Guideline No.M-29(202603)

# M-29

# METHANOL-FUELLED ENGINES

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**Foreword**

China Classification Society (hereinafter referred to as CCS) Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed service@ccs.org.cn.

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Main changes: None

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# METHANOL-FUELLED ENGINES

## 1 Application

1.1 This Guideline applies to the plan approval, type approval and product inspection of methanol-fuelled engines (including dual-fuel engines and single-fuel engines) for main propulsion, generator drive and auxiliary machinery.

1.2 The emissions of methanol-fuelled engines shall comply with the relevant statutory requirements.

## 2 Normative references

(1) CCS Rules for Classification of Sea-Going Steel Ships

(2) CCS Rules for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk

(3) CCS Guidelines for the Application of Methanol/Ethanol as Marine Fuels

(4) IMO MSC.1/Circ.1621 Interim Guidelines for the Safety of Ships Using Methanol or Ethanol as Fuel

(5) ISO 6583:2024 Methanol as a fuel for marine applications - General requirements and specifications

(6) MSA Interim Rules for the Technology and Inspection of Alcohol-Fuelled Power Ships

(7) GB/T 338-2025 Methanol for industrial use

(8) GB/T 42416-2023 M100 Methanol fuel for motor vehicles

For dated reference documents cited in this Guideline, only the editions with the indicated dates apply. For undated reference documents, the latest editions (including all amendments) shall apply.

## 3 Terms and definitions

3.1 The definitions given in the CCS Rules for Classification of Sea-Going Steel Ships and CCS Guidelines for the Application of Methanol/Ethanol as Marine Fuels are applicable to this Guideline.

3.2 The additional definitions for this Guideline are as follows:

(1) Pilot fuel ratio: The ratio of the calorific value corresponding to the pilot fuel injection per working cycle of a methanol-fuelled engine to the total calorific value corresponding to the fuel injection per working cycle of the engine at the rated power.

(2) Fuel substitution ratio: The ratio of the calorific value corresponding to the methanol injection per working cycle of a methanol-fuelled engine to the total calorific value corresponding to the injection of all fuels per working cycle of the engine.

(3) Net calorific value: The heat released when a unit quantity of fuel is completely combusted and the water vapor in the combustion products remains in the gaseous state (uncondensed).

**4 Drawings and documents**

4.1 In addition to the drawing requirements specified in 9.1.12 of Chapter 9, Part 3 and Appendix 10 of the CCS Rules for Classification of Sea-Going Steel Ships, the following plans and technical documents shall be submitted to CCS for approval (where applicable):

(1) Layout drawing of crankcase ventilation and gas concentration measurement, layout drawing of oil mist concentration detector (or engine bearing temperature monitor or equivalent device) and methanol leakage detector;

(2) Schematic diagram of purging system or inerting system;

(3) Schematic diagram of control oil and sealing oil systems;

(4) Safety philosophy;

(5) Other drawings as deemed necessary by CCS.

4.2 The following plans and technical documents shall be submitted to CCS for information:

(1) Design description, including the working principle and control mode of the methanol-fuelled engine;

(2) Operation manual (including the emergency handling procedure for methanol leakage).

**5 Technical requirements**

5.1 Methanol-fuelled engines shall specify the applicable range of key physical and chemical indicators of methanol (including methanol content, water content, net calorific value, etc.), which shall generally comply with ISO 6583:2024, GB/T 338, GB/T 42416 or other applicable standards.

5.2 The design of components in contact with methanol shall be based on the following safety principles:

(1) Minimize the risk of fire and explosion to demonstrate a safety level equivalent to that of fuel oil engines.

(2) If explosion-proof safety valves are fitted, or the strength design of components is sufficient to withstand the overpressure generated by the ignition of leaked methanol under the worst-case conditions, the consequences of explosion shall be mitigated to an acceptable level of residual risk. The specific implementation of this design principle (e.g. installation of safety relief valves, adequate structural reinforcement) shall comply with recognized explosion-proof standards (e.g. IEC 60079 series) or analytical verification methods accepted by CCS.

5.3 Methanol pipelines on methanol-fuelled engines shall additionally comply with the following provisions:

(1) Interfaces for inerting or purging the methanol fuel piping system shall be provided;

(2) The installation and arrangement of methanol pipelines shall have necessary flexibility to adapt to the rolling or vibration of the methanol-fuelled engine and prevent fatigue damage at the joints between the pipelines and the engine;

(3) Butt welds with full penetration at the root shall be used as far as possible for pipeline connections, and flange connections shall be minimized. Metallic materials sensitive to methanol such as aluminum alloys, galvanized steel and lead alloys shall not be used. Acceptable metallic materials include but are not limited to austenitic stainless steel and duplex stainless steel. Non-metallic materials sensitive to methanol such as nitrile rubber and butyl rubber shall not be used for gaskets in flange connections. Acceptable non-metallic materials include but are not limited to polytetrafluoroethylene (PTFE), perfluoroelastomer (FFKM) and ethylene propylene diene monomer (EPDM);

(4) Where insulating isolation is adopted between pipelines or pipe joints, hose joints and the hull structure, electrical earthing measures shall be provided;

(5) Methanol pipelines shall be marked with a uniform color or identification.

5.4 Dual-fuel engines shall be capable of rapidly switching from methanol mode to fuel oil mode under all conditions and power levels. The switch from fuel oil mode to methanol mode shall only be carried out at the specified power levels and conditions, for which the safety and reliability of the mode switch have been verified by tests.

5.5 Pilot fuel system:

(1) The quantity of pilot diesel fuel shall ensure the reliable ignition of methanol; the supply of methanol fuel to the combustion chamber shall be immediately stopped in the event of failure of pilot fuel injection.

(2) Pilot fuel injection shall be monitored, and the supply of methanol fuel to the combustion chamber shall be stopped in case of failure.

(3) For normal shutdown and emergency shutdown, the cut-off of methanol fuel supply shall not be later than the cut-off of the ignition source. When cutting off the ignition source, it shall be ensured that the methanol fuel supply to each cylinder or the entire engine is cut off in advance or simultaneously.

5.6 Ignition systems such as spark plugs and glow plugs:

(1) In the event of ignition failure of the ignition system, the methanol-fuelled engine shall be shut down, unless the ignition fault is limited to one cylinder, the methanol fuel supply to the faulty cylinder can be immediately cut off, and the safe operation of the engine with one cylinder out of service has been verified by risk analysis and tests, in which case continuous operation of the engine is acceptable.

(2) For normal shutdown and emergency shutdown, the cut-off of methanol fuel supply shall not be later than the cut-off of the ignition source. When cutting off the ignition source, it shall be ensured that the methanol fuel supply to each cylinder or the entire engine is cut off in advance or simultaneously.

5.7 Process control requirements

In addition to complying with the general requirements for the manufacturing process control of diesel engines specified in Chapter 9, Part 3 of the CCS Rules for Classification of Sea-Going Steel Ships, the manufacturing process control for components in contact with methanol shall be additionally implemented for methanol engines:

(1) The welding procedure for methanol pipelines shall be qualified.

(2) For components in contact with methanol subject to surface treatment (e.g. plating, passivation), relevant process documents shall be provided.

**6 Materials and components**

6.1 The materials and components of the product shall be controlled in accordance with the relevant requirements of the current CCS Rules and Chapter 3 of the CCS Guidelines for the Application of Methanol/Ethanol as Marine Fuels.

6.2 Additional components and their requirements for methanol engines:

(1) Engine-mounted methanol pipelines and accessories: Including double-wall pipes, valves, joints, bellows, etc., the materials shall be resistant to methanol corrosion. Acceptable metallic materials include but are not limited to austenitic stainless steel and duplex stainless steel.

(2) Methanol injectors/valves (high pressure/low pressure): Shall be resistant to the swelling effect of methanol. Sealing elements shall be made of materials including but not limited to polytetrafluoroethylene (PTFE), perfluoroelastomer (FFKM) and ethylene propylene diene monomer (EPDM).

(3) Methanol pressurization device: Maintains the stability of the supply pressure of high-pressure methanol, generally including booster pumps, pressure regulators, common rails and other components; the materials shall be resistant to methanol corrosion and high pressure.

(4) Methanol leakage detector (if fitted): When the methanol concentration or liquid level triggers an audible and visual alarm, the engine shall switch to fuel oil mode (for dual-fuel engines) or shut down (for single-fuel engines).

(5) Electronic control system for methanol-fuelled engines: Including methanol injection control module and monitoring and alarm module.

(6) Sealing oil system: Used for the lubrication and sealing of high-pressure methanol injection valves, and shall prevent chemical reactions (e.g. esterification) between methanol and sealing oil that may cause failure of the sealing oil.

(7) Inert gas (or other means) purging pipelines and accessories: Including double-wall pipes, valves, joints, bellows, etc., the materials shall be resistant to methanol corrosion (e.g. austenitic stainless steel, duplex stainless steel).

6.3 Among the above components, product certificates shall be provided for methanol pipelines and valves, as well as cast steel or forged cylinder heads (with cylinder bore＞300 mm or single-cylinder power＞400 kW); approval certificates shall be provided for the electronic control system of methanol-fuelled engines; hydraulic test reports shall be provided for methanol injection valves and methanol pressurization devices; manufacturer's quality certificates or test reports shall be provided for other components.

**7 Type test**

7.1 Selection principles for approval prototypes

7.1.1 Low-speed engines: A representative model manufactured in accordance with the approved drawings and verified to be reliable through factory tests shall be selected.

7.1.2 Medium and high-speed engines: A model with higher enhanced performance indicators that reflects the manufacturer's production level shall be selected.

7.1.3 The models of methanol-fuelled engines shall be classified by: methanol supply pressure (high pressure/low pressure), injection method (direct injection/premixed injection), and ignition method (pilot diesel ignition, spark plug ignition, glow plug ignition, etc.).

7.2 Type test items

7.2.1 The manufacturer's test bench, as the approval test site, shall be capable of completing the test items specified in the test program. CCS shall verify and confirm that the test capability, testing means and test personnel meet the requirements.

7.2.2 Prior to the test, it shall be ensured that all safety systems and equipment are in normal operation. In particular, the strength and tightness of the methanol supply system shall be reliable, the system shall operate normally, and the safety system shall be dependable; the measuring instruments used for the test shall have valid metrological verification certificates.

7.2.3 The type test of methanol-fuelled engines shall be carried out in accordance with the provisions of Appendix 4 and Appendix 10 of Chapter 9, Part 3 of the CCS Rules for Classification of Sea-Going Steel Ships. In addition to complying with Table 7.2.1 of CCS Guideline M01 for Diesel Engines and Their Important Components, the specific test items, methods and requirements shall include the following additional tests:

**Table 7.2.3 Additional Type Test Items, Methods and Requirements for Methanol-Fuelled Engines**

| No. | Test Item | Test Method and Requirements |
|---|---|---|
| 1 | Tightness Test of Double-Wall Methanol Piping System | 1. Prior to the operation of the methanol-fuelled engine, the air/liquid tightness of all methanol pipelines (including purging pipelines) installed on the engine shall be verified, with the test pressure generally being the design pressure of the pipeline system.<br>2. A ventilation function test shall be conducted for vented double-wall pipes. The suction-type mechanical ventilation system shall provide a ventilation capacity of at least 30 air changes per hour. |
| 2 | Safety Protection/Alarm Test for Methanol Mode | 1. Tests shall be carried out in accordance with the monitoring items specified in Table 1 Monitoring and Safety Protection for Methanol/Ethanol-Fuelled Engines of Appendix 10, Chapter 9, Part 3 of the CCS Rules for Classification of Sea-Going Steel Ships.<br>2. If methanol leakage sensors are fitted on the engine, a simulated alarm test shall also be conducted to verify the effectiveness of the alarm system. |
| 3 | Load point and function test under methanol mode | 1,Load point and function tests shall be carried out in accordance with the power and speed diagram shown in Figure 2.2.3 of Appendix 4 to Chapter 9, Part 3 of the Rules for the Classification of Sea-going Steel Ships.<br>2,The methanol mode of dual-fuel engines may not be required to undergo the 110% load test. |
| 4 | Operation Mode test for dual-fuel engines | 1. Carry out the switch between methanol and fuel oil operating modes in accordance with the switch operating condition range set by the manufacturer, and record the power fluctuation and response time. The switch from methanol mode to fuel oil mode shall be possible under all operating conditions.<br>2. The switch from fuel oil mode to methanol mode of the engine shall be automatic, and the switch process shall be capable of being manually interrupted under all circumstances.<br>3. When the engine power drops below the minimum power for methanol mode, the engine shall automatically switch to fuel oil mode. |
| 5 | Determination of fuel substitution ratio | 1. Determine the pilot fuel ratio for single methanol-fuelled engines.<br>2. Determine the fuel substitution ratio for dual-fuel engines (at least including the 75% rated load point). |

## 8 Unit/batch inspection

The unit/batch inspection after approval shall comply with the unit/batch inspection requirements of CCS Guideline M01 for Diesel Engines and Their Important Components and the relevant requirements of Table 7.2.3 of this Guideline, among which only a blow-through test is required for the annular space of the ventilation type double-wall pipe.

For the on-board conversion of conventional diesel engines to methanol dual-fuel engines, tests shall be applied for to a CCS surveyor in accordance with the manufacturer's technical requirements, and the converted engines shall meet the same safety protection and test conditions as those for the type approval test. If the test conditions cannot be achieved (e.g. performance test at 100% load), an alternative scheme may be applied for to the surveyor.