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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

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Foreword

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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.

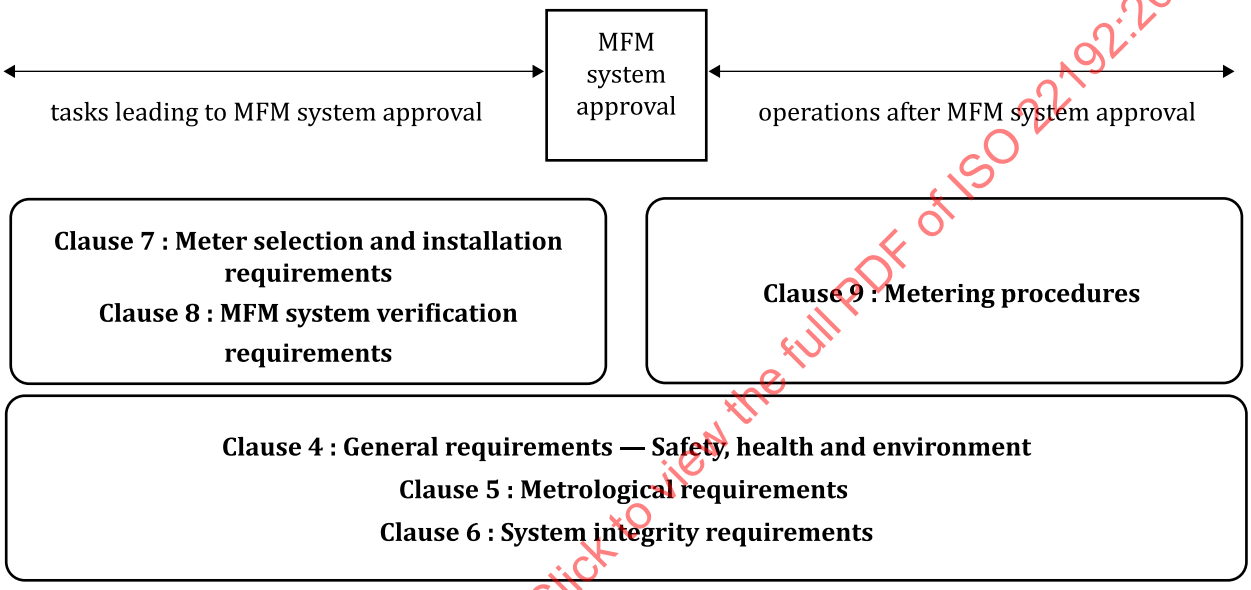


Figure 1 — Application of MFM bunkering requirements

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, $Q_{\text{min,}}$ 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.

6 System integrity requirements

6.1 General

6.1.1 Clause 6 shall be read in conjunction with Clauses 5, 7, 8 and 9.

6.1.2 System integrity aims to ensure that:

a) MFM system is set up and approved for bunkering operations in accordance with the system integrity requirements specified in this International Standard and

b) MFM system's measurement is secured against any interference before, during or after bunkering operations and the bunker quantity as measured is delivered to the receiving vessel.

This clause specifies the requirements and procedures to ensure the system integrity of a MFM system. It includes documentation, equipment checks for mechanical, software, electrical and operational security. It covers the stages of pre-installation, installation, commissioning, operations and maintenance as well as controls. See Annex C for metrological and system integrity requirements at each stage.

6.2 Metrological control

6.2.1 Documentation

MFM intended for the measurement of bunker fuel is subject to type or pattern evaluation testing to ensure compliance with the OIML Recommendations. Type evaluation ensures the reliability of the instruments by prescribing the metrological, technical and construction requirements on the design of the type of instruments.

6.2.2 Type approval and pattern evaluation

The MFM shall be subjected to evaluation in accordance with the OIML R117-1 by OIML's recognized testing bodies and appointed issuing authorities and examination programs or equivalent to ensure the following:

a) Hardware and software integrity in regard to requirement set-out in OIML R117-1;

b) Appropriate for trade use;

c) Applicable for bunkering application with characteristics and specifications;

d) Rated operating conditions.

6.3 Security features

6.3.1 Equipment security

The MFM system shall be sealed against unauthorised adjustment, tampering or dismantling. Bunker tanker owner/operator shall ensure that the seals of the MFM system remain intact and secured at all times.

6.3.2 Software security

All MFM system software shall be protected to meet the requirements for custody transfer measurement. This is to prevent any unauthorised changes to the software and parameter settings. Any changes to the configuration of the software that affects measurement integrity shall be authorized by the accredited body and properly documented. The MFM system shall be able to trace any changes affecting the custody transfer measurement.

6.3.3 Data security

All MFM system shall be installed with a data logger to record all data obtained from the MFM system. The records shall include history of operations, batches and critical alarms for future reference. These data are required to be kept on board for a minimum of 3 months. Any data interface shall be secured. The data logger is an integral part of the custody transfer and as such it should be secured to prevent tampering.

6.3.4 Critical alarm

A critical alarm is activated under the following conditions:

— power failure;

— equipment communication failure;

— meter failure (include bunkering computer).

Refer to 9.8.1 for the required actions.

6.4 Installation and commissioning

6.4.1 Pre-installation and MFM system sealing plan

MFM system pipeline shall be designed or modified to ensure proper system integrity.

All MFM and its ancillary devices together with the blanks and flanges are to be clearly labelled and sealed by a party approved by the accredited body. Prior to the sealing of the blank or the flange, it is also important to know and identify the required sealing points. Refer to Annex E on sealing points.

Identification of the sealing points shall be carried out by the bunker tanker owner / operator at the planning phase of installing the MFM system. All drainage points, pressure release, sampling points and all other fixtures located after the meter shall be included in the class approved piping diagram. The sealing plan and Class-approved piping diagram shall be submitted to the accredited body for approval before final sealing.

Upon completion of sealing of the MFM system, a seal verification report shall be submitted to the accredited body.

6.4.2 Installation and re-installation

Bunker tanker owner/operator shall ensure that the seals of the MFM system remain intact and secured at all times. Any deviation shall be reported to the relevant authority immediately.

6.4.3 Commissioning

To ensure the readiness of MFM System, each meter vendor shall complete a commissioning check list as part of the documentation. It is the responsibility of the meter vendor to ensure that the commissioning of the MFM system is completed.

If an MFM is required to be removed for update and/or upgrade of software or hardware, meter re-calibration, the existing configuration of the meter has to be downloaded and recorded before any seal is broken.

A copy of the meter configuration, before and after, shall be kept and submitted, as required by the accredited body. Any difference in the meter configuration shall be explained and subjected to approval by the accredited body.

6.4.4 Re-commissioning

For a good audit trail of the MFM, check to ensure that configuration impacting measurement is maintained as that determined from the acceptance tests. Any setting change during re-commissioning shall be traceable. A checklist shall be maintained by meter vendor together with other supporting documents prior to re-sealing of system. A copy of these documents shall be deposited with the accredited body.

Only conformity body are allowed to break the seals to carry out the required configuration and re-sealing the meter upon completion. When the meter is returned and resealed, the meter configuration has to be checked to ensure that the critical parameters in the configuration, before and after commissioning, are traceable.

Re-sealing shall be carried out by a conformity body before use for custody transfer.

Prior to re-sealing, zero verification shall be conducted by parties authorized by the accredited body. Refer to 5.4.2 for zero verification.

6.5 Operational security

Bunker tanker representative shall be responsible to ensure that the MFM system integrity is not compromised for the purpose of bunker delivery. Bunker tanker representative shall check for any critical alarms (refer 6.3.4) on the MFM system and shall not proceed if a critical alarm is found to be activated. The accredited body shall be notified immediately of a breach of system integrity.

If operational seals are required to ensure MFM system integrity, the location of these seals shall be indicated in the approved piping diagram.

The bunker surveyor (when engaged) shall check for any breach of system integrity and status of critical alarm. The chief engineer shall be allowed to check the MFM system integrity.

6.6 Maintenance and control of MFM system

6.6.1 Inspection and verification

The MFM system shall be maintained, as required, based on 5.4. The MFM system shall be made available for inspection and verification by the accredited body, when required.

6.6.2 Breaking of seals and re-sealing of MFM system

All seals shall be maintained intact at all times.

If any seal is found to be broken or is required to be broken, the MFM system shall not be used and the matter shall be reported to the accredited body.

The MFM system shall be verified before re-sealing.

7 Meter selection and installation requirements

7.1 General

Clause 7 covers the selection and installation of the MFM system to meet the requirements set out in Clauses 5 and 6. It includes site survey, selection, installation and commissioning. The process in this clause involves the meter vendor and the user or owner of the MFM system.

7.2 Site survey onboard tankers

The objective of survey is to identify a suitable location for the installation of the meter and system components to ensure measurement integrity and system integrity for bi-directional operation. The following shall be considered:

a) location of manifolds;

b) location of loading lines;

c) location of cargo pumps;

d) location of flow boom(s);

e) piping arrangement (new pipe or existing pipe modifications);

f) location of spectacle blank(s);

g) location/relocation of new/existing valve(s);

h) meter location shall be as close as possible to the transfer point;

i) installation location for other components of the metering system;

j) any other relevant factors.

7.3 Meter selection

Proper meter selection ensures that the MFM system is fit for this application. The owner/bunker craft operator shall:

a) Provide all necessary information to the meter vendor. Refer to Annex F for the checklist of typical parameters for meter selection.

b) Ensure meter vendor's recommendations on meter sizing are based on the following criteria:

   — proposed metering system shall meet the requirements in this document;

   — selected mass flow meter, including the ancillary devices, are pattern evaluated in accordance with the OIML R117-1.

7.4 Meter installation

7.4.1 Prior to meter installation, the metrological requirements in 5.2 shall be met.

7.4.2 In preparation for meter installation, the system integrity requirements in 6.4.1 and 6.4.2 shall be met. The bunker tanker owner/operator shall:

a) submit piping modification and meter installation drawing (including bypasses, blanks and sealing points) highlighting the changes, to the classification society or equivalent recognized organization for approval, prior to modification work;

b) provide nuts and bolts sealing arrangement for flange and blank connections. Refer to Annex E;

c) provide pipe support (if required) to the MFM;

d) use intrinsically safe cables for marine environment; cables shall be installed in conduits for protection against harsh marine environment and to ensure signal integrity;

e) provide a secondary source of power supply to the metering system in case of power failure;

7.4.3 Refer to Annex G for the typical schematic diagram for an MFM system installation. The MFM system shall include devices to measure and display the pressure and temperature of the bunker fuel.

7.4.4 Each MFM shall bear the following marking information by the meter vendor for verification purposes. The list below is not exhaustive:

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

b) designation selected by the manufacturer, if appropriate;

c) year of manufacture;

d) serial number.

7.4.5 Meter vendor can provide a stamping plate to be permanently fixed on the MFM.

NOTE National regulation can apply.

7.5 Meter commissioning

7.5.1 The commissioning includes all work for ensuring proper functionality of the MFM system which includes zero adjustment and zero verification of the MFM. Refer to 6.4.3 on readiness of MFM system.

7.5.2 At the end of the commissioning, the MFM system shall be ready for onsite verification. Refer to Clause 8.

8 MFM system verification requirements

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

The conformity body shall ensure the MFM system setup meets the relevant requirements stated in Clause 5, 6, 7, and 9.

9 Metering procedures

9.1 General

Clause 9 covers the pre-delivery, delivery and post-delivery documentation and procedures that meets the requirements of metrology (Clause 5) and system integrity (Clause 6) for the delivery of bunker using a MFM system.

9.2 Documentation

9.2.1 General

9.2.1.1 Shipowners/buyers are strongly advised to document agreed detailed specifications in their contract with bunker suppliers. Shipowners/buyers are reminded that if no detailed specification is agreed upon, this may prejudice any subsequent claims in the event of a dispute.

9.2.1.2 No documents shall be endorsed by the bunker tanker representative, chief engineer or bunker surveyor (when engaged) prior to the completion of required procedure, as listed in this document. All data shall be in the form of a permanent written record at the time the procedures are performed.

9.2.1.3 All stakeholders involved in the bunkering operation shall complete, maintain and store traceable completed records of all steps involved in the bunkering operation. These documents shall contain terms which are consistent with this document.

9.2.1.4 A complete bunkering operation shall include the following documentation that bears the bunker supplier's name:

a) Bunker requisition form (mass flow metering) (see Annex H);

b) Mass flow metering system seals checklist (see Annex I);

c) Meter reading record form (delivery) (see Annex J);

d) Bunker metering ticket (see Annex K) — shall be printed at the end of delivery and filed for reference.

e) Bunker delivery note (see 9.8.4).

Bunker suppliers shall have all these documents available on board the bunker tanker. The bunker tanker representative shall prepare the documents for the chief engineer without being asked to do so.

Bunker suppliers may have their own formats for the above documents, but the information as set out in such specific formats shall not contain terms which are inconsistent with this document.

9.2.2 Pre-delivery documentation

9.2.2.1 The following documents shall be completed/prepared, as required, at the pre-delivery stage:

a) bunker requisition form (mass flow metering);

b) bunkering pre-delivery safety checklist (see Annex L);

c) mass flow metering system seals checklist;

d) meter reading record form (delivery).

One original and at least two copies of the above documents shall be completed and signed by the bunker tanker representative, the chief engineer and the bunker surveyor (when engaged). The original shall be retained by the bunker tanker and the duplicate shall be given to the chief engineer. The last copy shall be given to the bunker surveyor (when engaged).

9.2.3 Post-delivery documentation

The following documents are to be completed/printed:

a) mass flow metering system seals checklist;

b) meter reading record form (delivery);

c) bunker metering ticket; and

d) bunker delivery note (BDN).

9.3 Additional documentation for bunker surveyor

9.3.1 The role and responsibilities of the bunker surveyor (when engaged) is to ensure the bunkering operation follows the procedures stated in this document.

9.3.2 Bunker surveyors (when engaged) shall use the following documents for the bunker survey. Documents listed below, from c) and d), prepared by the bunker surveyor (when engaged) shall bear

the name of the bunker surveying a company accredited with the national accreditation body along with their accreditation mark.

a) mass flow metering system seals checklist (see Annex I);

b) meter reading record form (delivery) (see Annex J);

c) survey time-log (see Annex M);

d) statement of facts (if applicable) (see Annex N);

Bunker surveyors (when engaged) may have their own formats for the documents as set out in 9.3.2 c) and 9.3.2 d), but the information as set out in the relevant annexes to this document shall be provided.

9.3.3 Survey time log and statement of facts

Bunker surveyors shall record the time of all relevant events related to the entire bunkering operation until their return to base. The times shall be neatly recorded in the survey time-log. Abnormal events shall be stated in a statement of fact, a copy of which shall be submitted to the accredited body.

9.4 Additional documentation for bunker tanker

9.4.1 Meter totalizer log

9.4.1.1 Every bunker tanker shall keep and maintain a meter totalizer log. An example of the format of the meter totalizer log is shown in Annex O.

9.4.1.2 The entries of the meter totalizer log shall contain the following:

a) Date and time of receipts and deliveries;

b) Product grade, totalizer reading, bunker tanker tank numbers and source of receipts;

c) Product grade, totalizer reading, bunker tanker tank numbers and destination of deliveries;

d) Description of documents evidencing receipts and/or deliveries; and

e) Name and signature of the person preparing the daily entries.

9.4.1.3 The bunker tanker representative shall prepare the entries and sign the meter totalizer log with his name clearly written immediately after any meter totalizer movement.

9.4.1.4 The relevant pages of the meter totalizer log showing all the totalizer movements related to the bunker delivery shall be made available for inspection and photocopying by the accredited body, the chief engineer and bunker surveyor (when engaged).

9.4.1.5 The meter totalizer log shall be kept on board the bunker tanker for a minimum period of three months, counting from the current date and shall be made available to the accredited body upon request.

9.4.2 Documents carried onboard the bunker tanker

The following documents shall be kept up-to-date and made available onboard the bunker tanker for reference:

a) meter calibration certificate;

b) MFM system diagram and sealing points;

c) meter seal verification report;

d) meter zero verification report;

e) cargo system piping diagram;

f) document stating the Q_{min}, Q_{max} and MMQ of the MFM system (to be issued by the meter vendor);

g) MFM system approval letter from accredited body for custody transfer;

h) document evidencing the bunker tanker representative is trained on the MFM system for bunker delivery.

9.5 Planning for bunkering operation

MMQ, Q_{min} and Q_{max} requirements should be considered during the planning of bunkering operation by the bunker supplier in consultation with the bunker buyer.

9.6 Pre-delivery procedures

9.6.1 Flow measurement conditions and checks on system integrity

The conditions of the flow measurements shall meet the requirements of Clause 5. The mass flow rate shall be maintained between Q_{min} and Q_{max} except for line packing, line clearing and tank stripping phases.

The system integrity requirements shall be checked and maintained throughout the bunkering operation.

9.6.2 Pre-delivery conference

Prior to the commencement of the bunker delivery, a pre-delivery conference shall be conducted between the representatives of the bunker tanker, vessel and bunker surveyor (when engaged). Such a conference shall include safety, health and environmental checks, review of the pre-delivery safety checklist and establishing communication links.

The bunkering pre-delivery safety checklist as set out in Annex L shall be presented by the representative of the bunker tanker to the representative of the vessel and bunker surveyor (when engaged) at the pre-delivery conference. This should assist the masters in adhering to the relevant safety procedures of a bunkering operation. The safety checklist is an essential reminder of the principal safety factors and should be supplemented by continuous vigilance throughout the whole bunkering operation.

9.6.3 Bunker requisition form (mass flow metering)

9.6.3.1 The bunker requisition form (mass flow metering) is not intended to vary the terms of any pre-existing contract between the buyer and the bunker supplier.

9.6.3.2 The bunker requisition form shall be completed and signed by the bunker tanker representative and the chief engineer with their names clearly printed. The bunker surveyor (when engaged) shall witness and sign the completed bunker requisition form between the two parties. The bunker tanker representative shall confirm with the chief engineer the requirements of the vessel, including the quantity, grade of bunker(s) and pumping rate (not lower than stated Q_{min} of the MFM system onboard). This form shall be endorsed with the bunker tanker's stamp and the vessel's stamp. This form shall contain the information as set out in Annex H.

9.6.3.3 If more than one grade of bunker(s) is to be supplied, the bunker tanker representative shall indicate on the form the order in which the grades are to be supplied. To avoid contamination of product, it is recommended that the lighter grade should be supplied first followed by the heavier grade, unless otherwise requested by the chief engineer in writing.

9.6.3.4 Any cancellation or amendment on this form shall be signed by the bunker tanker representative, chief engineer and bunker surveyor (when engaged).

9.6.3.5 Bunkering pre-delivery safety checklist

9.6.3.5.1 Upon completion of the bunker requisition form, the bunker pre-delivery safety checklist as set out in Annex L shall be completed and signed by the bunker tanker representative, chief engineer and bunker surveyor (when engaged), with their names clearly printed.

9.6.3.5.2 Any cancellation or amendment of this checklist shall be signed by the bunker tanker representative, chief engineer and bunker surveyor (when engaged).

9.6.3.5.3 One original and at least two copies of this checklist shall be completed and signed. The copies shall be given to the chief engineer and the bunker surveyor (when engaged).

9.6.4 Mass flow metering system seals checklist

9.6.4.1 Before the commencement of the bunkering operation, the metering system diagram and all sealing points shall be checked and confirmed to be intact jointly by the bunker tanker representative, chief engineer and bunker surveyor (when engaged). The seal numbers observed, shall match the seal numbers recorded in the latest seal verification report, onboard the bunker tanker.

9.6.4.2 Section A of the mass flow metering system seals checklist in Annex I shall be completed and signed by the chief engineer, the bunker tanker representative and the bunker surveyor (when engaged). Refer to Annex I for an example of the mass flow metering system seal checklist.

9.6.4.3 In the event any seal in the metering system is missing or broken or if there is any discrepancy (e.g. seal numbers do not match), the matter shall be reported immediately to the accredited body for further advice. The meter shall not be used for the custody measurement of bunker transfers until the missing or broken seal is replaced and approved for use by the accredited body.

9.6.4.4 If the chief engineer declines the invitation, the bunker tanker representative shall record this on this form and this shall be endorsed by the chief engineer.

9.6.5 Meter reading record form (delivery)

9.6.5.1 The meter reading record form (delivery) is to record meter readings as witnessed by the bunker tanker representative, the chief engineer and the bunker surveyor (when engaged).

9.6.5.2 The bunker tanker representative shall invite the chief engineer and the bunker surveyor (when engaged) to witness and record the opening meter readings of the non-resettable totalizers in the meter reading record form (delivery), and ensure that the resettable totalizer meter reading is set to zero.

9.6.5.3 The chief engineer is strongly advised to witness the opening meter readings before the commencement of the bunkering operation. If the chief engineer declines the invitation, the bunker tanker representative shall record this on the form and this shall be endorsed by the chief engineer and witnessed by the bunker surveyor (when engaged).

9.6.5.4 Section A of the meter reading record form (delivery) in Annex J shall be completed and signed by the bunker tanker representative, chief engineer and bunker surveyor (when engaged) with their names, date and time of signature clearly written. This form shall be endorsed with the bunker tanker's stamp and the vessel's stamp.

9.6.5.5 Any cancellation or amendment on this form shall be counter-signed (and stamped) by the bunker tanker representative and chief engineer bunker surveyor (when engaged).

9.7 Delivery procedures

9.7.1 General

9.7.1.1 It shall be the chief engineer's responsibility to prepare the vessel for receiving bunker(s), including removal of the blank flange(s) from the vessel's bunker manifold(s).

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

9.7.1.3 Bunker tanker representative shall be responsible to ensure that the MFM system integrity is not compromised for the purpose of bunker delivery. Bunker tanker representative shall check for any critical alarms on the MFM system. If a critical alarm is found to be activated, the bunker tanker representative shall check and rectify before the commencement of delivery. If the critical alarm issue cannot be resolved, delivery by MFM system shall not proceed and alternative means for quantity determination such as ISO 13739 shall be employed.

9.7.1.4 Bunker surveyor (when engaged) shall check for breach of system integrity and status of critical alarm.

9.7.1.5 All loading and delivery operations shall go through the approved MFM system.

9.7.2 Start of delivery

9.7.2.1 Once the pre-delivery requirements have been completed and bunker hose(s) has/have been properly connected and ready to commence pumping, the chief engineer, the bunker tanker representative and the bunker surveyor (when engaged) shall agree to start the delivery. The following list of actions shall be completed.

a) Record the non-resettable totalizer readings in Section A of the meter reading record form (delivery) in Annex J.

b) Check the resettable totalizer is showing zero.

c) Record the start time in the meter reading record form.

9.7.2.2 Every measure should be taken to pack the meter as quickly as practicable at the start and throughout the delivery process.

9.7.2.3 Entrained air present in the bunker fuel can affect the accuracy of measurement of the meter and shall be minimised and controlled. Refer to 9.7.2.8 to 9.7.2.11 for steps to minimize aeration.

9.7.2.4 Communication between the bunker tanker and the vessel shall be maintained throughout the entire bunkering operation.

9.7.2.5 The bunker tanker representative shall ensure that the agreed pumping rate is adhered to by the bunker tanker within safe operating practices. The agreed pumping rate should not be exceeded unless requested by the chief engineer and duly endorsed by him. In addition, the agreed pumping rate shall not be lower than Q_{min} of the MFM.

9.7.2.6 When an order to stop pumping is given by the vessel, the bunker tanker shall stop the pumping immediately.

9.7.2.7 All stoppages and reasons for doing so shall be recorded in the bunker tanker's meter totalizer log. Bunker surveyor, when engaged, shall record the reasons for the stoppages in the statement of fact.

9.7.2.8 A sufficient trim by stern shall be maintained to minimize stripping time, if required. No stripping of nominated supplying tanks shall be carried out concurrently during delivery.

9.7.2.9 Stripping and line clearing of bunker hose(s) shall only be carried out at the end of the pumping operation. Any stripping of tanks should be carried out independently when there is no delivery from the other tanks. This is to reduce air entrainment during the delivery process.

The procedures for stripping and line clearing the bunker hose(s) are as follows:

a) The bunker tanker representative shall notify the chief engineer and bunker surveyor (when engaged) prior to the commencement of the stripping and line clearing operation;

b) The bunker tanker representative shall close the discharge valve after the pump and build up the pressure in the pipeline by using the bunker tanker's pump;

c) Once the pressure is built up, the bunker tanker representative shall open the discharge valve for the remaining bunker(s) in the bunker hose(s) to be cleared into the vessel's tank.

9.7.2.10 No air compressors or air bottles shall be used by the bunker tanker for the line clearing process.

9.7.2.11 If line clearing is allowed after the completion of the pumping operation, it shall be limited to achieve the objective and carried out with mutual agreement between bunker tanker and vessel.

9.7.2.12 During the entire bunkering process, no other bunker tanker shall be allowed to come alongside the bunker tanker delivering bunker(s) to the vessel, unless two different products are to be delivered to the vessel simultaneously.

9.7.3 End of delivery

9.7.3.1 After the line clearing process is completed, there is no more back flow of bunker and the meter has stopped measuring, the chief engineer, bunker tanker representative and bunker surveyor (when engaged) shall agree that this is the end of the delivery.

9.7.3.2 No re-pumping of bunkers shall be allowed.

9.7.3.3 The bunker tanker representative shall invite the chief engineer and the bunker surveyor (when engaged) to complete the end of delivery. The time of the end of delivery and the closing meter totalizer readings shall be witnessed and recorded in the meter reading record form (delivery).

9.7.3.4 The delivered quantity shall be determined from the recorded meter totalizer readings on the bunker tanker's MFM system as witnessed by the chief engineer, the bunker tanker representative, and bunker surveyor (when engaged).

9.7.3.5 If the chief engineer has earlier indicated his intention to witness the meter totalizer readings but subsequently declines the invitation to witness the closing meter readings, the bunker tanker representative shall indicate the change on the meter reading record form (delivery) and this fact shall be endorsed by the chief engineer and bunker surveyor (when engaged).

9.7.3.6 The bunker metering ticket shall be printed and post-delivery checks and documentation shall commence.

9.8 Post-delivery procedures and checks

9.8.1 Meter reading record form (delivery)

9.8.1.1 One original and at least two copies of the completed meter reading record form (delivery) shall be signed by the bunker tanker representative, chief engineer and bunker surveyor (when engaged), with their names clearly printed and stamped with the bunker tanker's stamp and the vessel's stamp.

9.8.1.2 A copy of the meter reading record form shall be attached to each copy of the BDN.

9.8.2 Mass flow metering system seals checklist

9.8.2.1 On completion of the pumping operation, the chief engineer and the bunker surveyor (when engaged) shall verify that seals remain intact and the seal numbers match the seal numbers indicated in the latest seal verification report onboard the bunker tanker.

9.8.2.2 One original and at least two copies of the completed mass flow metering system seals checklist shall be signed by the bunker tanker representative, chief engineer and bunker surveyor (when engaged), with their names clearly printed and stamped with the bunker tanker's stamp and the vessel's stamp.

9.8.3 Bunker metering ticket

The bunker metering ticket shall be printed and the ticket shall contain the following information:

a) name of bunker tanker and IMO number;

b) meter unique identification number;

c) bunker start date and time;

d) bunker end date and time;

e) print time;

f) conventional mass or mass in air.

NOTE This value is derived from a calculation involving air buoyancy correction. Refer to 3.3 for its definition.

An example of the bunker metering ticket is shown in Annex K.

9.8.4 Bunker delivery note

9.8.4.1 A BDN shall be used for each individual bunker delivery. For multiple deliveries by bunker tanker, a separate BDN will be issued for each bunker tanker delivery.

9.8.4.2 While every supplier will have his own format for the BDN, it shall be prepared by the Bunker tanker representative and shall contain at least the following information:

a) name of receiving vessel;

b) IMO number of the receiving vessel;

c) date and time of commencement and completion of the delivery;

d) name, address and telephone number of the bunker supplier;

e) bunker specification (grade name);

f) quantity in tonnes (to indicate in air or in vacuum);

g) density at 15 °C, as supplied;

h) viscosity at 40 °C or 50 °C, as supplied;

i) sulfur content as supplied;

j) declaration signed and certified by the bunker supplier's representative that "The bunker(s) supplied is/are in conformity with Regulation 14.1 or Regulation 14.3 and Regulation 18.3 of MARPOL Annex VI"[9];

k) a record of the supplier's sample seal numbers and any counter seal numbers on the sample;

l) delivery port;

m) bunker tanker name, road tanker identification number or name of supplying terminal;

n) next port of call;

o) receiving vessel's stamp and signature of the master/chief engineer;

p) signature and, where applicable, stamp from the bunker tanker representative;

q) section for comments.

NOTE 1 MARPOL Annex VI[9] requires the BDN to be retained for a period of three years after the fuel oil has been delivered on board.

NOTE 2 The certificate of quality (COQ) density stated above is for fuel specification only and not for transfer quantity determination.

9.8.4.3 The BDN shall contain the information in 9.8.4.2.

NOTE Refer to Regulation 18.3 of MARPOL Annex VI[9] for further details.

9.8.4.4 After the end of delivery, the bunker tanker representative shall prepare the BDN for the chief engineer to sign. A copy of the meter reading record form shall be attached to each copy of the bunker delivery note (BDN).

9.8.4.5 All relevant and applicable columns of the BDN shall be filled in, and "N.A." (not applicable) shall be inserted in blank columns.

9.8.4.6 Any cancellation or amendment on the BDN shall be endorsed and stamped by the bunker tanker representative and the chief engineer.

9.8.4.7 One original and at least two copies of the completed BDN shall be signed by the bunker tanker representative and the chief engineer with their names clearly printed and stamped with the bunker tanker's stamp and the vessel's stamp.

9.8.5 Custody transfer quantity

9.8.5.1 The chief engineer and bunker surveyor (when engaged) shall verify the delivered quantity as stated in the bunker delivery note. The figure of the quantity delivered in the BDN shall be taken from the meter reading record form.

9.8.5.2 For delivery using MFM system, the COQ density stated in the BDN is for referencing of fuel specification only and not for determination of the delivered quantity. The COQ density is not to be used for quantity dispute claims.

9.9 Others

9.9.1 MFM system failure

9.9.1.1 In the event that there is a MFM system failure (as may be indicated by a critical alarm) which occurs during a bunkering operation where the delivery cannot be continued, pumping shall cease immediately and the meter's totalizer readings shall be recorded in the meter reading record form. A BDN shall be completed.

9.9.1.2 A secondary system, where applicable in accordance to ISO 13739, shall be used to determine the remaining quantity to be delivered and a separate BDN shall be completed.

9.9.1.3 The final quantity delivered shall be the sum of the quantities recorded in the respective BDNs.

9.9.2 Quantity dispute

9.9.2.1 If bunker supplier and buyer do not agree on the delivered quantity through the MFM system, it could be considered as a quantity dispute situation. Both parties shall proceed to resolve the quantity dispute situation by checking if the bunker delivery is conducted in accordance with this document. If the dispute situation is not resolved, the party making the claim shall issue a letter of protest (refer to Annex P), which shall be signed for receipt by the other party.

9.9.2.2 Refer to Annex Q for details on procedures and documents to ascertain compliance to this document.

10 Sampling

The sampling of bunkers for analysis is outside the scope of this document. Refer to sampling procedures in ISO 13739.

Annex A
(informative)

Safety, health and the environment

A.1 Pre-delivery conference

Prior to the commencement of the bunker delivery, a pre-delivery conference shall be conducted between the representatives of the bunker tanker, vessel and bunker surveyor (when engaged), as set out in Clause 5.

A.2 Planning for safety

A.2.1 Firefighting

Firefighting equipment shall be ready for immediate use at all times on the bunker tanker and the vessel.

A.2.2 Emergency preparedness

Despite careful attention to safety procedures, emergencies can occur. Often such events can be contained and their effects minimised by preparing the vessel crew through a system of drills, to deal with a variety of emergencies. Appropriate drills should be held in accordance with the vessel's approved contingency plans. Such drills, when carried out, should be documented.

A.2.3 Condition of crew

The masters of the bunker tankers and the vessel shall ensure that they, as well as all senior personnel and crew members involved in the bunkering operation, are properly rested and not in any way under the influence of alcohol or any controlled drug.

A.2.4 Bunkering pre-delivery safety checklist

The safety checklist for bunkering operations as set out in Annex L shall be presented by the representative of the bunker tanker to the representative of the vessel at the pre-delivery conference. This should assist the masters in adhering to the relevant safety procedures of a bunkering operation. The safety checklist is an essential reminder of the principal safety factors and should be supplemented by continuous vigilance throughout the whole bunkering operation. A copy of the completed pre-delivery safety checklist shall be made available to the bunker surveyor (when engaged).

A.3 Observing safe work practices

A.3.1 Smoking and naked lights

Regulations regarding smoking and the use of naked lights shall be strictly enforced. Warning notices should be clearly and appropriately displayed.

A.3.2 Safe access

A.3.2.1 The vessel shall provide accommodation ladder or ladders in compliance with SOLAS regulations.

A.3.2.2 The access shall be safely rigged and properly illuminated during darkness.

A.3.2.3 Personnel shall only use the designated means of access between the bunker tanker and vessel.

A.3.3 Outboard deckway

Crew on the bunker tanker are reminded to walk on the outboard side of the main deck to avoid exposure to falling objects from the vessels, such as lashing materials.

A.3.4 Unauthorised craft

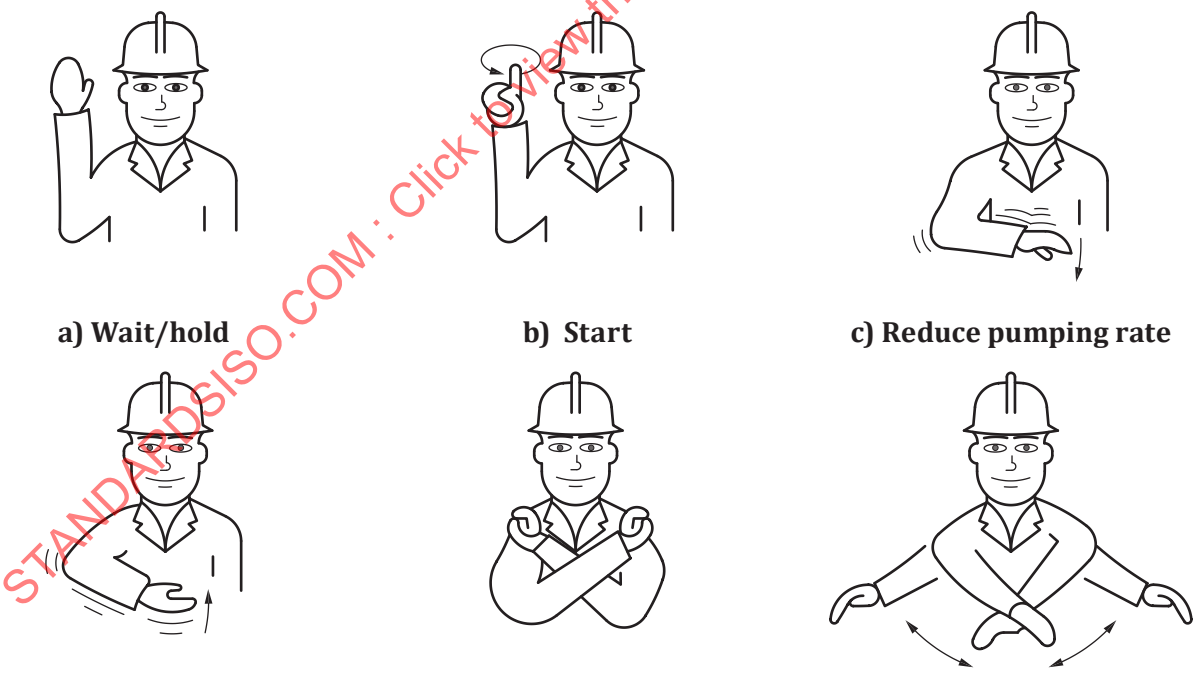
No unauthorised craft shall be allowed alongside either vessel or bunker tanker throughout the bunkering operation unless permitted by the respective duty officers.

A.3.5 General communication

A.3.5.1 Good communication between the bunker tanker and vessel is an essential requirement for successful bunkering operations.

A.3.5.2 To avoid any misunderstanding, a common language for communication should be agreed before commencement of bunker operations.

A.3.5.3 Hand signals for communication as set out in Figure A.1 could also be established between the parties.



a) Wait/hold **b) Start** **c) Reduce pumping rate**

d) Increase pumping rate **e) Stop** **f) Finish**

Figure A.1 — Examples of hand signals for bunkering communication

A.3.5.4 During bunkering operations, essential personnel on the bunker tanker and the vessel should have a reliable, common means of communication at all times, including a backup system. It is recommended that spare radios and batteries are available on the bunker tanker and the vessel.

A.3.5.5 An agreed emergency signal in the form of an air horn and/or hand signals as set out in Figure A.1 shall be established. In the event of a breakdown of communication channels between the bunker tanker and the vessel, the emergency signal should be sounded and all operations in progress should be suspended immediately.

A.3.5.6 Bunkering operations should not be resumed until satisfactory communication capability has been re-established.

A.3.6 Emergency shut down

A.3.6.1 Any crew member of the bunker tanker and vessel shall be empowered to initiate an emergency shut down of the bunkering operation in an emergency or suspicious circumstance.

A.3.6.2 The bunkering operations shall remain suspended until it is agreed between the relevant personnel/authorities that it is safe to resume.

A.4 Preventing exposure to health hazards

A.4.1 Gas monitors

A.4.1.1 Hydrogen sulphide (H_2S)

A.4.1.1.1 H_2S is a colourless, transparent gas with a characteristic rotten-egg odour at low concentrations. At high concentrations, it has a sweetish odour, and at even higher concentrations, an odour may not be detected.

A.4.1.1.2 Vessels performing a bunkering operation should be aware that the concentration level of H2S exceeding 10 ppm constitutes a health hazard.

A.4.1.1.3 Bunker tankers loading bunkers at the terminal shall inform the terminal representative immediately if H_2S concentration level exceeding 10 ppm is detected in the immediate vicinity where personnel are working.

A.4.1.1.4 All bunker tankers carrying MDO and MFO shall be equipped with at least two units of the H_2S personal detectors and these detectors shall be worn by the bunker tanker personnel during any bunker transfer operation.

A.4.1.2 Oxygen (O_2)

All bunker tankers shall be equipped with at least two units of the O_2 personal detectors and these detectors shall be worn by the bunker tanker personnel before entering any enclosed or confined space. Refer to Annex L.

A.4.2 Accommodation openings

All access doors to the accommodation shall be kept closed during the bunkering operation. The master of the bunker tanker and the vessel should designate those access doors that are to be used for personnel transit. Where possible, only doors remote from the main deck cargo area should be used. All doors opened for personnel transit should be closed immediately after use. The air conditioning system for the accommodation should be switched to the re-circulation mode.

A.4.3 Safety data sheet

A.4.3.1 Safety data sheet (SDS) provides the information necessary for customers, bunker craft operators, emergency workers and others to decide on the appropriate handling and management of petroleum products.

A.4.3.2 All bunker tankers shall have the SDS of bunker(s) carried on board.

A.4.3.3 A copy of the SDS shall be provided to the chief engineer prior to the loading of the bunker(s). A copy of the SDS shall be made available to the bunker surveyor (when engaged).

A.5 Protection of the marine environment

A.5.1 Oil spill handling equipment

Oil spill handling equipment shall be ready for immediate use on the bunker tanker and the vessel at all times.

A.5.2 Scuppers

All scuppers and drains on board should be properly plugged during bunkering operations. Any accumulation of water should be drained off periodically.

A.5.3 Oil spill

In the event of any spillage causing or likely to cause pollution, masters of the bunker tanker and the vessel, regardless of who is responsible, shall immediately take such actions as are reasonably necessary to effect clean up.

NOTE Local laws and regulations can apply on these actions.

Annex B
(informative)

Uncertainty budget table

No:	Sources contributing to uncertainty measurement	Components
1	reference standard and equipment (MFM) used	a) linearity of MFM, reproducibility, error b) long term instability — zero instability c) calibration of MFM
2	method and reference materials used (bunker fuel)	a) process- error of zero instability, stripping and line packing b) hydraulic circuit — e.g. the 'custody transfer point'
3	environmental conditions	a) repeatability b) resolution
4	properties and conditions of MFM	a) low flow cut-off b) zero instability c) operation conditions error
5	operator	Repeatability

Annex C
(informative)

Metrological and system integrity requirements

Phase	Requirement	Remarks	
meter selection and installation	evaluated meter pattern	refer to 6.2, metrological control	
	meter and ancillary device calibration	refer to Clause 5, metrological requirements	
	verification of critical parameters	refer to 6.4.4, Re-commissioning	
	zero adjustment	refer to 3.21 and 5.3.4, Initial zero adjustment	
	system security	refer to 6.3, security features	
system in-service	zero verification	refer to 6.4, post approval maintenance	quarterly for first year and every six months for subsequent years
	meter subsequent verification and/or calibration	refer to 5.4.3, meter and ancillary devices verification and/or calibration frequency	periodical
	ancillary devices (pressure and temperature transmitter) verification and/or calibration	refer to 5.4.3, meter and ancillary devices verification and/or calibration frequency	with meter verification / calibration

Annex D
(informative)

Procedures for zero verification

D.1 The objective of the zero verification is to ensure the zero offset does not exceed the limit of 0,2 % of Q_{min}.

D.2 A change in zero offset can be caused by:

— changes in the tubes caused by stress due to variation in temperature, pressure, density, environmental and marine conditions;

— poor installation practice;

— drift in electronic components in the transmitter;

— erosion/corrosion of flow tubes that can affect the pipe stiffness and thickness.

D.3 The following sets the conditions (typical and not limited to) to perform zero verification:

— ensure bunker fuel flow condition is stable (ie. captured flow readings are constant);

— close downstream valves to pack flow sensor with non-aerated bunker fuel at positive pressure;

— the verification of the stored zero value requires that flow through the meter be stopped and then the indicated mass flow rate under this condition be monitored

D.4 When the above conditions are met and considering manufacturer's guidelines, a minimum of three zero readings at regular intervals are to be taken. The zero readings taken should not exceed 0,2 % of Q_{min}.

D.5 If the observed zero readings exceed 0,2 % of Q_{min}, it is due to the packing condition of the flow sensor tubes not being satisfactory. In this case, perform another zero verification to re-validate the zero readings observed.

D.6 If the zero verification still fail to meet these requirements after a few attempts, the accredited body shall be informed immediately and the meter shall not be used for custody transfer.

D.7 Zero verification is an indication of a meter's health. A non-satisfactory zero verification result will affect the overall accuracy of measurement. A change in the zero reading can be caused by:

— erosion/corrosion of flow tubes, which affects the pipe stiffness and thickness;

— environmental conditions due to prolong use.

D.8 Zero adjustment may require to be conducted in the event that the meter is not able to meet the prescribed 0,2 % limit.

Annex E
(informative)

Sealable bolts and nuts for blanks and ancillary device

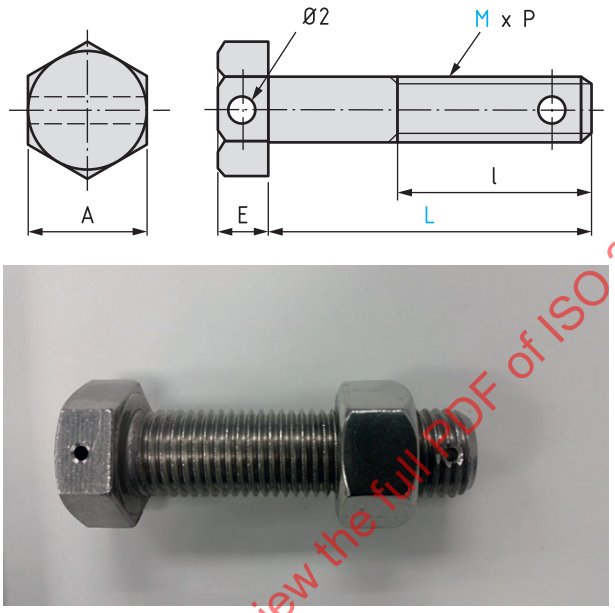


Figure E.1 — Sealable bolt and nut

Figure E.2 — Example of sealed pipe blank

Figure E.3 — Example of sealed pressure transmitter

Annex F
(informative)

Request for information checklist

Bunker tanker information

Country of build	
Customer name	
Bunker tanker owner/operator	
Bunker tanker name	
IMO No.	
Bunker tanker dead weight	
Bunker tanker	☐ New ☐ Existing

Process/application information

For bunker tanker:	☐ Loading ☐ Delivery

Fluid type: HFO	☐ IFO180 ☐ IFO500 ☐ Low sulfur	☐ IFO380 ☐ IFO700 ☐ Others_____	
	Min.	Normal	Max.
Flow range – Loading (MT/h)			
Flow range – Delivery (MT/h)			

Fluid type: MGO ☐ Others_____			
	Min.	Normal	Max.
Flow range – Loading (MT/h)			
Flow range – Delivery (MT/h)			

	Min.	Max.
Bunker quantity (mt)		

	Min.	Normal	Max.
Density range: (kg/m^3) Measured at 15 °C and follow ISO 3675 or ISO 12185			
Viscosity range: (cSt) Measured at 50 °C and following ISO 3104			
Operating pressure (MPa)/(bar)			
Operating temperature (°C)			

Vessel mechanical / electrical information

	(m^3/h)/(MT/h)
Cargo pump (HFO) capacity	
Cargo pump (MGO) capacity	
Stripping pump capacity	

	(inch)/(mm)
Pipe size (HFO)	
Pipe size (MGO)	

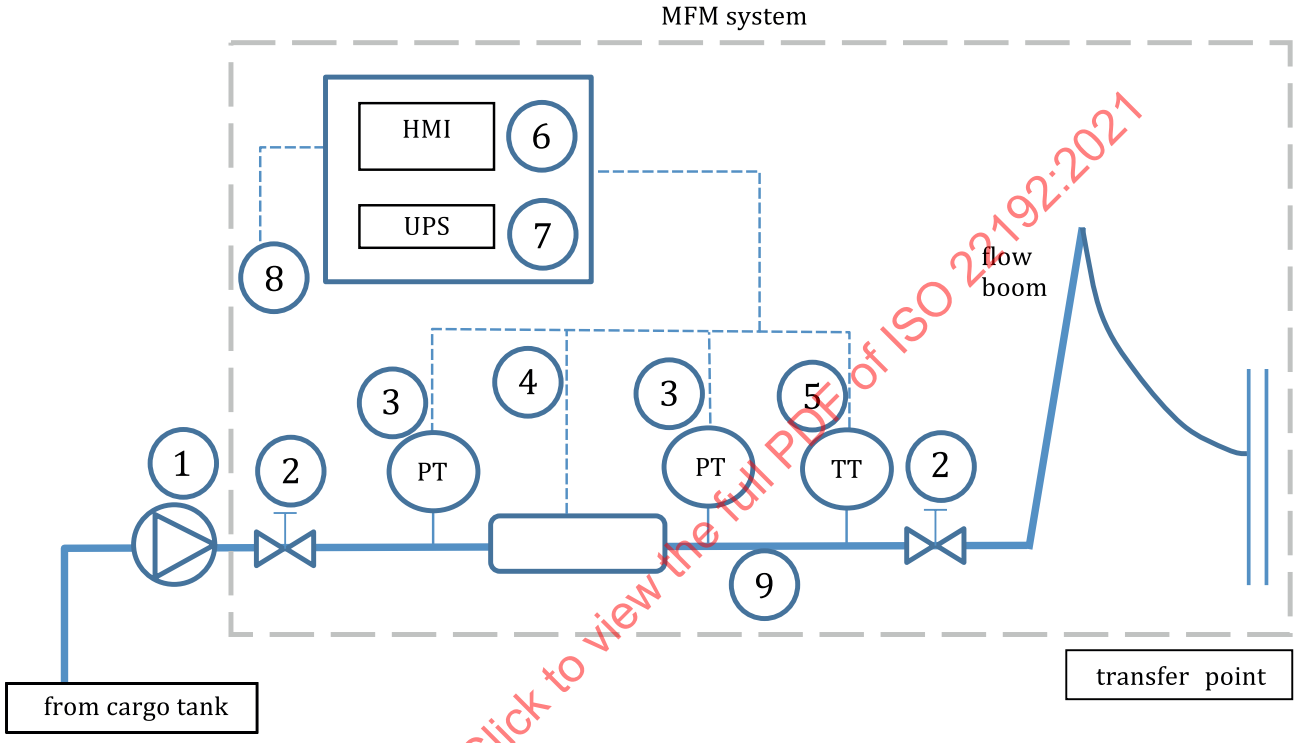
Flange connection type:	
Hazardous area approval (zone 1/zone 2)	

	(VAC)/(VDC)	(Hz)
Electrical power requirements:		

	Yes	No
Cargo piping layout provided		

Annex G
(informative)

Typical schematic diagram for MFM system (for delivery)



Key

1 pump
2 gate/isolation valve
3 pressure transmitter
4 Coriolis flow meter
5 temperature transmitter
6 human machine interface (HMI)
7 uninterrupted power supply (UPS)
8 custody printer (CP)
9 pipeline

Annex H
(normative)

Example of bunker requisition form (mass flow metering)

BUNKER REQUISITION FORM
(MASS FLOW METERING)

The Chief Engineer
MV/SS : _____

Date : _____
Location : _____

We have been nominated to supply you the following grade(s) for bunker:

_____ Tonnes of Marine Fuel Oil of _____ cSt.
_____ Tonnes of Marine Diesel Oil/ Gas Oil

We undertake to supply you with the above grade(s) of bunkers. Some basic characteristics of the bunkers are as follows:

Product Name	Product was blended on board in advance? (Yes / No)	Kinematic Viscosity @ 40 °C or 50 °C, mm^2/s ISO 3104	* COQ Density @ 15 °C, kg/m^3 ISO 3675 ISO 12185	Water Content % V/V ISO 3733	Flash Point °C ISO 2719	Sulphur Content %, m/m ISO 14596 ISO 8754

* The COQ (Certificate of Quality) Density stated above is for fuel specification only and not for custody transfer quantity determination.

We will supply _____ first, followed by _____. The approximate delivery temperature is _____°C.
The rated pumping capacity of our bunker tanker is _____ tonnes per hour.

1) What pumping rate do you require?
   Marine Fuel Oil _____ tonnes per hour
   Marine Gas/ Diesel Oil _____ tonnes per hour
2) Will you allow line clearing at the end of bunkering to clear the bunkers in the hose? #Yes / No
3) Is your vessel under any fuel quality testing programme? #Yes / No
4) Is the vessel equipped with scrubbers? #Yes / No

NOTE 1 Witnessing of meter reading(s) is compulsory.
NOTE 2 For analysis of bunker quality, only the representative sample collected shall be used.

Acknowledge by:

Signature of Bunker Tanker Representative	Signature of Chief Engineer	Signature of Bunker Surveyor (when engaged)
Name in Full: _____ (Block Letters)	Name in Full: _____ (Block Letters)	Name in Full: _____ (Block Letters)
Bunker Tankers's Stamp : _____ Date/ Time : _____	Vessel's Stamp : _____ Date/ Time : _____	Company's Stamp : _____ Date/ Time : _____

Custody Transfer Sampling is compulsory. If custody transfer sample(s) cannot be taken at the bunker manifold of the vessel, describe the physical limitation/ constraint encountered.

_____
_____

Signature of Bunker Tanker Representative	Signature of Chief Engineer	Signature of Bunker Surveyor (when engaged)
Date/ Time : _____	Date/ Time : _____	Date/ Time : _____

#Delete as necessary
NA - Not Applicable

Annex I
(informative)

Example of mass flow metering system seals checklist

Mass Flow Metering System Seals Checklist

Name of Bunker tanker : _____ Licence / IMO No.: _____

Date : _____ Location : _____

Seal Verification Report No.: _____

All questions should be joinly answered by the Bunker Tanker Representative, Chief Engineer and Bunker Surveyor (when engaged) by clearly initialing in the appropriate box.

No.	Item Description		Tag No.	Seal No.	Section A Before delivery intact		Section B After delivery intact		Remarks
					Yes	No	Yes	No	
1	Mass flow metering instrument*	Mass flow meter	MFT-01						
2		Junction box (P)	MJB-02						
3		Junction box (S)	MJB-03						
4		Pressure transmitter (P2)	MPT-04						
5		Pressure transmitter (P1)	MPT-05						
6		Temperature transmitter	MTT-06						
7		Bunker metering computer	MFC-07						
8	Pipe line system*	Pipe flange blank (Port)	PF-2P-01						
9		Pipe flange blank (Stbd)	PF-3S-02						
10		Pipe end blank (Port)	PB-3P-03						
11		Pipe end blank (Stbd)	PB-4S-04						
12									
13	Operational seals								
14									
15									
16									

Declaration

We, the undersigned have jointly checked all items on this checklist.

Section A - Before Delivery	Section B - After Delivery
Signature of Chief Engineer/Vessel's stamp: Name: Date / Time:	Signature of Chief Engineer/Vessel's stamp: Name: Date / Time:
Signature of Bunker Tanker Representative/Bunker Tanker's stamp: Name: Date / Time:	Signature of Bunker Tanker Representative/Bunker Tanker's stamp: Name: Date / Time:
Signature of Bunker Surveyor (when engaged)/Company's stamp: Name: Date / Time:	Signature of Bunker Surveyor (when engaged)/Company's stamp: Name: Date / Time:

* Please refer to document "Seal Verification Report For M/T _____ (IMO No. _____)"

Annex J
(informative)

Example of meter reading record form (delivery)

Meter Reading Record Form (Delivery)

Bunker Tanker's Name : _____ Licence/IMO No.: _____

Vessel's Name : _____ Meter Serial No. : _____

BDN No. : _____ Bunker Metering Ticket (BMT) No. : _____

Section A- Start of delivery

Delivery meter totaliser reading (MT) [A]		Loading meter totaliser reading (MT) [X]	

Sampling container seal no._____ Needle valve seal no._____

Vessel has sufficient tank space for purging : Yes / No

Remarks (if any) : _____

Bunker Tanker's Representative	Vessel's Representative	Bunker Surveyor (when engaged)
_____ Signature of Bunker Tanker Representative Name in full : _____ Date/Time : _____ (Start of delivery) Bunker Tanker's Stamp : _____	_____ Signature of Chief Engineer Name in full : _____ Date/Time : _____ (Start of delivery) Vessel's Stamp : _____	_____ Signature of Bunker Surveyor Name in full : _____ Date/Time : _____ (Start of delivery) Company's Stamp : _____

Section B- End of delivery

Delivery meter totaliser reading (MT) [B]		Loading meter totaliser reading (MT) [Y]	

Quantity delivered (MT) [(B-A) – (Y-X)]	

Bunker Tanker's Representative	Vessel's Representative	Bunker Surveyor (when engaged)
_____ Signature of Bunker Tanker Representative Name in full : _____ Date/Time : _____ (End of delivery) Bunker Tanker's Stamp : _____	_____ Signature of Chief Engineer Name in full : _____ Date/Time : _____ (End of delivery) Vessel's Stamp : _____	_____ Signature of Bunker Surveyor Name in full : _____ Date/Time : _____ (End of delivery) Company's Stamp : _____