# No. 151 Recommendation for fuel oil treatment systems

(July 2017) (Rev.1 Nov 2020)

## I Recommendation for the treatment of fuel oil on board ships

### 1 Application

The following provisions should apply to fuel treatment systems for oil fuelled machinery on board ships. The aim of these recommendations is to improve the operational safety of the vessel by improving reliability of the oil fuelled machinery. The provisions cover the complete fuel oil treatment system, from the fuel bunker connection through to the interface with the oil fuelled machinery; this includes fuel tanks, the fuel cleaning equipment and the fuel conditioning equipment.

This recommendation recognizes a disparity between the quality of fuel bunkered and delivered in accordance with ISO 8217:2017, and the fuel quality typically specified by marine diesel engine manufacturers. The performances of the system and equipment contained therein is fundamental to reducing the level of contaminants to within the oil fuelled machinery manufacturers specifications.

### 2 Definitions

2.1 A service tank is a fuel oil tank intended to contain only fuel of a quality ready for use, i.e. fuel with properties that meet the specification recommended by the equipment manufacturer.

2.2 Fuel oil means petroleum fuels for use in marine diesel engines and other machinery.

2.3 Fuel oil treatment system means a system intended for:

- Cleaning of the fuel oil by removal of water, catalyst fines (cat fines), water bound ash constituents (e.g. sodium) and particulate matter,

- Conditioning of the fuel oil to ensure efficient combustion.

(Note: The “fuel oil treatment system” does not cover the use of additives.)

2.4 Oil fuelled machinery means all machinery combusting fuel oil, including main and auxiliary engines, boilers, gas turbines.

### 3 System level objectives

#### 3.1 Functional objectives

The fuel oil treatment system should reduce the level of contaminants and condition the fuel such that it ensures the fuel is ready for use by the oil-fuelled machinery and that it has no detrimental effect on the reliability and safety of such machinery.

#### 3.2 Performance objectives

3.2.1 The capacity and arrangements of the fuel oil treatment system should be suitable for ensuring availability of treated fuel oil for the Maximum Continuous Rating (MCR) of the propulsion plant and normal operating load at sea of the generator plant.

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3.2.2 The capacity and arrangements of the fuel oil treatment system should be determined on the basis of the requirements of the oil fuelled machinery manufacturer and the types of fuel: Residual Marine Fuel (RMF), Distillate Marine Fuel (DMF) to be bunkered to the ship.

3.2.3 The fuel oil treatment system should be provided with redundancy so that failure of one system will not render the other system(s) inoperative. Arrangements should ensure that any single failure in the system will not interrupt the supply of clean fuel to machinery used for propulsion and electrical generating purposes where the fuel conditioning system is installed between fuel oil service tanks and the inlet to the combustion system.

3.2.4 Main bunker tanks should be arranged to limit the need to mix newly bunkered fuel with fuel already on-board. When mixing of fuel oil is necessary, a compatibility test should be performed prior to transfer.

3.2.5 The fuel oil at engine inlet should be of properties recommended by the engine manufacturer.

3.2.6 The maximum amount of water reaching the engine should be 0.3 % v/v or according to engine maker's recommendations.

3.2.7 The maximum amount of catalyst fines reaching the engine should be 10 ppm Al+Si and in some instances this might rise to 15 ppm however every attempt must be made to reduce the catalyst to the lowest possible levels. Note: Particle size has a significant influence on the capacity of the centrifugal separators to lower the level of catalyst fines in the fuel, with particles of 2 microns or less being particularly difficult to remove. The presence of particles of 2 microns size or lower may cause difficulties in achieving the 10 ppm limit. Engine manufacturer recommendations should also be referred to for any further system specific recommendations.

### 3.3 System interfaces

3.3.1 Bunkered fuels should meet ISO 8217:2017 or may meet an oil-fuelled machinery consumer manufacturers' specification.

#### 3.3.2 Sampling points

3.3.2.1 The fuel oil treatment system should be provided with sampling points.

3.3.2.2 The sampling points should meet MEPC.1/Circ.864/Rev.1 'Guidelines for on board sampling and verification of the sulphur content of the fuel oil used on board ships' (approved at MEPC74 in May 2019) and should be located as follows:

.1 after the transfer pump discharge,

.2 before and after the fuel cleaning equipment, and

.3 after the fuel oil service tank, before any fuel change over valve,

.4 before fuel enters the oil fuelled machinery.

3.3.2.3 Sampling points should be provided at locations within the fuel oil system that enable samples of fuel oil to be taken in a safe manner.

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3.3.2.4 The position of a sampling point should be such that the sample of the fuel oil is representative of the fuel oil quality passing that location within the system.

3.3.2.5 The sampling points should be located in positions as far removed as possible from any heated surface or electrical equipment so as to preclude impingement of fuel oil onto such surfaces on equipment under all operating conditions.

### 3.4 Verification

3.4.1 Review of plans and documents

3.4.1.1 Plans and documents demonstrating compliance with the recommendations included in section 3.4 should be submitted for consideration.

3.4.2 Shipboard verification

3.4.2.1 The fuel oil treatment system is recommended to be inspected by the Surveyor after installation on board to confirm that the arrangement, installation and workmanship are in accordance with the equipment specification and this recommendation.

3.4.2.2 The fuel oil treatment system should be provided with sampling cocks located in convenient positions e.g. at the transfer pump from the bunker tanks, before and after the centrifuges and after the service tank.

3.4.2.3 It is recommended that diagram of sampling points showing sampling points location be retained on board the ship and be presented to the surveyor during regular surveys.

3.4.2.4 It is recommended that records of fuel sample analysis according to ISO 8217:2017 be retained on board the ship and be presented to the surveyor during regular surveys.

3.4.2.5 It is recommended that a drip sample of fuel should be taken during bunkering in accordance with ISO 13739:2020, in particular its Section 9 and taking into account ISO 3170:2004 for manual sampling or ISO 3171:1988 for automatic sampling as applicable.

3.4.2.6 It is recommended that once a new bunker has started to be used, a fuel system audit is performed by a responsible person on board, taking fuel samples from before and after the treatment plant and at the engine fuel rail.

## 4 Equipment level objectives

### 4.1 Fuel tanks

#### 4.1.1 Functional objectives

4.1.1.1 Settling and service tanks for fuel oil should be designed and constructed in such a way as to direct water and sludge towards a drainage outlet.

4.1.1.2 If settling tanks are not provided, the fuel oil bunker (storage) and daily service tanks should be designed and constructed in such a way as to direct water and sludge towards a drainage outlet.

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### 4.1.2 Performance objectives

4.1.2.1 Provisions should be made so that fuel is maintained at a temperature commensurate with the needs of system equipment to function in accordance with manufacturers' requirements.

4.1.2.2 A temperature controller of PID type should be fitted to ensure that the fuel is maintained at the temperature required for optimum system performance.

### 4.1.3 Equipment interfaces

4.1.3.1 Open drains for removing the water from fuel tanks should be fitted with valves or cocks of the self-closing type.

4.1.3.2 A tank drain cock should not be considered as a sampling point.

4.1.3.3 Fuel suction points should be located at an appropriate distance above the tank drain point to prevent accumulated water and sludge being drawn into the fuel oil treatment system (e.g. a minimum 5% of the tank volume is below the suction of the high suction pipe).

4.1.3.4 It is recommended that at least one low suction point and one high suction point be provided on the settling and service tank.

### 4.1.4 Equipment Operations

4.1.4.1 Provision should be made for collecting the discharge from the fuel oil tank bottom drain valves. Appropriate access should be provided for personnel to enable tank maintenance operations to be conducted safely.

### 4.1.5 Physical characteristics

4.1.5.1 The bottoms of fuel settling tanks and fuel service tanks should slope towards the drainage outlet.

4.1.5.2 The internal surfaces of the bottoms of heavy fuel oil settling tanks and service tanks should be such that the passage of sludge to the lowest part of the tank is not restricted.

4.1.5.3 The materials and/or their surface treatment used for the storage and distribution of fuel oil should be selected such that they do not introduce contamination or modify the properties of the fuel.

4.1.5.4 The service tank overflow return line to the settling tank should be drawn from near the bottom of the service tank to the top of the settling tank to ensure any accumulating sediment in the service tank bottom is minimised.

### 4.1.6 Verification

4.1.6.1 Review of plans and documents

.1 Plans and documents demonstrating compliance with the recommendations of section 4.1 should be submitted for consideration.

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4.1.6.2 Manufacturing

.1 It is recommended to confirm that the sampling device is of an appropriate type recognized by the Society.

### 4.2 Fuel temperature management equipment

#### 4.2.1 Functional objectives

4.2.1.1 Heaters and coolers should safely manage the temperature of fuel oil, commensurate with the needs of the system design from storage to combustion machinery fuel rail. Cold Filter Plugging points and Cloud Points as well as the pour point for DMF fuels need to be considered in light of the ship's intended operating area and ambient temperatures.

4.2.1.2 When the engines use low viscosity DMF (~ 2,0 – 3,0 cSt at 40 °C) it is recommended to install a cooler to the fuel oil return line to ensure that minimum fuel injection viscosity specified by the equipment manufacturers can be maintained.

4.2.1.3 Fuel heater control should be able to respond quickly to sudden fuel flow changes to avoid overheating, for example, during the discharge cycles of the centrifugal separators.

4.2.1.4 The presence on board of spare heaters and coolers should be considered.

#### 4.2.2 Performance objectives

4.2.2.1 Where heating or cooling of the fuel oil is required for the efficient functioning of the fuel oil treatment system, a minimum of two heating or cooling units should be provided. Each heating or cooling unit should be of sufficient capacity to maintain the required temperature of the fuel oil for the required delivery flow rate.

4.2.2.2 Automatic viscosity controllers should be provided as the primary means to control required injection viscosity with manual temperature control being only a secondary back up options in order to ensure that the broadening range of fuel formulations to meet the lower sulphur limits for both inside and outside ECA-SOx operations is addressed smoothly and not overlooked by the crew.

#### 4.2.3 Equipment interfaces

4.2.3.1 Heaters and coolers should be located to avoid oil spray or oil leakages onto hot surfaces or other sources of ignition, or onto rotating machinery parts. Where necessary, shielding should be provided.

4.2.3.2 Heaters and coolers should be located to allow easy access for routine maintenance.

#### 4.2.4 Verification

4.2.4.1 Review of plans and documents

.1 Plans and documents demonstrating compliance with the recommendations of section 4.2 should be submitted for consideration.

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4.2.4.2 Manufacturing

.1 It is recommended that final testing of heaters and coolers be conducted in the presence of the Society's Surveyor or an Alternative Certification Scheme specified in UR Z26 be applied to manufacturing and testing. Alternatively, testing at an "accredited laboratory/testing facility" could be considered.

4.2.4.3 Shipboard verification

.1 It is recommended that satisfactory heater or cooler operation be verified after installation on board.

### 4.3 Pumps

#### 4.3.1 Functional objectives

4.3.1.1 Fuel pumps should be capable of pumping all grades of fuel expected within the section of fuel system to which they are fitted.

#### 4.3.2 Performance objectives

4.3.2.1 Fuel pump capacity should ensure that fuel flow rate through the fuel system is sufficient to maintain the installed oil-fuelled machinery's fuel consumption during normal operation, according to SOLAS Regulation II-1/26.3.

#### 4.3.3 Equipment interfaces

4.3.3.1 Fuel pumps should be protected from coarse and abrasive solids entering the pump. The degree to which such solids are filtered should be in accordance with the pump manufacturer's instructions.

4.3.3.2 Pumps should be located to allow easy access for routine inspection and maintenance.

#### 4.3.4 Verification

4.3.4.1 Review of plans and documents

.1 Plans and documents demonstrating compliance with the recommendations of section 4.3 should be submitted for consideration.

4.3.4.2 Manufacturing

.1 It is recommended that final testing of fuel pumps be conducted in the presence of the Society's Surveyor or an Alternative Certification Scheme specified in UR Z26 be applied to manufacturing and testing. Alternatively, testing at an "accredited laboratory/testing facility" could be considered.

4.3.4.3 Shipboard verification

.1 It is recommended that satisfactory fuel pump operation be verified after installation on board.

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### 4.4 Filters

#### 4.4.1 Functional objectives

4.4.1.1 Fuel filters should reduce the level of contaminants in the fuel in order to minimise wear or other damage to functional elements of the fuel system e.g. pumps and oil fuelled machinery.

#### 4.4.2 Performance objectives

4.4.2.1 Capacity of fuel filters should be sufficient to reduce the level of contaminants in the fuel to a level commensurate with the downstream equipment manufacturers' specifications.

#### 4.4.3 Equipment interfaces

4.4.3.1 Filters should be located to avoid oil spray or oil leakages onto hot surfaces or other sources of ignition, or onto rotating machinery parts. Where necessary, shielding should be provided.

4.4.3.2 Filters should be located to allow easy access for routine maintenance.

4.4.3.3 The arrangements of filters should be such that any unit can be cleaned without interrupting the supply of filtered oil to the combustion system.

4.4.3.4 The design of filter and strainer arrangements should be such as to avoid the possibility of them being opened inadvertently when under pressure.

#### 4.4.4 Equipment Operations

4.4.4.1 The design and construction of fuel filters should facilitate their safe maintenance and replacement of filter elements.

#### 4.4.5 Physical characteristics

4.4.5.1 Filters should be fitted in the fuel oil supply lines to each oil fuelled machinery to ensure that only suitably filtered oil is fed to the combustion system.

#### 4.4.6 Verification

4.4.6.1 Manufacturing

.1 The manufacturer should verify and document that each fuel filter meets the declared performance specifications.

4.4.6.2 Shipboard verification

.1 It is recommended that maintenance records for fuel oil filters be available to the surveyor during regular surveys.

.2 It is recommended that documentation be available to the surveyor which demonstrates that the correct fuel oil filter cleaning procedures and prescribed associated equipment are available.

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## 4.5 Centrifugal Separators

### 4.5.1 Functional objectives

4.5.1.1 Where necessary to ensure reliable operation of main propulsion machinery and all auxiliary machinery essential to the propulsion and the safety of the ship, centrifugal separators should remove water and particulates that would otherwise cause excessive wear or other related failures of the oil fuelled machinery.

### 4.5.2 Performance objectives

4.5.2.1 The total installed capacity of centrifugal separators should be determined as part of the overall system design in order to achieve the oil fuelled machinery manufacturers requirements for fuel quality. However, a minimum of two separators, each of a capacity to ensure reliable operation of the fuel oil fuelled machinery, should be fitted, and arranged so that they can be operated in parallel to address the removal of gross contamination of water and abrasives.

4.5.2.2 The performance of the separator should not be impaired by any equipment upstream or downstream of it in the system as recommended by the separator manufactures.

### 4.5.3 Equipment interfaces

4.5.3.1 Centrifugal separators should be located to avoid oil spray or oil leakages onto hot surfaces or other sources of ignition, or onto rotating machinery parts. Where necessary, shielding should be provided.

4.5.3.2 Centrifugal separators should be located to allow easy access for routine maintenance.

### 4.5.4 Equipment Operations

4.5.4.1 The design and construction of centrifugal separators should facilitate their maintenance in a safe manner.

### 4.5.5 Verification

4.5.5.1 Recognised standards

.1 Centrifugal separators should be certified for a flow rating in accordance with a recognised standard.

.2 Centrifugal separators should meet the safety requirements of a recognised standard, e.g. EN 12547:2014, Centrifuges — Common safety requirements.

4.5.5.2 Manufacturing

.1 It is recommended that final testing of centrifugal separators be conducted in the presence of the Society's Surveyor or an Alternative Certification Scheme specified in UR Z26 be applied to manufacturing and testing. Alternatively, testing at an "accredited laboratory/testing facility" could be considered.

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4.5.5.3 Shipboard verification

.1 It is recommended that correct operation of centrifugal separators be verified after installation on-board.

.2 It is recommended that maintenance records of centrifugal separators be available to Surveyors during regular surveys.

## II Tests procedures to confirm the ability of RMF fuel oil pumps operation with marine fuels with low viscosity

### 5 Application

5.1 The following provision should be applied to the fuel oil pumps used in the fuel oil treatment and transfer systems when operating with marine fuels with low viscosity.

5.2 The provision should be applied to:

- Primary essential services fuel oil pumps (main and stand-by) used in all services that need to be maintained in continuous operation. These include: separator fuel oil supply pumps; booster pumps, feeder pumps, fuel valve cooling pumps, (in systems which use fuel oil for this service).

- Fuel pumps that are not required to be in continuous operation, e.g. fuel oil transfer pumps.

### 6 Fuel oil pump arrangements

For ships intending to use RMF and/or DMF in non-restricted areas and marine fuels with a sulphur content not exceeding 0.10 % m/m and minimum viscosity of 2.0 cSt in emission control areas, the pump arrangements should be based upon MSC.1/Circ.1467 in compliance with SOLAS regulation II-I/26.3.4. (See also IACS UI SC255).

### 7 Tests procedures to confirm the ability of HFO fuel oil pumps operation with marine fuels with a sulphur content of 0.10% and a minimum viscosity of 2,0 cSt

#### 7.1 Testing

7.1.1 Each fuel oil pump intended for use in a fuel oil system on board a ship should be subjected to testing in the presence of the Society's Surveyor, or an Alternative Certification Scheme specified in UR Z26 should be applied to manufacturing and testing. Alternatively, testing at an "accredited laboratory/testing facility" could be considered.

7.1.2 Type tests carried out for a particular type of pump will be accepted for all pumps of the same type built by both Licensors and Licensees.

#### 7.2 Running test

7.2.1 A running test should be carried out with a minimum or lower viscosity fuel oil with a sulphur content of 0.10 % m/m or less specified in ISO 8217:2017 Specifications for Marine Fuels; recommended fuel oil viscosity value for the test should be 2,0 cSt at the fuel pump.

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7.2.2 The lubricity of fuel oil for running test should be less than 520 µm as determined by a high-frequency reciprocating rig test according to ISO 12156-1:2018.

7.2.3 The running test should be conducted for a minimum of 250 hours for pumps for both continuous and non-continuous operation and at a discharge pressure equal to the nominal pump pressure rating.

7.2.4 During the running test the following data should be verified:

- volume rate of flow Q [$m^3$/h]
- delivery head H [m]
- pump power input P [kW]
- speed of rotation n [min-1]

7.2.5 During the running test, the pump should be checked for smooth running (for example ISO 10816 series and/or ISO 20816-1:2016 could be used as a basis for acceptance) and bearing temperature. The assessment should be based on international standard or a Society's requirements, if applicable. This may be based on the pump manufacturer's in-house testing procedures acceptable to the Society.

**7.3 Pumps suitability**

7.3.1 All elastomeric components in the fuel oil system (e.g. diaphragms) should be made of fluoro-rubber or other material suitable for use with marine fuels according to MSC.1/Circ.1321.

7.3.2 Displacement pumps should be fitted with relief valves. The discharge from the relief valve is normally to be led back to suction side of the pump.

7.3.3 The maximum amount of catalyst fines reaching the engine should be 10 ppm Al+Si and in some instances this might rise to 15 ppm however every attempt must be made to reduce the catalyst to the lowest possible levels. Note: Particle size has a significant influence on the capacity of the centrifugal separators to lower the level of catalyst fines in the fuel, with particles of 2 microns or less being particularly difficult to remove. The presence of particles of 2 microns size or lower may cause difficulties in achieving the 10 ppm limit. Engine manufacturer recommendations should also be referred to for any further system specific recommendations.

7.3.4 Dedicated continuous monitoring of the quantity of cat fines between the pump and the service tank outlet should be considered. If continuous monitoring of cat fines is not implemented, and the fuel type used is RMF, then weekly sampling and analysing of cat fine level at service tank outlet is recommended to ensure that cat fine level doesn't exceed maximum level.

7.3.5 Compatibility test kits, approved or recommended by the fuel oil manufacturer, should be used when bunkering two or more different fuel types, e.g. a high sulphur and low 0,10 % m/m sulphur fuel.

7.3.6 An automated fuel oil changeover valve/system or manual valve/system that can provide for timed changeover of fuel oil from one type to another should be provided and done in accordance with the engine manufacturers' recommendation.

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7.3.7 Each vessel or installation should have established procedures for fuel oil changeover and crew should be trained how to do it safely.

**7.4 Verification of pump design and test documentation**

7.4.1 All types of fuel oil pumps used for operation with low-sulphur fuel oil installed on-board should be tested and the evidence of test should be kept on-board.

7.4.2 The scope of design documentation supplied by the pump manufacturer and kept on board should include:

- Pump(s) arrangement drawing, pump installation diagram with position and characteristics of sensors/monitoring system details,
- List of components with characteristics of materials critical for reliable operation of pump,
- Sealing arrangements,
- Reliability and life cycle data,
- Operational manual with performance and life cycle guidance,
- Test programme of the pump(s) for class survey.

7.4.3 The following certificates are required to be submitted and attached to the pump documentation:

7.4.3.1 The running test certificate containing:

- Manufacturer details,
- The test stand location and accreditation – approval details,
- Pump type and serial number,
- Duration of test,
- Viscosity of used medium,
- Parameters as mentioned in 7.2,
- Minimum operating temperature,
- Result of running test,

7.4.3.2 Hydraulic test certificate.

7.4.3.3 Materials certificates.

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