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Ships and marine technology — Bunker fuel mass flow meters on receiving vessel — Requirements

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Foreword

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This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Accurate measurement of large quantities of bunker fuels received by ships around the world has historically been difficult, with many ships relying on outdated methods of verification, such as before-and-after manual measurement of fuel tank levels. The potential for inaccuracies is significant and can result in disputes between the fuel supplier and the ship.

This document addresses the need for standardization of meters used to accurately measure the quantity of fuel received. Traditionally, volumetric flow meters have raised accuracy concerns because of the potential for air and other gases to affect the measurement of the fluid. Also, entrained air can cause inaccurate shipboard tank readings during and immediately after bunkering.

Accurate measurement of bunker fuel receipt quantities using mass flow meters will result in greater efficiencies in the ship bunkering process and reduce disputes.

Ships and marine technology — Bunker fuel mass flow meters on receiving vessel — Requirements

1 Scope

This document specifies requirements for Coriolis mass flow meter (MFM) systems installed on and used by vessels for the accurate measurement of bunker fuels received. It defines metrology and security requirements as well as testing requirements of the MFM system for the receiving vessel. This document complements ISO 8217, ISO 22192 and OIML R117.

This document does not cover mass flow meters used for custody transfer, nor does it address overall bunker delivery procedural issues, such as delivery system integrity and transfer operations. It is not applicable to cryogenic fuels such as LNG.

For bunker delivery using a Coriolis mass flow meter system in a custody transfer role, refer to ISO 22192.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
bunker
bunker fuel
fuel (Class F) supplied to a vessel for its propulsion and/or operation

Note 1 to entry: Class F fuels are specified in ISO 8217.

3.2
mass flow meter
MFM
equipment designed to directly measure and indicate the mass of *bunker fuel* (3.1) received by a ship

3.3
maximum allowable working pressure
MAWP
highest stress to which a piping system component can be subjected, based on materials and design calculations

3.4
maximum mass flow rate
Q_{max}
maximum flow rate up to which the *MFM system* (3.5) has been qualified to operate in compliance with the required accuracy

Note 1 to entry: The maximum value is normally determined by the application.

3.5
MFM system
bunker fuel (3.1) receiving system, comprising the *mass flow meter* (3.2) and its ancillary devices, pipelines and seals between the vessel's bunker manifold and the mass flow meter

3.6
minimum mass flow rate
Q_{min}
minimum flow rate to which the metering system has been qualified to operate, in compliance with the required accuracy

Note 1 to entry: The minimum value is normally determined by the flow metering system.

3.7
minimum measured quantity
MMQ
smallest quantity of liquid for which the measurement is metrologically acceptable for a given system or element

4 Symbols and abbreviated terms

AC	alternating current
DC	direct current
DN	nominal diameter
IEC	International Electrotechnical Commission
LFC	low flow cut-off
Q_{max}	maximum flow rate
Q_{min}	minimum flow rate
P	pressure
MAWP	maximum allowable working pressure
MFM	mass flow meter
MMQ	minimum measured quantity
OIML	International Organization of Legal Metrology

5 Design and environment testing

5.1 Materials and equipment

MFM casings, as well as any pressure-retaining parts, shall be of metallic construction. Materials rendered ineffective by heat shall not be used in the construction of the meter casing or any pressure-retaining parts. All other parts shall be constructed of materials suitable for the service intended. Fasteners in contact with interior fluid shall be of corrosion-resistant materials.

Threaded fittings shall not be used in pipe sizes greater than DN 50.

5.2 Environmental tests

Unless otherwise specified, environmental tests shall be conducted on a prototype of each meter model.

MFM for marine applications should have documentation of completion of the following tests:

a) vibration,

b) temperature,

c) weather tightness.

The tests above should be acceptable to a member of the International Association of Classification Societies (IACS), based on environmental testing requirements for shipboard electrical/electronic equipment.

5.3 Hydrostatic test

Each MFM shall be subjected to a hydrostatic test at 1,5 times the MAWP in accordance with an appropriate test standard.

5.4 Temperature

MFM shall be designed to operate within an ambient temperature range of -40 °C to +60 °C.

5.5 Pressure rating

MFM shall have a minimum pressure rating of not less than 1 MPa (145 psig).

The maximum pressure of the fluid measured shall not affect the sensitivity of the measuring device or indicating mechanism.

5.6 Non-metallic materials

Gaskets, seals and O-rings used for the installation and construction of the meter that can come in contact with the fuel being measured shall be suitable for the application. Security seals should be fabricated of materials that do not deteriorate due to corrosion or UV exposure.

5.7 Marking

MFM shall be marked with the following minimum information:

a) manufacturer's identification mark, trademark or name;

b) designation selected by the manufacturer, if appropriate;

c) maximum allowable working pressure;

d) fluid flow direction, by an arrow or another indicator;

e) serial number (MFM);

f) transmitter model and serial number;

g) year of manufacture.

6 Metrological requirements

6.1 General

This clause specifies the MFM's metrological traceability, calibration and re-calibration requirements for the approval of the MFM system applicable to non-custody transfer bunkering. The MFM system should be operated within rated conditions as set out in these requirements to meet the 0,5 % expanded

measurement uncertainty for bunker fuel application (see 6.3.1). The MFM system performance should be confirmed during the commissioning and maintained during operation.

Verification on board shall be performed by a qualified and independent party (see Clause 9).

6.2 MFM requirements

6.2.1 Every MFM shall be calibrated before being installed on the ship and shall include its adjustment device(s) and ancillary device(s).

The device shall be calibrated with water as the fluid with a certification issued by either a national metrology institute or an appointed OIML Issuing Authority in accordance with the relevant OIML Recommendations, accompanied by relevant supporting documents, confirming that the MFM performance meets the requirement of maximum measurement uncertainty for bunker fuel fluid flow measurement to be not more than 0,2 %.

Alternatively, any hydrocarbon or synthetic oil with a density/viscosity similar to that of the bunker fuels specified in ISO 8217 may be used as the calibration fluid.

6.2.2 MFM shall be calibrated with direct traceability to an SI unit of mass by a laboratory meeting the requirements of ISO/IEC 17025. The calibration shall cover flowrates across the measurement range applications. See Annex A for an example of a MFM test.

6.3 MFM system requirements

6.3.1 The guideline of 0,5 % expanded measurement uncertainty should take into consideration the following uncertainty sources influenced by:

— MFM calibration;

— product condition, e.g. viscosity and density;

— process flow condition, e.g. aeration flow and flow turbulences, etc.;

— piping line system configuration and meter installations, which can affect measurement conditions;

— any other source that may influence the mass flow measurement.

6.3.2 Requirement of zero offset limit and zero verification.

— Zero setting is required during commissioning.

— Zero stability should be periodically checked by zero verification.

— Maximum permissible zero offset shall be not more than 0,2 % of Q_{min}.

6.3.3 The low flow cut-off (LFC) setting value shall be not more than 20 % of Q_{min}.

6.3.4 The process flow rate range shall not be less than Q_{min} and not more than Q_{max}.

7 Security requirements

7.1 General

This clause specifies the general requirements and procedures to ensure that the system integrity of the MFM system is confirmed during commissioning and maintained during operation.

System integrity aims to ensure that the MFM system:

— measures all bunker fuel received and there shall be no diversion of bunker fuel before the receiving MFM; and

— performs and operates to its intended purpose without external interference that affects the measurement.

Refer to Annex B for the schematic diagram of a MFM system on a receiving vessel.

The vessel shall keep onboard an updated bunker receiving procedure and a piping and instrumentation diagram (P&ID) showing the MFM system.

7.2 Security features

7.2.1 Equipment security

The MFM system shall be secured against unauthorised adjustment, tampering or dismantling.

No foreign object(s)/device(s) that could cause irregularity and/or affect the measurement shall be placed on, or in the vicinity of, the MFM or any part of the MFM system during the entire bunkering operation.

7.2.2 Software security

All MFM system software shall be protected to meet the requirements for fuel measurement. This is to prevent any unauthorised changes to the software and parameter settings. The MFM system shall be able to trace any changes affecting the fuel measurement.

7.2.3 Measurement data recording

History of operations with supporting documents should be recorded.

8 MFM selection and installation requirements

8.1 General

This clause covers the selection and installation of the MFM system to meet the requirements set in this document, in particular in Clause 5 and Clause 6, as well as the owner's operational requirements. This includes pre-selection evaluation and site survey.

8.2 MFM selection

Successful and accurate measurements begin with proper meter selection. The MFM shall be applicable for bunker receipt application with appropriate characteristics and specifications.

The MFM selected shall consider the process flow rate range for the bunker received. This includes the following:

1. Q_{min}
2. Q_{max}
3. MMQ

Refer to Annex C for the checklist of typical parameters required from the vessel owner/operator for meter selection.

The MFM should be installed as close as possible to the custody transfer point. All bunker fuel received shall pass through the MFM before distribution into designated ship fuel storage tanks.

The selected and installed system should meet the following criteria:

a) the selected MFM, including the ancillary devices, are pattern evaluated in accordance with OIML R117;

b) the proposed MFM should meet the application requirements.

For MFM selection, all relevant information should be submitted to the meter supplier — see example in Annex C. It is recommended to use one form (see Annex C) for each meter selection.

8.3 MFM system installation and commissioning

The MFM shall be installed in accordance with the manufacturer's instructions. The manufacturer and purchaser (ship owner/operator) shall come to an agreement on specific responsibilities for shipboard installation.

The piping layout design should be such that the MFM is packed immediately to minimise aeration.

The installation and modification of the MFM system on the vessel shall take into consideration the classification society requirements.

Pipe supports (if required) shall be provided to support the installation of the MFM.

Cables shall be installed in conduits for protection against harsh marine environment to ensure signal integrity.

The manufacturer shall provide the purchaser with an operating manual that includes specific instructions regarding proper operation and any capacity or pressure limitations. The manual shall also include diagrams of associated parts, and maintenance/repair procedures.

The MFM equipment shall facilitate disassembly, assembly, location of trouble sources, and calibration and maintenance. Functional parts shall be readily identifiable, accessible and removable for replacement. Functional parts are defined as individual component parts or replaceable functional assemblies.

The commissioning includes all work for ensuring proper functionality of the MFM system. This includes zero setting of the MFM.

At the end of commissioning, the MFM system shall be ready for onsite MFM system verification. See Clause 9.

9 MFM system verification

The MFM system is required to undergo and pass an onsite verification to ensure that the metrological and system integrity requirements are met.

10 Metering procedures

10.1 General

This clause guides the ship's crew in monitoring measurement conditions as the bunker fuel is received, thereby helping to verify the bunker delivery by the bunker supplier.

10.2 Documentation

Shipowners/operators having a MFM on the vessel should indicate requirements as specified in this document for metering procedures in their contract with bunker suppliers.

Shipowners/operators apart from the bunker delivery operations documents should keep proper documentations of bunker receipt and make these documents available on board the vessel.

10.3 Bunker fuel receipt

10.3.1 Custody transfer pre-delivery conference

Prior to the commencement of the bunker delivery, a pre-delivery conference on the bunker tanker is normally conducted between the representatives of the bunker tanker, vessel and bunker surveyor (when engaged). Such conferences shall include safety, health and environmental checks, review of the pre-delivery safety checklist and establishing communication links. During this conference, the chief engineer should state the use of the MFM system for bunker receipt measurement. All line clearing or bunker tanker's tank stripping should be carried out at the end of operations with the concurrence of the chief engineer.

10.3.2 Preparation of MFM system for bunker receipt

All bunker receiving operations shall go through the receiving MFM system before the fuel flows into the vessel's fuel storage tanks. It shall be the chief engineer's responsibility to prepare the vessel for receiving bunkers, including removal of any blank flange(s) from the vessel bunker manifold(s).

The chief engineer shall be responsible to ensure that the MFM system integrity is not compromised. The chief engineer shall check for any critical alarms on the MFM system.

NOTE A critical alarm can include the following conditions:

— power failure;

— equipment communication failure;

— MFM failure (include bunkering computer).

The vessel owner/operator shall ensure continuous power supply to the metering system at all times.

10.3.3 Start of bunker receipt

Once the correct receiving tanks are lined up for bunker receipt, the following actions shall be completed:

a) record the non-resettable totaliser readings;

b) check that the resettable totaliser is showing zero; and

c) record date and start time.

Entrained air present in the bunker fuel or created during the flow can affect the measurement accuracy of the MFM and shall be minimised and controlled. A good MFM system set-up and good control on the process conditions from start to the end of bunker receipt minimise aeration.

The chief engineer shall monitor and ensure that the receiving flow rate is not lower than $Q_{\min}$ of the MFM during the normal receiving phase. The MAWP should not be exceeded.

During the normal receiving phase, if there is aeration affecting the quality of measurement, the chief engineer should immediately investigate the cause to resolve the issue.

10.3.4 End of receipt

After the bunker receipt process is completed, the chief engineer shall record the following:

a) non-resettable totaliser readings;

b) total quantity received;

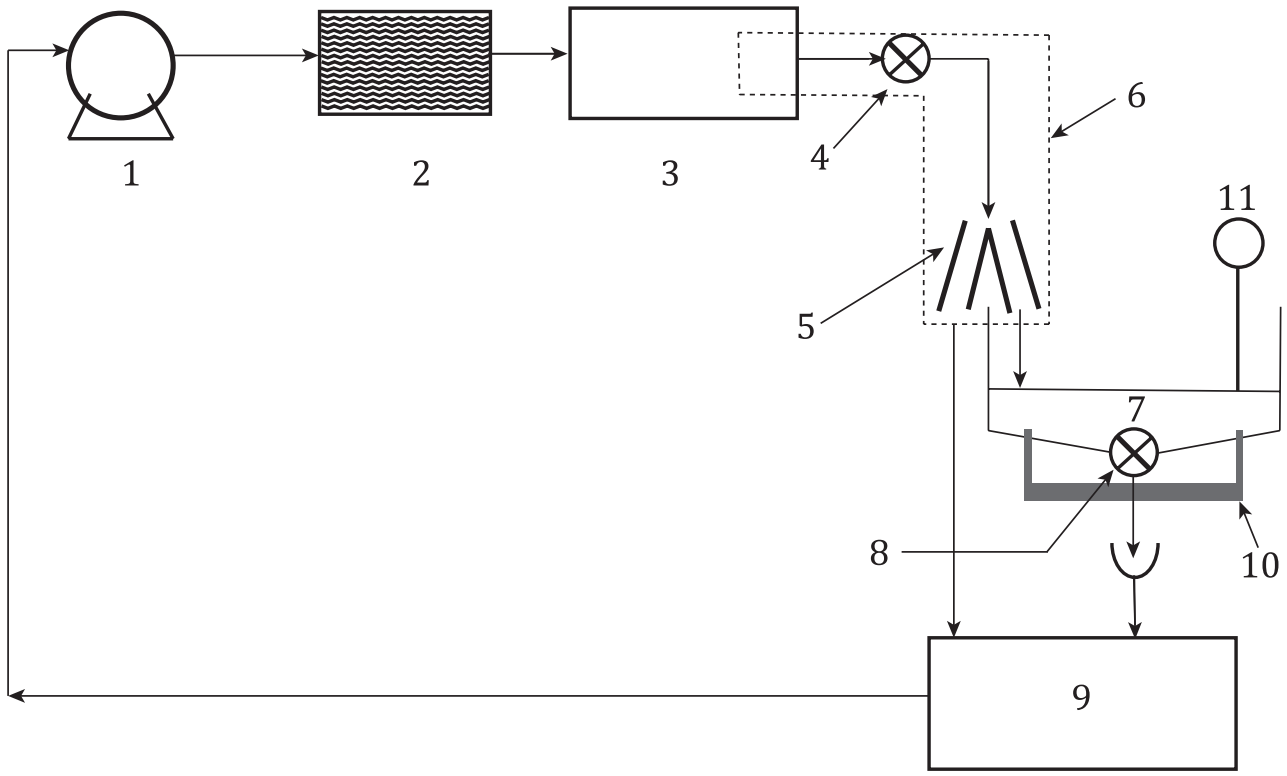
c) date and end time.

Annex A
(informative)

Example set-up of a laboratory calibration facility for a Coriolis MFM — Gravimetric (weighing) method

See Figure A.1 for a diagram of a standard gravimetric liquid flow.

Refer to ISO 4185 for the gravimetric liquid flow calibration method.



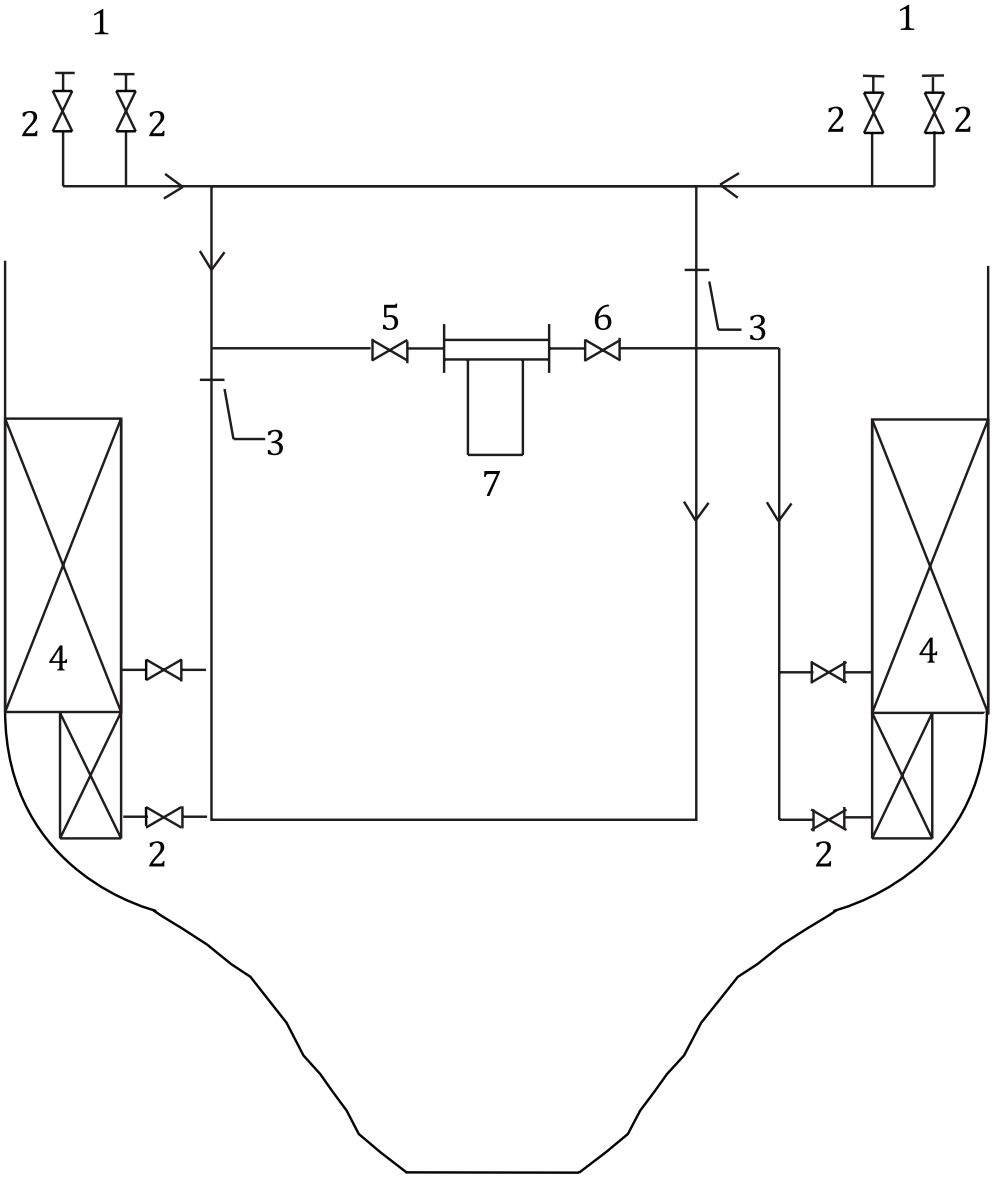
Key

1	pump	7	collection tank
2	heat exchanger/flow conditioner	8	drain valve
3	flow meter under test	9	supply tank
4	flow control valve	10	scale
5	diverter valve	11	temperature sensor
6	inventory volume		

Figure A.1 — Diagram of a standard gravimetric liquid flow

Annex B
(informative)

Schematic diagram of MFM system on receiving vessel



Key

1 bunker manifold
2 valve
3 blank flange
4 bunker tanks
5 upstream gate valve
6 downstream gate valve
7 mass flow meter (MFM)

Figure B.1 — MFM system on receiving vessel

Annex C
(informative)

Information required — Checklist

Receiving vessel information

Country of build	
Customer name	
Receiving vessel owner/operator	
Receiving vessel name:	
IMO number	

Process/application information

Fuel grade	**Flow range — Receiving (t/h)**[a]		
	Min.	**Normal**	**Max.**
1.			
2.			
3.			
[a] 1 t (tonne) = 1 000 kg.			

	Min.	**Normal**	**Max.**
Bunker quantity (t)[a]			
[a] 1 t (tonne) = 1 000 kg.			

	Min.	**Normal**	**Max.**
Density range: (kg/m^3) — *Measured at 15 °C and following ISO 3675 or ISO 12185*			
Viscosity range: (mm^2/s or cSt)[a] — *Measured at 50°C and following ISO 3104*			
Operating pressure (MPa or bar)[b]			
Operating temperature (°C)			
[a] 1 cSt = 1 mm^2/s. [b] 1 bar = 0,1 MPa.			

Vessel mechanical/electrical information

	(mm) / (inch) [a]
Pipe size (DN)	
Pipe size (DN)	
[a] 1 inch = 25,4 mm.	

Flange connection type:	
Hazardous area approval (Zone 1/2)	

	Voltage (V) (AC/DC)	**Frequency (Hz)**
Electrical power requirements:		

	Yes	**No**
Bunker receiving piping layout provided		

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