INTERNATIONAL STANDARD

ISO 22192

First edition
2021-01

Bunkering of marine fuel using the Coriolis mass flow meter (MFM) system

Soutage de fioul marin à l'aide d'un débitmètre massique (MFM) selon le principe de Coriolis

Reference number
ISO 22192:2021(E)

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*, Subcommittee SC 2, *Measurement of petroleum and related products*.

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

This document was developed for the benefit of the bunker industry comprising ship owners, operators, charterers, bunker suppliers, bunker craft operators and bunker surveyors and is intended to enhance the efficiency of bunkering operations and promote best practices in the measurement of bunker fuel delivered.

This document sets out the international best practices which documents principles, requirements and procedures in the application of mass flow metering to bunkering.

This document does not alter the contractual obligations of the parties involved in the bunker delivery.

Figure 1 shows the application of MFM bunkering requirements for bunker custody transfer.

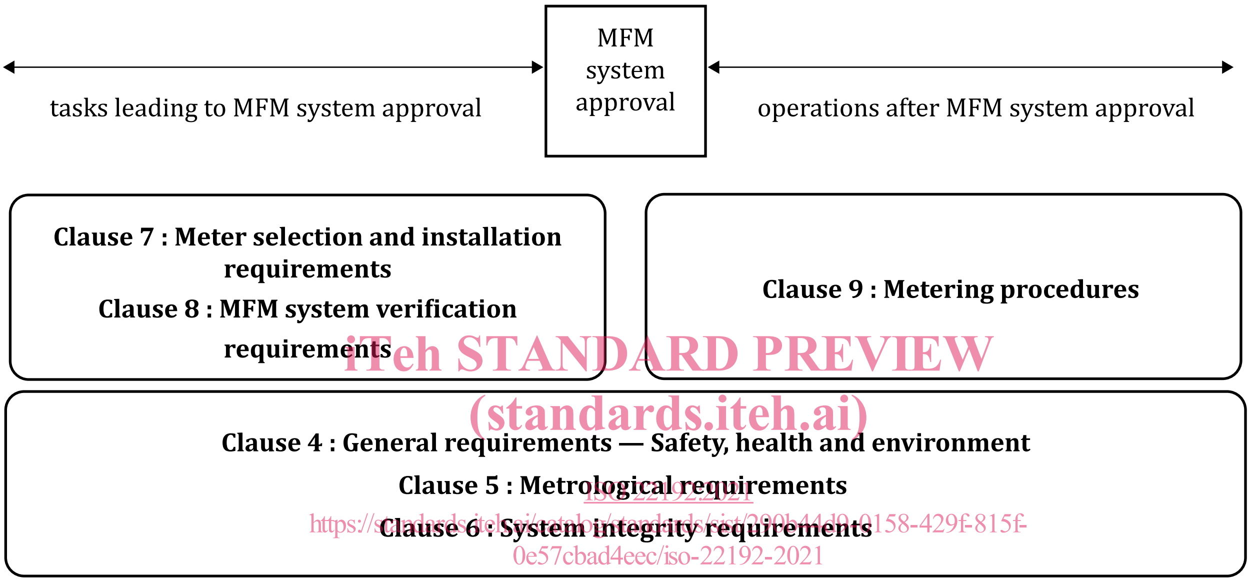

Figure 1 — Application of MFM bunkering requirements

Bunkering of marine fuel using the Coriolis mass flow meter (MFM) system

1 Scope

This document specifies procedures and requirements for the transfer of bunkers to vessels by bunker tankers using the Coriolis mass flow meter (MFM) system. It encompasses the process leading to the approval of the MFM system as installed on bunker tankers and post-approval bunkering operation. It covers terminology, specifications, requirements and procedures on metrology, system integrity, metering system selection and installation, MFM system verification, bunker delivery and dispute handling.

NOTE Local and international regulations, such as the International Convention for the Prevention of Pollution from Ships (MARPOL) can apply.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM: 1995)*

ISO 13739, *Petroleum products — Procedures for the transfer of bunkers to vessels*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

International Recommendation OIML R117-1, *Dynamic measuring systems for liquids other than water*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
accuracy of measurement
closeness of the agreement between the result of a measurement and the conventional, true value of the measurement

Note 1 to entry: Good accuracy implies small random and systematic errors.

Note 2 to entry: The quantitative expression of accuracy should be in terms of uncertainty of measurement.

3.2
adjustment
set of operations carried out on a measuring system to provide prescribed indications corresponding to given values of quantity to be measured

Note 1 to entry: Types of adjustment of a measuring system include zero adjustment of a measuring system, offset adjustment and span adjustment (sometimes called gain adjustment).

Note 2 to entry: Adjustment of a measuring system should not be confused with calibration, which is a prerequisite for adjustment.

Note 3 to entry: After an adjustment of a measuring system, the measuring system shall be recalibrated.

[SOURCE: JCGM 200]

3.3
air buoyancy correction
correction applied to obtain the conventional mass from true mass to take into account the reduction in true mass due to the buoyancy effect of air

3.4
ancillary device
device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results

EXAMPLE Zero adjustment device, repeating indicating device, printing device, memory device, totalising indicating device, correction device, conversion device, pre-setting device, self-service device.

3.5
bunker(s)
fuel supplied to a *vessel* (3.47) for its propulsion and/or operation

Note 1 to entry: Fuel with reference to Class F of ISO 8217.

3.6
bunker delivery note
BDN
proprietary document of the *bunker supplier* (3.9) providing details of the quality and quantity of the *bunker(s)* (3.5) delivered by the *bunker tanker* (3.11) to the *vessel* (3.47)

3.7
bunker metering ticket
BMT
ticket printed at the end of a *bunkering operation* (3.8)

3.8
bunkering operation
bunker delivery from *bunker tanker* (3.11) to *vessel* (3.47)

3.9
bunker supplier
company which contractually agrees with the buyer to deliver the product

3.10
bunker surveyor
person who inspects, measures, samples, investigates and reports as required on the bunkering operations

3.11
bunker tanker
bunker tanker supplying bunker(s) to the *vessel* (3.47)

3.12
bunker tanker operator
company which operates the *bunker tanker* (3.11)

3.13
bunker tanker representative
individual who represents the *bunker supplier* (3.9) and is responsible for *bunkering operations* (3.8) and documentations

3.14
calibration
operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

[SOURCE: JCGM 200]

3.15
calibration factor
numerical factor unique to each sensor derived during sensor *calibration* (3.14), which when programmed into the *transmitter* (3.44) ensures that the meter performs to its stated specification

[SOURCE: ISO 10790:2015,3.1.10, modified — the term has been changed from "calibrating factor" to "calibration factor" and Note 1 to entry has been merged in the definition.]

3.16
chief engineer
engineer of the *vessel* (3.47) who is responsible for receiving bunkers and documentation of the *bunkering operation* (3.8)

3.17
commissioning
process whereby the critical precision parameters impacting custody transfer are verified and checked

Note 1 to entry: Any setting changes during commissioning or re-commissioning is traceable to factory settings and justified *adjustments* (3.2) to meet the *measurement uncertainty* (3.30) or type classification.

3.18
conformity body
independent party or party accredited by national body that undertake conformity assessment activities such as verification, testing, inspection and certification

3.19
conventional mass
mass value of a body equal to the *mass* (3.24) of a standard that balances this body under conventionally chosen conditions

Note 1 to entry: The unit of a conventional mass is the kilogram. It is also known as mass in air.

[SOURCE: OIML D028]

3.20
custody transfer point
point at which, the *bunker* (3.5) is defined as being delivered or loaded

3.21
initial zero adjustment
setting of the indication of *mass flow rate* (3.27) to zero with the flowrate completely stopped and to fully filled flow meter according to approved procedure, before it is ready for custody transfer usage

3.22
linearity of MFM
linearity of mass flow meter
consistency of change in the scaled output of a Coriolis flow meter, for a related, scaled change in the input of the flow meter

[SOURCE: ASME MFC-11]

3.23
low flow cut-off
transmitter (3.44) setting which sets the meter output(s) to zero flow if the flow rate falls below a preset value

Note 1 to entry: This setting inhibits the registration of flow when the flow meter is not properly filled with subject fluid that can lead to large measurement errors.

3.24
mass
physical quantity which can be ascribed to any material object and which gives a measure of its quantity of matter

Note 1 to entry: Also known as true mass.

[SOURCE: OIML D028, modified — Note 1 to entry has been added.]

3.25
mass flow meter
MFM
device consisting of a flow sensor (primary device) and a *transmitter* (3.44) (secondary device) which primarily measures the mass flow by means of the interaction between a flowing fluid and the oscillation of a tube or tubes; it may also provide measurements of the density and the process temperature of the fluid

3.26
mass flow meter system
MFM system
system that comprises the *mass flow meter* (3.25), its *ancillary devices* (3.4), pipelines and sealing points between the pump suction and the *custody transfer point* (3.20)

3.27
mass flow rate
flow rate at which the quantity of fluid which passes the *MFM* (3.25) is expressed as mass and denoted in MT/h

3.28
master
person in charge of the *bunker tanker* (3.11) or the vessel receiving bunker(s) as the case can be

3.29
maximum mass flow rate
Q_{max}
maximum flow rate, up to which, the *MFM system* (3.26) has been qualified to operate in compliance with the required *accuracy* (3.1)Note 1 to entry: The maximum value is normally determined by the application

3.30
measurement uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

[SOURCE: JCGM 200]

3.31
meter reading
value obtained from the *non-resettable totalizer(s)* (3.37)

3.32
meter stability
property of a measuring instrument, whereby, its metrological properties remain constant over time

Note 1 to entry: Stability may be quantified in several ways:

— in terms of the duration of a time interval over which a metrological property changes by a stated amount;

— in terms of the change of a property over a stated time.

[SOURCE: JCGM 200]

3.33
metering
measurement of quantity by the *MFM system* (3.26)

3.34
metering profile
graphical overview of the process parameters recorded during a *bunkering operation* (3.8) and retained for purpose of providing transparent assessment

3.35
minimum mass flow rate
Q_{min}
lowest flow rate required to which the metering system has been qualified to operate, in compliance with the required *accuracy* (3.1)

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

3.36
minimum measured quantity
MMQ
smallest quantity of liquid for which the measurement is metrologically acceptable for that system or element

3.37
non-resettable totalizer
device that indicates the total cumulated flow quantity through the *MFM* (3.25) after it is secured for use in custody transfer such that its value is not resettable to zero or to other values

3.38
quantity delivered
cumulative mass quantity measured between the start of delivery and end of delivery and transferred to the *vessel* (3.47)

3.39
repeatability
proximity of a match among a series of results obtained with the same method on identical test material, under the same conditions (same operator, same apparatus, same laboratory and short intervals of time)

3.40
resettable totalizer
device that indicates total flow quantity through the *MFM* (3.25) from the start to the end of each batch and its value can be reset to zero

3.41
sample
bunker (3.5) specimen defined by time, location and method of sampling

3.42
stored zero value
value stored in the electronics after the zero-adjustment procedure

Note 1 to entry: Stored zero value is recorded during every zero-offset determination. Depending on manufacturer, the stored zero value can be in flow rate units or in time units or in % units.

3.43
traceability
metrological property of a measurement result, whereby the result can be related to a reference through a documented unbroken chain of calibrations verified by a national metrology institute, each contributing to the *measurement uncertainty* (3.30)

[SOURCE: JCGM 200]

3.44
transmitter
electronic control system that provides the drive and transforming the signals from the flow sensor, to give output(s) of measured and inferred parameters, and that also provides corrections derived from parameters such as temperature

3.45
update
installation of new system components, hardware or software, which have no significant effect on the metering result

Note 1 to entry: No testing is required after installation.

3.46
upgrade
installation of new system components, hardware or software, which can have a significant effect on the metering result

Note 1 to entry: New certification testing is required after installation.

3.47
vessel
ship that receives the *bunker(s)* (3.5)

3.48
zero offset
measurement output indicated under zero flow conditions

Note 1 to entry: A zero offset might be caused by stress being applied to the oscillating tubes by the surrounding pipework and by process conditions.

Note 2 to entry: A zero offset can be reduced by means of a zero-adjustment procedure.

3.49
zero offset limit
maximum allowable observed *zero offset* (3.48) in relation to the stored zero value, used to determine when to re-zero the flow meter, generally defined by the manufacturer

[SOURCE: API MPMS 5.6]

3.50
zero stability
magnitude of the meter output deviation from the stored zero value at zero flow after the zero adjustment procedure has been completed, expressed by the manufacturer as an absolute value in mass per unit time

Note 1 to entry: The stated value for zero stability is valid for stable conditions where the fluid is free of bubbles and sediment.

3.51
zero verification procedure
procedure to verify that the *zero offset* (3.48) does not exceed the *zero offset limit* (3.49)

4 General requirements (safety, health and the environment)

4.1 The requirements to be observed by all personnel for the safe transfer of bunker in port are set out in Annex A. Internationally accepted safety standards, as appropriate, shall also be observed by the personnel of both the bunker tanker and the vessel and also the bunker surveyor (when engaged) for the safe transfer of bunkers in port.

NOTE Local requirements can also apply.

4.2 The respective masters of the bunker tanker and the vessel shall remain responsible for the safety of their vessel, crew, cargo and equipment at all times and should not permit safety to be prejudiced by the actions of others.

4.3 All parties involved in the bunkering processes shall equip themselves with the following minimum safety items:

— safety helmet;

— safety shoes;

— gloves;

— life jacket.

They shall wear personal protective equipment at all times while on board the vessel and the bunker tanker. They shall equip themselves with H_2S and O_2 monitors and use them throughout the operation.

4.4 All parties involved in the bunkering operation shall be free from the influence of any alcohol, drugs or other substances which impairs the safe and efficient execution of their work and personal health.

5 Metrological requirements

5.1 General

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

5.2 Mass flow meter requirement

5.2.1 Every MFM shall be calibrated before custody transfer use for bunkering and shall include its adjustment device(s) and ancillary device(s).

5.2.2 The calibration should be done using bunker fuel or equivalent fluid once the primary calibration facilities are available to meet the traceability and calibration uncertainty requirements. Until the requirements in this subclause are fulfilled, the calibration requirements as stated in 5.2.3 and 5.2.4 shall apply for every MFM before approval for custody transfer use.

5.2.3 For water calibration (level 1) with direct traceability to S.I. unit of mass, the maximum error of MFM shall not more than 0,1 % of reading. The calibration shall be carried out by a laboratory meeting the requirements of ISO/IEC 17025.

5.2.4 There shall be a letter, accompanied by relevant supporting documents, declaring that the meter performance meets the requirement of maximum measurement uncertainty for bunker fuel fluid flow measurement to be not more than 0,2 % (level 2).

NOTE Supporting documents are inclusive but not limited to type evaluation certificates for regional directives (e.g. EC/EU type examination), and reports of tests conducted as part of the process in obtaining these type evaluation certificates.

The report(s), supporting documents and letter shall be issued by either:

a) a national metrology institute; or

b) an appointed International Organization of Legal Metrology (OIML) issuing authority in accordance with the relevant OIML recommendations.

5.2.5 The MFM calibration report shall comprise the following details in addition to what is in ISO/IEC 17025:

a) expanded measurement uncertainty;

b) meter errors across the measurement range between the minimum mass flow rate, Q_{min}, and the maximum mass flow rate, Q_{max};

c) configuration and parameter setting values, including calibration factors to a specific MFM such as serial number and stored zero value.

5.2.6 The MFM used for bi-directional measurements shall be calibrated at forward and reverse flow directions with at least five evenly spaced flowrates in each direction across the measurement range between Q_{min} and Q_{max} of the MFM. Each flowrate shall have at least 3 runs.

5.2.7 The MFM shall also be tested to prove the meter stability periodically. MFM shall be re-calibrated if the requirement 5.3.7 is not met.

5.3 Mass flow meter system requirements

5.3.1 The expanded measurement uncertainty of overall performance of the MFM system shall be not more than 0,5 %. It should take into consideration the following uncertainty sources influenced by:

— meter calibration;

— product condition e.g. viscosity and density;

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

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

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

5.3.2 The expanded measurement uncertainty should include all the uncertainty components outlined in Annex B.

5.3.3 The measurement uncertainty shall be assessed and evaluated in accordance with ISO/IEC Guide 98-3.

5.3.4 The requirements of zero offset limit and zero verification include the following:

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

b) Zero setting and zero verification are required during commissioning. These operations shall be performed by conformity body.

c) Zero setting is done through measuring and storing the zero offset during no flow condition, so that a new base line is formed for the measured mass flow when particular criteria (depending on meter type used) are met.

d) Periodical check on zero stability is required according to zero verification procedure. See 5.4 and Annex D.

e) To achieve a proper zero adjustment/verification procedure, the status of the Coriolis meter during no flow should be representative of single-phase flow conditions.

5.3.5 The low flow cut-off setting value shall be not more than 12 % of Q_{min}.

5.3.6 The operating mass flow rate for custody transfer shall not be less than Q_{min} and not more than Q_{max}. In addition, the transferred quantity shall not be less than the minimum measured quantity (MMQ) in order to achieve the requirement of 0,5 % overall expanded measurement uncertainty of the metering system.

5.3.7 The meter-long term stability shall be not more than a variance of ± 0,2 %.

5.3.8 The flow measurement error due to aeration effects shall not cause the overall expanded measurement uncertainty of the MFM system to exceed 0,5 %.

5.4 Post approval maintenance

5.4.1 Meter zero verification frequency

Zero verification shall be done quarterly in the first year and every six months thereafter. Certified and authentic copies of the latest zero verification report shall be kept on board the bunker tanker.

5.4.2 Zero verification procedure

Zero verification shall be carried out during a forward flow by filling the flow sensor with non-aerated bunker fuel. Refer to Annex D for the procedures of zero verification.

5.4.3 Meter and ancillary devices verification and/or calibration frequency

The meter shall be verified and/or calibrated periodically. The ancillary devices shall be verified or calibrated periodically if required.

5.4.4 Software upgrade/ software update

In the event that upgrade/update of software is required for the MFM system, verification shall be carried out to confirm that the performance of the MFM system meets the metrological requirements.