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# Ships and marine technology — Marine environment protection — Specification for collecting data on ship's fuel oil consumption

*Navires et technologie maritime — Protection de l'environnement marin — Spécifications relatives à la collecte de données sur la consommation de mazout des navires*



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# Foreword

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This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 2, *Marine environment protection*.

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# Introduction

The International Maritime Organization (IMO) Marine Environment Protection Committee, at its seventieth session (MEPC 70), adopted resolution MEPC.278(70) on Amendments to MARPOL, Annex VI, on data collection systems for fuel oil consumption of ships, which entered into force on 1 March 2018.

In accordance with regulation 22.2 of MARPOL, Annex VI, on or before 31 December 2018, the ship energy efficiency management plan (SEEMP) for ships of 5 000 gross tonnage (GT) and above is required to include a description of the methodology used to collect the data required by regulation 22A of MARPOL, Annex VI, including the process used to report the data to the ship's administration.

In addition, in accordance with regulation 5.4.5 of MARPOL, Annex VI, administrations are required to ensure that for each ship to which regulation 22A applies, the SEEMP complies with regulation 22.2. This is required to be done prior to collection of data under regulation 22A to ensure the methodology and the process are in place prior to the beginning of the ship's first reporting period.

Resolution IMO MEPC.282(70) 2016, *Guidelines for the development of a ship energy efficiency management plan (SEEMP)*[3], already provides detailed guidelines for the IMO data collection system. Additionally, Part 2 of the SEEMP, *Ship fuel oil consumption data collection plan*, is expected to be verified by the administrations or recognized organizations (RO). However, some portions needed to be clarified to prevent controversy between the administrations to improve data quality. This especially pertains to the methods to measure fuel oil consumption. Three methods for measuring fuel oil consumption (by bunker delivery note [BDN], flow meter, and sounding) are needed to specify the density calculation and calibration of each of the measuring devices.

# Ships and marine technology — Marine environment protection — Specification for collecting data on ship's fuel oil consumption

## 1 Scope

This document provides a method for ships of 5 000 gross tonnage (GT) and above to collect data on fuel oil consumption, as required by regulation 22A of MARPOL, Annex VI. It specifies practical methods to measure the fuel oil consumption, the distance travelled and the hours underway. Annex A provides an example of a ship fuel oil consumption data collection plan.

## 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.

IMO MARPOL Convention Annex VI, *Regulations for the prevention of air pollution from ships*

## 3 Terms and definitions

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

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

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

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

**3.1**
**ship fuel oil consumption data**
data required to be collected on an annual basis and reported as specified in Appendix IX of MARPOL, Annex VI

**3.2**
**emission**
release of substances, subject to control by MARPOL, Annex VI, from ships into the atmosphere or sea

**3.3**
**fuel oil**
fuel delivered to and intended for combustion purposes for propulsion or operation on board a ship, including distillate and residual fuels

**3.4**
**conversion factor**
non-dimensional conversion factor between *fuel oil* (3.3) consumption and $CO_2$ *emission* (3.2)

Note 1 to entry: It is defined in the *2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships* (resolution MEPC.245(66)), as amended[4].

**3.5**
**voyage**
movement of a ship between a *departure from a berth* (3.6) to the *arrival at the next berth* (3.7)

**3.6**
**departure from a berth**
**departure**
starting point when a ship leaves a *berth* (3.11) at one single *port boundary* (3.12)

**3.7**
**arrival at the next berth**
**arrival**
starting point when a ship is berthed (moored, anchored and/or adrift) at one single *port boundary* (3.12)

**3.8**
**calendar year**
period from 1 January until 31 December of a year

**3.9**
**hours underway**
duration the ship is in operation under its own propulsion

**3.10**
**distance travelled**
actual distance travelled over the ground, in nautical miles

**3.11**
**berth**
named or numbered place where a vessel is moored at a wharf

**3.12**
**port boundary**
geographic area defined by the designated authority of the states, encompassing the individual port facilities within a port

# 4 Information on the ship and fuel oil consumers

## 4.1 Ship particulars

The following basic vessel information shall be collected:

a) name of the ship;

b) IMO number;

c) company;

d) flag;

e) ship type;

f) gross tonnage;

g) net tonnage (NT);

h) deadweight tonnage (DWT);

i) energy efficiency design index (EEDI) (if applicable);

j) ice class (if applicable).

### 4.2 Ship fuel oil consumers

For collecting fuel oil consumption data, the following information shall be obtained (see Table 1):

a) fuel oil consumers;

b) type/model;

c) number (if a ship has two or more machineries in one fuel oil consumer);

d) power (kW);

e) fuel oil type (conversion factor, $C_F$).

**Table 1 — Example of fuel oil consumer data information format**

| | Fuel oil consumers | Type/model | Number | Power kW | Fuel oil types ($C_F$) Primary/secondary |
|---|---|---|---|---|---|
| 1 | Main engine | | | | |
| 2 | Auxiliary engine | | | | |
| 3 | Boilers | | | | |
| 4 | Inert gas generator | | | | |
| 5 | Gas turbines | | | | |

## 5 Methods to measure the fuel oil consumption

### 5.1 General

The fuel oil consumption should include all the fuel oil consumed on board including, but not limited to, the fuel oil consumed by the main engines, auxiliary engines, gas turbines, boilers and inert gas generator, for each type of fuel oil consumed, regardless of whether a ship is underway or not. The method for collecting data for annual fuel oil consumption used on a ship can be chosen from three methods as described in 5.2, 5.3 and 5.4. Except for the case of using a mass flow meter (see 5.3), when using an annual fuel oil consumption measurement method, the density shall be obtained by one of the following methods to calculate the volume correction factor and the weight correction factor for converting the measured fuel oil consumption value into metric tonnes units:

a) on board measurement systems;

b) bunker delivery notes (BDNs) from the fuel supplier at the bunkering port;

c) laboratory testing.

NOTE Data relating to boil-off gas (BOG) consumed on board the ship for propulsion or operation is collected and reported as fuel as part of the data collection system for fuel oil consumption of ships[1].

### 5.2 Use of bunker delivery notes (BDNs)

#### 5.2.1 Annual fuel oil consumption

This method determines the annual total amount of fuel oil used based on BDNs, which are required for fuel oil for combustion purposes, delivered to and used on board a ship in accordance with regulation 18 of MARPOL, Annex VI. Annual fuel oil consumption ($Q$) should be calculated as follows:

$$Q = T_1 + R - S - T_2$$

where

$Q$ is the annual fuel oil consumption;

$T_1$ is the remaining fuel oil in tank at the beginning of the year;

$R$ is the total fuel oil bunkered for the calendar year;

$S$ is the total fuel oil offloaded for the calendar year;

$T_2$ is the remaining fuel oil in tank at the end of the year.

Each value should be rounded off to two decimal places.

The amount of any fuel oil loaded or offloaded should be based on the records from the ship's oil record book. Any supplemental data used for closing identified differences in bunker quantity should be supported with documented evidence. In the case of a voyage that extends over a data reporting period, the tank reading should occur by tank monitoring at the ports of departure and arrival of the voyage and by statistical methods such as rolling average using voyage days.

### 5.2.2 Information from the bunker delivery note

The BDN includes at least the following information in accordance with Appendix V of MARPOL, Annex VI:

a) name and IMO number of receiving ship;

b) port of bunkering;

c) date of commencement of delivery;

d) name, address and telephone number of fuel oil supplier;

e) delivered product name;

f) quantity in metric tonnes;

g) density at 15 °C, kg/m$^3$;

h) sulfur content, % mass fraction;

i) a declaration signed and certified by the fuel oil supplier's representative that the fuel oil supplied is in conformity with regulation 18.3 of MARPOL, Annex VI and that the sulfur content of the fuel oil supplied does not exceed:

— ☐ the limit value given by regulation 14.1 of MARPOL, Annex VI;

— ☐ the limit value given by regulation 14.4 of MARPOL, Annex VI;

— ☐ the purchaser's specified limit value (% mass fraction), as completed by the fuel oil supplier's representative and on the basis of the purchaser's notification that the fuel oil is intended to be used:

.1 ☐ in combination with an equivalent means of compliance in accordance with regulation 4 of MARPOL, Annex VI; or

.2 ☐ is subjected to a relevant exemption for a ship to conduct trials for sulfur oxides emission reduction and control technology research in accordance with regulation 3.2 of MARPOL, Annex VI.

The declaration shall be completed by the fuel oil supplier's representative by marking the applicable box(es) with a cross (x).

### 5.3 Use of flow meters

This method determines the total annual amount of fuel oil consumption by measuring fuel oil flow on board with flow meters. The annual fuel oil consumption is the sum of daily fuel oil consumption data of all relevant fuel oil consuming processes on board measured by flow meters. The flow meters applied to monitoring should be located so as to measure all fuel oil consumption on board and should be identified in this plan. In case of flow meter malfunction, manual tank readings or other alternative methods shall be conducted instead. It should not be necessary to correct this fuel oil measurement method for sludge if the flow meter is installed after the daily service tank, as sludge is removed from the fuel oil prior to the daily service tank. Annex B gives, for information, a guidance on an automatic data collection system using fuel flow meters.

### 5.4 Use of fuel oil tank monitoring

#### 5.4.1 Remote sounding gauge

This method determines the total annual fuel consumption by measuring the remaining amount in the fuel oil tank through direct reading using an automatic system (remote reading). The total annual consumption is calculated by summing up the measured daily fuel consumption. The remaining amount of fuel in the tank is normally measured daily and every time the ship receives or discharges fuel oil. A summary of the measurement data, including a record of the measured fuel consumption, shall be provided on board.

#### 5.4.2 Manual sounding measurement

This method determines the residual amount in the fuel oil tank and the total annual consumption of the fuel oil by indirect measuring of the tank using sounding or dip tapes. Details of the equipment should be recorded.

The total annual consumption is calculated by summing up the daily measured fuel consumption. The measurement of the remaining amount in the tank is normally carried out daily and every time the ship receives or discharges fuel oil. A summary of the measurement data, including a record of the measured fuel consumption, shall be provided on board.

## 6 Method to measure the distance travelled

The distance travelled while the ship is underway under its own propulsion shall be included in the aggregated data of distance travelled for the calendar year. Distance travelled over the ground in nautical miles should be recorded in the logbook in accordance with SOLAS regulation V/28.1[9]. When the distance travelled is measured using satellite data, the devices used shall be recorded. Other methods to measure distance travelled accepted by the administration may be applied. In this case, the measurement method applied should be recorded.

The total distance travelled of a ship shall be aggregated for all voyages, which is the ship movement from the starting point when it departs from a berth to the arrival point when a ship is berthed, anchored and adrift at one single port boundary in a calendar year. It should exclude the distance for anchoring and drifting conducted outside of a single port boundary.

## 7 Method to measure the hours underway

Hours underway shall be an aggregated duration while the ship is underway under its own propulsion. The hours underway should be recorded in the logbook. The total hours underway of a ship shall be aggregated for all voyages, which is the ship movement from the starting point when it departs from a berth to the arrival point when it is berthed, anchored and adrift at one single port boundary in a calendar year. It should exclude the time for anchoring and drifting conducted outside of a single port boundary.

## 8 Aggregated data report

The following shall be considered when reporting data to the administration.

a) The date for the report is based on either the calendar year from the time 00:00:00 GMT on 1 January to the time 24:00:00 GMT on 31 December, or noon report from 1 January to 1 January of the next year. The Master is responsible for reporting the data collected from the ship to the company management team.

b) The aggregated value of each parameter (data) specified in Table C.1 shall be reported to its administration by a standardized format developed by the organization.

c) In the event of the change of a ship's flag, the company management team shall thereto report on the day of completion of the transfer or as close as practical from the losing administration, the aggregated datum for the period of the calendar year corresponding to that administration, as specified in Table C.1 and, upon prior request to that administration, the disaggregated data.

d) In the event of the change of a company, the previous company management team shall report on the day of completion of the transfer or as close as practical thereto to the ship's flag administration, the aggregated data for the period of the calendar year corresponding to the company, as specified in Table C.1 and, upon prior request of that administration, the disaggregated data.

## 9 Data quality control

### 9.1 Bunker delivery notes (BDN)

The following shall be considered for data quality control purposes.

a) The tank reading should be carried out at the beginning and end of the bunkering.

b) The sounding tape used shall be of sufficient length for the height of the tank to be gauged and markings shall be visible. It shall not be kinked or spliced.

c) During a bunkering, an even keel should be kept.

d) BDNs shall be retained on board for three (3) years after the fuel oil has been delivered.

e) When data gaps occurred due to unexpected conditions, a superintendent should inform the Chief Engineer. In this case, the Chief Engineer should correct the gap by using the average of the remaining on board (ROB) difference between arrival and departure ROBs. The Chief Engineer then should record the value as an error to the engine log book and inform this to the superintendent.

### 9.2 Flow meter

The following shall be considered for data quality control purposes.

a) Flow meters shall be periodically verified on board at intervals advised by the manufacturer, but not exceeding five (5) years.

b) Flow meters shall be verified at least by one of the following methods:

   1. flow meters shall be detached from original location and verified that the measured flow is correct by a competent person, including the Chief Engineer on board;

   2. verification shall be conducted by comparing manual sounding measurements of another method and the flow meter by a competent person including the Chief Engineer on board.

c) Flow meters shall be calibrated by the manufacturer when the standard error range of the flow meter is greater than 2 %.

d) Maintenance records of the flow meters shall be available on board and shall be kept for a minimum of five (5) years.

e) In case of failure of the flow meter, it is possible to replace it by using historical records in the log book.

f) When the relevant data are missing, the Chief Engineer shall perform as soon as possible tank sounding in order to close the gap. In the case where the missing data are not immediately identified, the responsible superintendent shall close the gap manually by using the average fuel consumption from the previous and the next day.

## 9.3 Fuel oil tank monitoring

### 9.3.1 Remote sounding gauge

The following shall be considered for data quality control purposes.

a) The remote sounding gauge shall be verified on board at intervals advised by the manufacturer but not exceeding 60 months.

b) Standard error range of the remote reading device shall be within 3 %.

c) Calibration and maintenance records of the remote reading device shall be available on board and shall be kept for a minimum of five (5) years.

d) Fuel oil tanks shall be measured directly on a regular basis to verify the validity of the remote reading device.

e) Measures shall be taken to ensure the validity of the measurements in the case of heavy weather.

### 9.3.2 Manual sounding measurement

The following shall be considered for data quality control purposes.

a) The sounding tape used shall be of sufficient length for the height of the tank to be gauged and markings shall be visible. It shall not be kinked or spliced.

b) Manual sounding measurement shall be avoided in heavy weather to prevent skewed values.

## 9.4 Distance travelled

The following shall be considered for data quality control purposes.

a) The distance travelled may be calculated with an electronic chart display and information system (ECDIS) installed on board the vessel and connected to a global navigation satellite system (GNSS) apparatus. The Master shall report the distance travelled through the daily messages (departure/noon/arrival) and record the distance travelled in the deck logbook.

b) In the event of a data gap related to distance travelled, while using an automated/electronic chart navigation system, the Master shall fill the gap by means of back-up methods such as terrestrial or celestial navigation being documented in the deck log book.

### 9.5 Hours underway

The following shall be considered for data quality control purposes.

a) The Master shall report the time as per the GPS (or the master clock(s)/local time zone or GMT) in the deck logbook and in the daily noon reports, arrival and departure. Hours underway shall be calculated at the end of each voyage and recorded on the voyage documents.

b) In the event of a data gap related to hours underway, the responsible operator shall immediately communicate with the Master, raise its existence and resolve it using the data from the statement of facts (SOF).

## 10 Direct $CO_2$ emissions measurement

A direct $CO_2$ emissions measurement is not required by regulation 22A of MARPOL Annex VI, but if a direct $CO_2$ emissions measurement is used as indicated in the IMO SEEMP, it should be as follows.

a) The method is based on the determination of $CO_2$ emission flows in exhaust gas stacks by multiplying the $CO_2$ concentration of the exhaust gas with the exhaust gas flow. In case of the absence and/or breakdown of direct $CO_2$ emissions measurement equipment, manual tank readings shall be conducted instead.

b) The direct $CO_2$ emissions measurement equipment applied to monitoring shall be located exhaustively so as to measure all $CO_2$ emissions in the ship.

c) The measurement device shall be calibrated in accordance with the manufacturer's guidance.

d) Calibration and maintenance records of the measurement device shall be available on board and shall be kept for a minimum of 12 months.

# Annex A
(informative)

# Example of a ship fuel oil consumption data collection plan

## A.1 Ship particulars

**Table A.1 — Example of format for documenting ship particulars**

| | |
|---|---|
| Name of ship | |
| IMO number | |
| Company | |
| Flag | |
| Ship type | |
| Gross tonnage | |
| Net tonnage | |
| DWT[a] | |
| | |
| | |

[a] DWT is the difference in displacement between the lightweight of ship and the summer load draught in water with a relative density of 1 025 kg/m$^3$. The summer load draught shall be the maximum summer draught specified in the stability booklet approved by the administration.

## A.2 Record of the revisions of the fuel oil consumption and data collection plan

**Table A.2 — Example of format for documenting the record of revisions**

| Date of revision | Revised provision |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

## A.3 Ship engines and other fuel oil consumers and fuel oil types used

**Table A.3 — Example of format for documenting consumers' data**

| | Engines and other fuel oil consumers | Power | Fuel oil types (primary/secondary) |
|---|---|---|---|
| 1 | Type/model of main engine | | |
| 2 | Type/model of auxiliary | | |
| 3 | Boiler | | |
| 4 | Inert gas generator | | |
| 5 | Gas turbines | | |

## A.4 Emission factor

The $C_F$ is a non-dimensional conversion factor between fuel oil consumption and $CO_2$ emissions in the 2014 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships (resolution MEPC.245(66)), as amended [4]. The annual total amount of $CO_2$ is calculated by multiplying the annual fuel oil consumption by $C_F$ for the type of fuel. Table A.4 provides a list of various fuel types and associated conversion factors.

**Table A.4 — Fuel types and conversion factors ($C_F$)**

| Fuel type | $C_F$ |
|---|---|
| Diesel/gas oil (e.g. ISO 8217 Grades DMX through DMB) | 3,206 |
| Light fuel oil (LFO) (e.g. ISO 8217 Grades RMA through RMK) | 3,151 |
| Heavy fuel oil (HFO) (e.g. ISO 8217 Grades RME through RMK) | 3,114 |
| Liquefied petroleum gas (LPG) (propane) | 3,000 |
| Liquefied petroleum gas (LPG) (butane) | 3,030 |
| Liquefied natural gas (LNG) | 2,750 |
| Methanol | 1,375 |
| Ethanol | 1,913 |
| Other | |

## A.5 Method to measure the fuel oil consumption

The applied method for the measurement of the fuel oil consumption of a ship is given below. The description refers to the appropriate Clause for measuring the data and for calculating the annual values, and for the measurement equipment required.

| Method | Description |
|---|---|
| ISO 23765 | Refer to ISO 23765:2021, Clause 5 |

## A.6 Method to measure the distance travelled

| Method | Description |
|---|---|
| ISO 23765 | Refer to ISO 23765: 2021,Clause 6 |

## A.7 Method to measure the hours underway

| Method | Description |
|---|---|
| ISO 23765 | Refer to ISO 23765: 2021, Clause 7 |

## A.8 Process to be used for reporting data to the administration

| Method | Description |
|---|---|
| ISO 23765 | Refer to ISO 23765: 2021, Clause 8 |

## A.9 Data quality

| Method | Description |
|---|---|
| ISO 23765 | Refer to ISO 23765: 2021, Clause 9 |

# Annex B
(informative)

# Guidance on technical specifications and test requirements for automatic data collection systems using fuel flow rate measuring devices for fuel consumption

## B.1 Introduction

This annex provides guidance on technical specifications and test requirements of an automatic data collection system using fuel flow rate measuring devices for fuel consumption which may be installed on board ships to collect data on the fuel consumption rate.

## B.2 Components of a data collection system

### B.2.1 General

The data collection system should measure, by fuel flow rate measuring devices, and record fuel consumption on board a ship.

The data collection system should be designed and constructed to satisfy the technical specifications in B.2.2 and the test requirements in B.3.

### B.2.2 Technical specifications

#### B.2.2.1 Data collection system

The data collection system should comprise:

a) a fuel flow rate measuring device to measure the rate of fuel consumption (B.2.2.2);

b) a fuel temperature measuring device to measure the fuel oil temperature (B.2.2.3);

c) a data collecting device with the following functions (B.2.2.4):

- a processor to calculate the fuel consumption;
- a data input interface to input data of fuel oil information;
- an alarm device;
- a recording device to record and store the data;
- a data display device to exhibit the current operational data.

#### B.2.2.2 Fuel flow rate measuring device

A fuel flow meter should be installed to measure fuel consumption of each of the main engines, auxiliary engine, boiler, inert gas generator and gas turbines.

#### B.2.2.3 Fuel oil temperature measuring device

A temperature sensor should be installed near the fuel flow rate measuring device so that the fuel oil temperature at the fuel flow measuring device is measured.

#### B.2.2.4 Data collecting device

##### B.2.2.4.1 Processor

a) The processor should receive signals from fuel flow rate measuring devices and fuel oil temperature measuring devices and should automatically compute the consumption rate (g/h) and integrated value (g) of fuel oil consumption.

b) If a volumetric flow meter is used, it should have a mass (kg) conversion function by temperature (°C) and density ($g/cm^2$).

c) In case it becomes necessary to collect the fuel consumption of consumers without the fuel flow rate measuring devices, the fuel consumption should be able to be manually input.

d) It should provide the ability for manual input of the density ($g/cm^2$) of each fuel oil.

e) The type of fuel oil used should be recorded.

f) The processor should normally include a device for the continuous generation of time and date information. It should be synchronized periodically with a global navigation satellite system (GNSS) date and time information.

g) In the event of power failure, the processor should retain its memory with respect to computation of the total quantity of fuel oil consumption, time and date.

h) A manual input function should be provided as an alternative measure to be used when equipment such as a fuel flow measuring device or fuel oil temperature measuring device falls.

##### B.2.2.4.2 Recording device

a) The recorded data should be retained on board the ship for at least 3 years.

b) The data to be automatically recorded should include at least the following:

- consumption of each type of fuel oil (g);
- consumption of each consumer (g);
- density of each type of fuel oil ($g/cm^2$);
- temperature of fuel oil at each fuel flow rate measuring device (°C);
- type of fuel oil;
- time and date (GMT);
- failure, if any (e.g. no signal);
- manual input action: any information inserted as a result of manual input action should be recorded.

##### B.2.2.4.3 Data display device

In addition to the recorded data, the current data should be visibly displayed and should at a minimum contain the following:

- consumption of each type of fuel (g);