follows:

BP

BPMSM	Downstream BP Measurement Standards Manual
BPMS 1.1.1	Crude Oil: Static Methods - Manual Tank Gauging
BPMS 1.1.2	Crude Oil: Static Methods - Tank Sampling & Temperature Measurement
BPMS 1.1.3	Crude Oil: Static Methods - Automatic Equipment
BPMS 1.1.4	Crude Oil: Static Methods - Sample Handling
BPMS 1.1.5	Crude Oil: Static Methods - Laboratory Methods of Measurement
BPMS 1.1.6	Crude Oil: Static Methods - Calculation Procedures
BPMS 1.1.7	Crude Oil: Static Methods - Data Consistency & Error Significance
BPMS 1.1.8	Crude Oil: Static Methods - Records Calculations and Loss Reporting
BPMS 1.1.9	Crude Oil: Static Methods - Computerisation of Calculations
BPMS 1.1.10	Crude Oil: Static Methods - Conversion of Units of Measurements
BPMS 1.1.11	Crude Oil: Static Methods - Definitions & Terminology
BPMS 2.1	Products: Static Methods - Introduction
BPMS 2.1.1	Products: Static Methods - Manual Tank Gauging & Water Measurement
BPMS 2.1.2	Products: Static Methods - Automatic Equipment
BPMS 2.1.3	Products: Static Methods - Manual Sampling & Temperature Measurement
BPMS 2.1.4	Products: Static Methods - Analysis Methods
BPMS 2.1.5	Products: Static Methods - Calculation, Records & Reporting
BPMS 2.1.6	Products: Static Methods - Measurement Errors & Data Consistency
BPMS 2.1.7	Products: Static Methods - Measurement by Weighing
BPMS 2.1.8	Products: Static Methods - Conversion of Measurement units
BPMS 2.1.9	Products: Static Methods - Definitions & Terminology
BPMS 3.1.1	Products: Static Methods - Units of Measurement
BPMS 3.2.2	Products: Static Methods - Static Measurement Equipment

British Petroleum (RPSE)

RP 30-02	Instrumentation and Control — Selection and Use of Measurement Instrumentation
RP 58-1	Non-Refrigerated Petroleum and Petrochemical Storage

Copyright © 2005, BP Group. All rights reserved. The information contained in this document is subject to the terms and conditions of the agreement or contract under which the document was supplied to the recipient's organization. None of the information contained in this document shall be disclosed outside the recipient's own organization without the prior written permission of Director of Engineering, BP Group, unless the terms of such agreement or contract expressly allow.



Table of Contents

	Page
1. Scope	4
2. Normative references.....	4
3. Classification of measurement applications	6
4. System design - general	6
5. Storage tanks and level measurement	7
5.1. General.....	7
5.2. Traceability of measurement.....	7
5.3. Tank gauging systems	9
5.4. Temperature measurement equipment	10
5.5. Pressure measurement equipment	12
5.6. Mixing requirement	12
5.7. Fluid sampling.....	13
5.8. Calculations	14
5.9. Special considerations for tank gauging of pressurised systems (LNG and LPG)	15
5.10. Special considerations for tank gauging of refrigerated systems (LNG and LPG).....	16
6. Weighbridges and weigh scales.....	17
6.1. General.....	17
6.2. Traceability of weight measurement.....	18
6.3. Weighing system design and installation.....	20
6.4. Operation and maintenance.....	20
7. Measurement computation facilities	20
7.1. Control philosophy	20
7.2. Storage tank and level measurement computation systems.....	21
7.3. Weigh bridge and weigh scale computation systems	23



1. Scope

This GP provides guidance on practice for selection, design, installation, operation, and maintenance of static fluid measurement systems with particular emphasis on Class 1 and Class 2 Systems.

For the purposes of this GP, the term “measurement” encompasses static quantity determinations of fluids held in storage tanks and vessels. This GP primarily addresses Class 1 & 2 measurement.

In addition to static tank measurement, this document also sets out basic requirements and recommendations for road and rail weighbridges; and weigh scales and platforms used for drum and cylinder weighing. It does not cover weighing devices used for in-motion weighing.

Whilst the guidance and references contained within this document predominantly refer to oil measurement, in general, the clauses and commentaries equally apply to all fluid products.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

American Petroleum Institute (API)

API MPMS 3.1B	Standard practice for level measurement of liquid hydrocarbons in stationary tanks by automatic tank gauging
API MPMS 3.3	Tank gauging: Standard practice for level measurement of liquid hydrocarbons in stationary pressurised storage tanks by automatic gauging
API MPMS 3.6	Measurement of liquid hydrocarbons by hybrid tank measurement systems
API MPMS 7.3	Static temperature determination using portable electronic thermometers
API MPMS 7.4	Static temperature determination using fixed automatic tank thermometers
API MPMS 12.1.1	Section 1: Calculation of static petroleum quantities Part 1: Upright cylindrical tanks and marine vessels
API MPMS 14.4	Converting mass of natural gas liquids and vapours to equivalent liquid volumes
API MPMS 17.1	Marine measurement: Guidelines for marine cargo inspection
API MPMS 17.2	Measurement of cargoes on board tank vessels
API MPMS 17.4	Marine measurement: Method for qualification of small volumes on marine vessels (OBQ/ROB)
API MPMS 17.5	Marine measurement: guideline for cargo analysis and reconciliation of cargo
API MPMS 17.6	Guidelines for determining the fullness of pipelines between vessels and shore tanks
API MPMS 19.1	Evaporative loss from fixed-roof tanks



API MPMS 19.2	Evaporative loss from floating-roof tanks
API MPMS 19.4	Recommended practice for the specification of evaporative losses

BP Engineering Technical Practices (ETP)

GP 12-45	Guidance on Practice for Electrical for Packaged Equipment
GP 30-01	Guidance on Practice for Temperature Instruments
GP 30-05	Guidance on Practice for Pressure Instruments
GP 30-20	Guidance on Practice for Miscellaneous Instruments
GP 30-25	Guidance on Practice for Field Instruments — General
GP 30-70	Guidance on Practice for Control & Instrumentation in Vendor Packaged Equipment
GP 64-01	Guidance on Practice for Fluid Measurement Management
GP 64-04	Guidance on Practice for Fluid Quality Measurement Systems

Energy Institute (EI, formerly Institute of Petroleum (IP))

HM 21	Static and dynamic measurement of light hydrocarbon liquids. Section 1: Calculation procedures (formerly IP PMM Part XII, Section 1)
HM 22	Static and dynamic measurement of light hydrocarbon liquids, Section 3 – Instruments for Primary measurement (formerly IP PMM XII Section 3)
HM 24	Electrical and/or electronic data transmission for automatic tank gauge systems (formally IP PMM Part XIII Section 2)

International Electrotechnical Commission (IEC)

IEC 60751	Industrial Platinum Resistance Thermometer Sensors
-----------	--

International Organization for Standardization (ISO)

ISO 4266-1	Petroleum and liquid petroleum products: Measurement of temperature and level in storage tanks— by automatic methods: Measurement of level in atmospheric tanks
ISO 4266-2	Petroleum and liquid petroleum products: Measurement of temperature and level in storage tanks— by automatic methods: Measurement of level in marine vessels
ISO 4266-3	Petroleum and liquid petroleum products: Measurement of temperature and level in storage tanks— by automatic methods: Measurement of level in pressurised storage tanks
ISO 4266-4	Petroleum and liquid petroleum products: Measurement of temperature and level in storage tanks— by automatic methods: Measurement of temperature in atmospheric tanks
ISO 4266-5	Petroleum and liquid petroleum products: Measurement of temperature and level in storage tanks— by automatic methods: Measurement of temperature in marine vessels
ISO 4266-6	Petroleum and liquid petroleum products: Measurement of temperature and level in storage tanks— by automatic methods: Measurement of temperature in pressurised storage tanks
ISO 6578	Refrigerated hydrocarbon liquids - Static measurement - Calculation procedure
ISO 8022	Petroleum measurement systems: Calibration - Temperature corrections for use when calibrating volumetric proving tanks



ISO 8310	Refrigerated Light Hydrocarbon Fluids - Measurement of temperatures in tanks containing liquefied gases. Thermocouples and Resistance Thermometers.
ISO 8697	Crude petroleum and petroleum products: Transfer accountability - Assessment of on board quantity (OBQ) and quantity remaining on board (ROB)
ISO 10574	Refrigerated light hydrocarbon fluids: Measurement of liquid levels in tanks containing liquefied gasses
ISO 13398	Refrigerated light hydrocarbon fluids - Liquefied natural gas - Procedure for custody transfer on board ship

3. Classification of measurement applications

- a. Reference shall be made to GP 64-01 for the general BP definitions of Class 1, Class 2 and Class 3 measurement systems.
- b. The security and fidelity of Class 1 & 2 static measurement systems shall be assured by the use of a system of seals and locks to ensure piping isolations and tank contents cannot be interfered with.
- c. For Class 1 & 2 systems, isolating valves and pressure relief systems should be tested routinely to confirm their integrity.

Clearly, routine testing of integrity is necessary for Class 3 systems also, on HSSE grounds but as a measurement precaution this might be less frequent than for Class 1 & 2 systems.

4. System design - general

- a. The measurement system design shall meet the requirements and take into consideration the recommendations, of GP 64-01.
- b. Instrument and electrical connections and installation shall be in accordance with GP 30-70 and GP 12-45.
- c. Static measurement equipment shall be suitable for the environment in which it is to be installed and maintained.
- d. Static measurement systems shall be built to a high standard by recognised specialist suppliers who are familiar with the associated commercial and regulatory requirements.

Often there are unique commercial agreements or measurement system specifications that have to be adhered to and reporting requirements and security precautions that need to be incorporated.

- e. The equipment proposed shall use accepted technology, which should be documented by industry measurement standards.
- f. Consideration shall be given to the nature of the fluid when selecting the technology.

For example, non-intrusive gauges for high pour point crude oils.

- g. The measurement system shall be capable of meeting any stated uncertainty requirements.

The final selection of measurement method may be influenced by cost in some applications but seldom should cost be the deciding factor. Measurement devices not covered by this GP may be proposed by a vendor if supported by a written technical case, and subject to approval by BP.



5. Storage tanks and level measurement

5.1. General

- a. Instruments for automatic storage tank gauging shall be designed, selected, and installed in accordance with GP 30-25 and more specifically ISO 4266 (all parts) and API MPMS 3.1B.
- b. Density or specific gravity instruments shall be designed, selected, and installed in accordance with GP 30-20 section 5.
- c. Sample and instrument access should be via “vapour control valves” to minimise the release of vapours to the atmosphere.

The recommended size of vapour control valves is 4” to allow flexibility of access for various sizes of sampling and test equipment.

5.2. Traceability of measurement

5.2.1. Tank calibration

- a. Tanks shall be periodically proved by recognised methods.

Relevant standards include: ISO 4269, ISO 7507-3, 4, 5 & ISO 12917; API MPMS 2.2, 2.7 & 2.8.

- b. Tank tables shall be confirmed to a resolution of not more than 1 mm.

Re-calibration of cylindrical tanks and road cars, in accordance with the appropriate industry standards, should be considered at ten and four year intervals respectively, unless national legislation recommends a shorter interval.

- c. Temperature correction tables shall be applied when calibrating volumetric tanks in accordance with ISO 8022.
- d. If modifications have been carried out on tanks that may affect the level-volume relationship, a re-calibration should be undertaken.

Tank calibrations and resulting tank calibration tables form the basis of all static measurement. The best gauging system is useless if it is based on doubtful calibration tables. Any inaccuracies in these tables consistently work as a systematic error - thus a large loss can accumulate over a period of time.

- e. Operations should be arranged so that it is never necessary to gauge a tank with the roof partially grounded.

Grounding and in particular partial grounding of roofs can lead to measurement errors and damage to the tank bottom.

- f. Drains should be well maintained and roofs frequently inspected.

Accumulations of water or debris on a floating roof will affect the tank calibration.

5.2.2. Measurement tapes

- a. Tapes used for fiscal measurement and custody transfer shall be calibrated by the manufacturer or an approved calibration authority before purchase and they shall meet a specification of ± 1.5 mm uncertainty in 30 m (equivalent to the IPM8 design tolerance contained in HM 4).

Tapes may require correction to compensate for:

- *calibration error during manufacture.*
- *incorrect tape tension during manufacture and calibration.*



- *thermal expansion/contraction of the tape in extreme ambient conditions or for fluid temperature where the deviation from the calibration temperature will result in a correction of >1 mm.*
- b. The same measurement tape and operator should be used to measure tank stocks before and after a transfer to avoid introducing additional bias errors.

5.2.3. Level gauges

The following procedures shall be used for zero adjustment and proving of automatic level gauges.

- a. The procedures shall be based upon those recommended in ISO 4266. Alternatively, the procedures described in API MPMS 3.1B or any similar approved national standard may be followed.
- b. Zero adjustment need only be applied after installation, maintenance or whenever there are doubts concerning the accuracy of the gauge.
- c. To ensure the highest degree of accuracy, zero adjustment should only be undertaken in calm conditions with wind less than Beaufort scale force 3.
- d. Routine proving shall be carried out at intervals not exceeding three months as follows:
 1. Separate automatic gauge and manual gauge readings shall each be averaged and the averages compared.
 2. Any difference in the upper reference levels or datum plate levels shall be taken into account.
 3. If these averages differ by more than ± 3 mm for servo-operated and radar gauges or ± 5 mm for mechanically operated gauges, the automatic gauge shall be adjusted, centrally and accurately, to meet this tolerance.
 4. After any re-setting, the procedure shall be repeated and the new average automatic gauge reading shall again be compared with the manual reading.
 5. Further adjustments shall be made if required until three consecutive readings agree within the above stated tolerance.

Special attention should be paid to the relevant standards associated with level measurement of refrigerated hydrocarbon in tanks and vessels, where applicable; namely: ISO 8311, ISO 9091-1 & ISO 9091-2.

5.2.4. Temperature measurement

- a. The deviation of the average of the tank temperature measurements from the average of manual reference temperature measurements shall lie within $\pm 0.5^\circ\text{C}$.
- b. Routine calibration shall be carried out at intervals not exceeding six months assuming control charts confirm acceptable stability.

5.2.5. Pressure measurement

- a. The deviation of the average gauge pressure measurements from the average of the working range by manual reference measurements shall lie within $\pm 0.25\%$ full scale.
- b. Routine calibration shall be carried out at intervals not exceeding six months assuming control charts confirm acceptable stability.

