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RULES FOR PREVENTIVE MACHINERY MAINTENANCE SYSTEMS

Chapter 1 GENERAL

1.1 General

1.1.1 Scope

The Rules for Preventive Machinery Maintenance Systems (hereinafter referred to as “the Rules”) apply to all systems provided for preventive maintenance of machinery, organically integrating condition monitoring and diagnostic systems as well as maintenance management systems for main propulsion machinery, etc. (hereinafter referred to as the “preventive machinery maintenance systems”) of ships classified or intended to be classified by the NIPPON KAIJI KYOKAI (hereinafter referred to as “the Society”) and intended to comply with [Chapter 3 of the Regulations for the Classification and Registry of Ships](#).

1.1.2 Equivalency*

Preventive machinery maintenance systems which do not fully comply with the requirements of the Rules may be accepted provided that they are deemed by the Society to be equivalent to those specified in the Rules.

1.1.3 Preventive Machinery Maintenance Systems with Novel Design Features

In the case of preventive machinery maintenance systems with novel design features, the Society may impose, to the extent that is practically applicable, all appropriate requirements of the Rules as well as any additional requirements made on design and test procedures other than those specified in the Rules.

1.1.4 Modification of Requirements*

In cases where considered appropriate, the Society may modify parts of any requirements specified in the Rules after taking into consideration the national requirements of ship flag states, ship type and intended service areas of ships.

1.1.5 Definitions

The definitions of those terms which appear in the Rules are specified as following (1) and (2):

- (1) “Condition monitoring and diagnostic systems” are those systems that monitor operating conditions of main propulsion machinery, etc., with sensors and output useful information for preventive maintenance by diagnosing the performance and the conditions of any equipment or their components on the basis of monitored data.
- (2) “Preventive maintenance management systems” are those systems that manage preventive maintenance plans on the basis of information received from condition monitoring and diagnostic systems, and include plans and execution of maintenance and inspection for each piece of equipment and its components.

Chapter 2 SURVEYS

2.1 General

2.1.1 Kinds of Surveys

Surveys are to be of the following kinds:

- (1) Surveys for registration of preventive machinery maintenance systems (hereinafter referred to as “registration surveys”).
- (2) Surveys for maintaining such registration (hereinafter referred to as “registration maintenance surveys”)

The kinds of registration maintenance surveys are to be as follows:

- (a) Special Surveys
- (b) Annual Surveys
- (c) Occasional Surveys
- (d) Unscheduled Surveys

2.1.2 Period of Surveys*

- 1 Registration Surveys are to be carried out at the time of application for registration.
- 2 Registration Maintenance Surveys are to be carried out at the following intervals:
 - (1) Special Surveys are to be carried out at those intervals specified in **1.1.3-1(3), Part B of the Rules for the Survey and Construction of Steel Ships**.
 - (2) Annual Surveys are to be carried out at those intervals specified in **1.1.3-1(1), Part B of the Rules for the Survey and Construction of Steel Ships**.
 - (3) Notwithstanding above (1) and (2), Occasional Surveys are to be carried out independently of Special Surveys and Annual Surveys in cases. To implement the survey, in lieu of the traditional ordinary surveys where a surveyor is in attendance, the Society may approve survey methods which it considers to be appropriate.
 - (a) In cases where any main parts of systems have been damaged, repaired or renewed
 - (b) In cases where any systems have been modified or altered
 - (c) In cases where considered necessary by the Society.
 - (4) The classed ships may be subject to Unscheduled Surveys when the confirmation of the status of systems by survey is deemed necessary in cases where the Society considers the systems to be subject to **1.4-3 of the Conditions of Service for Classification of Ships and Registration of Installations**.

2.1.3 Special Surveys and Annual Surveys Carried Out in Advance, etc.

- 1 Surveys carried out in advance

The requirements for Special Surveys and Annual Surveys carried out in advance are to be in accordance with those provisions specified in **1.1.4, Part B of the Rules for the Survey and Construction of Steel Ships**.

- 2 Postponement of Special Surveys

The requirements for the postponement of Special Surveys are to be in accordance with those provisions specified in **1.1.5-1(1) or 1.1.5-1(2), Part B of the Rules for the Survey and Construction of Steel Ships**.

2.1.4 Preparation for Surveys

- 1 All such preparations required for surveys to be carried out as well as any preparations which may be required by Surveyors as necessary in accordance with the requirements given in the Rules are to be made by survey applicants. Such preparations are to include necessary facilities and necessary records for survey execution. Any inspection, measuring and test equipment, which Surveyors rely on to make decisions affecting classification are to be individually identified and calibrated to standards deemed appropriate by the Society. However, Surveyors may accept simple measuring equipment (*e.g.* rulers, measuring tapes, weld gauges, micrometers) without individual identification or confirmation of calibration, provided that they are of standard commercial design, properly maintained and periodically compared with other similar equipment or test pieces. Surveyors may also accept equipment fitted on board a ship and used in the examination of shipboard equipment (*e.g.* pressure, temperature or rpm gauges and meters) based either on calibration

records or comparison of readings with multiple instruments.

2 Survey applicants are to arrange supervisors who are well conversant with those survey items intended for survey preparation in order to provide any necessary assistance to Surveyors according to their requests during surveys.

3 Surveys may be suspended in cases where the necessary preparations have not been made, any appropriate supervisor mentioned in the -2 above is not present, or Surveyors consider that safety for survey execution is not ensured.

2.1.5 Disposition when Repairs are Considered Necessary

In cases where repairs are deemed necessary by the Surveyor or as a result of a survey, survey applicants are to make all necessary repairs to the satisfaction of the Surveyor.

2.1.6 Laid-up Ships

1 Laid-up ships are not subject to Registration Maintenance Surveys. However, Occasional Surveys may be carried out at the request of owners.

2 When laid-up ships are about to be re-entering service, the following surveys and surveys for specific matters which have been postponed due to being laid-up, if any, are to be carried out.

- (1) If the due dates for Registration Maintenance Surveys have not transpired while the ship was laid-up, then an equivalent to the Annual Surveys specified in 2.3.2 is to be carried out.
- (2) If the due dates for Registration Maintenance Surveys have transpired while the ship was laid-up, then these Registration Maintenance Surveys are, in principle, to be carried out. However, in cases where Special Surveys and Annual Surveys are due, only the Special Surveys may be carried out.

2.2 Registration Surveys

2.2.1 Drawings and Data

In the case of preventive machinery maintenance systems intended for registration, three copies of the following drawings and data are to be submitted to the Society for approval.

- (1) Drawings and data concerning the preventive machinery maintenance systems
 - (a) System specifications and particulars
 - (b) Equipment and components monitored by such systems
 - (c) Drawings showing system configurations and arrangements
 - (d) Procedures for sea trials
 - (e) Any other drawings and data deemed necessary by the Society
- (2) Drawings and data concerning condition monitoring and diagnostic systems
 - (a) Instruction manuals for system functions and usage
 - (b) Condition monitoring and diagnostic procedures and sensor lists
 - (c) Kinds and contents of information to be outputted
- (3) Drawings and data concerning preventive maintenance management systems
 - (a) Instruction manuals for system functions and usage
 - (b) Contents of Preventive maintenance plans
- (4) Any other drawings and data deemed necessary by the Society

2.2.2 Shop Tests*

After manufacture, preventive machinery maintenance systems are to be subjected to the following tests. To implement surveys for tests, in lieu of traditional ordinary surveys where the Surveyor is in attendance, the Society may approve other survey methods which it considers to be appropriate in the following cases.

- (1) Environmental tests

Fixed detectors (temperature sensors, pressure sensors, revolution sensors, piston ring surveillance sensors, etc.) are to be subjected to those environmental tests specified in **18.7.1(1) Part D of Rules for the Survey and Construction of Steel Ships** at places of manufacture. Procedures for such tests are to be as deemed appropriate by the Society.
- (2) Completion tests

All components of condition monitoring and diagnostic systems are to be subjected to those tests specified in **18.7.1(2), Part**

D of the Rules for the Survey and Construction of Steel Ships after assembly has been completed. Procedures for such tests are to be as deemed appropriate by the Society.

2.2.3 Sea Trials*

1 Condition monitoring and diagnostic systems are to be inspected and tested in accordance with those test procedures submitted in advance to confirm that they function satisfactorily. Such test procedures are to at least include the following items for confirmation:

- (1) Condition monitoring functions and diagnostic functions of systems while ships are navigating at the output ranges of main engines
- (2) Condition monitoring functions and diagnostic functions of those systems for auxiliaries for main propulsion machinery subject to condition monitoring during normal seagoing conditions

2 Preventive maintenance management systems are to be inspected and tested in accordance with those test procedures submitted in advance to confirm that they function satisfactorily. Such test procedures are to at least include tests to confirm that such preventive maintenance management systems are capable of functioning as planned based on data received from condition monitoring and diagnostic systems.

2.3 Registration Maintenance Surveys

2.3.1 Special Surveys*

1 During Special Surveys, condition monitoring and diagnostic systems and maintenance management systems are to be subjected to general examination and performance tests to ensure that they are in good order.

2 The requirements for such general examination and performance tests may be suitably modified based on appropriate routine maintenance records and any records of previous surveys.

3 In the case of condition monitoring and diagnostic systems, sea trials may be requested after completion of any of the performance tests mentioned in **-1** above in cases where considered necessary by the Society.

2.3.2 Annual Surveys

During Annual Surveys, condition monitoring and diagnostic systems are to be subjected to general examination and performance tests. However, in cases where appropriate records of daily checks and periodical maintenance have been kept, parts of these tests may be omitted at Surveyor discretion.

2.3.3 Occasional Surveys*

During Occasional Surveys, inspections or tests or investigation are to be carried out on necessary items according to individual cases to the satisfaction of Surveyors. To implement the survey, in lieu of the traditional ordinary surveys where a surveyor is in attendance, the Society may approve survey methods which it considers to be appropriate.

2.3.4 Unscheduled Surveys

At Unscheduled Surveys, investigations, examinations or tests are to be made to the satisfaction of the Surveyor with respect to the matters concerned.

Chapter 3 PREVENTIVE MACHINERY MAINTENANCE SYSTEMS

3.1 General

3.1.1 Scope

The requirements of this Chapter apply to those preventive machinery maintenance systems comprising condition monitoring and diagnostic systems as well as preventive maintenance management systems.

3.2 Condition Monitoring and Diagnosis Systems

3.2.1 General*

Condition monitoring and diagnostic systems are to comply with the following requirements (1) through (6):

- (1) Condition monitoring and diagnostic systems are to be capable of diagnosing the deterioration of any equipment or equipment components either independently or integrally based on the data obtained from centralized machinery monitoring and control systems or data obtained directly from sensors monitoring the conditions of such equipment or its components. Sensors used for these systems are to be of a fixed type. However, in cases where providing fixed sensors is unpractical and the Society considers portable sensors capable of providing data equivalent in quality to fixed-type sensors, the above requirement may be dispensed with.
- (2) In cases where condition monitoring and diagnostic systems collect data via alarms and monitoring systems, such systems are not to have any adverse effect on these alarms and monitoring systems.
- (3) Data analysis functions of condition monitoring and diagnosis systems are to satisfy requirements (a) to (c) below:
 - (a) Condition monitoring is to be carried out from the trend of data changes and to be capable of indicating the results of condition diagnosis in forms that are readily understandable.
 - (b) Trend analysis of condition monitoring data is to be suitable for easy execution.
 - (c) In the case of main engines, measurements at all measuring points to be scanned by condition monitoring systems for each output range are to be taken during shop trials or sea trials, they are to be taken as the initial values for condition monitoring, and these initial value data are to be used as reference values for condition monitoring. In the cases of condition-monitored auxiliaries for propulsion machinery, measurements at all measuring points under the normal sea-going conditions are to be taken during sea trials, and they are to be used as reference values for condition monitoring.
- (4) Monitored condition data are to be capable of being regularly stored in memory devices of computers, recalled and displayed arbitrarily. Furthermore, trend data are to be capable of being displayed in readily visible ways either independently or in combination with other data.
- (5) Condition monitoring and diagnostic systems are to be provided with suitable interface units to make back-ups of databases.
- (6) Computers used for condition monitoring and diagnostic systems are to satisfy requirements (a) through (e) given below:
 - (a) Computers are to be configured so that the effects of any system failures in parts of any circuits or devices can be limited to a certain degree as far as possible.
 - (b) System components are to be protected against any overvoltage (electrical noise) likely to enter through input/output terminals.
 - (c) Central processing units and important peripheral devices are to have self-monitoring functions.
 - (d) Important programmes and data are not to be deleted in the event of any temporary failures of external power supply sources.
 - (e) Spare parts for important system components that require specialist services for repairs are to be supplied in readily replaceable part units.

3.2.2 Equipments and Components subject to Monitoring and Diagnosis Scheme

The items of equipment and their components subject to monitoring and diagnosis scheme are to include the following (1) through (4):

- (1) Reciprocating internal combustion engines used as main propulsion machinery
 - (a) Parts around combustion chambers
 - (b) Main bearings
 - (c) Turbochargers
- (2) Turbines used as main propulsion machinery
 - (a) Turbine rotors
 - (b) Turbine rotor bearings
 - (c) Rotor thrust bearings
- (3) Propulsion power transmission systems
 - (a) Thrust bearings of propulsion shafting systems
 - (b) Reduction gear bearings of propulsion shafting systems
- (4) Prime movers driving generators
 - (a) Reciprocating internal combustion engines
 - (b) Steam turbines

3.2.3 Condition Monitoring and Diagnostic Functions for Reciprocating Internal Combustion Engines used as Main Propulsion Machinery*

Condition monitoring and diagnostic functions for reciprocating internal combustion engines used as main propulsion machinery are, at least, to comply with the following requirements (1) through (8):

- (1) Condition monitoring sensors are to be provided for temperature, pressure and all other operating parameters given in [Table 3.1](#).
- (2) Cylinder pressure sensors, scavenging air pressure sensors and crank angle sensors are to be provided in order to monitor combustion conditions.
- (3) Sensors for suitably monitoring the condition of cylinder liners and piston rings are to be provided.
- (4) Sensors for suitably monitoring the condition of main bearings are to be provided.
- (5) Sensors for suitably monitoring any deterioration in the performance of turbochargers are to be provided.
- (6) Conditions of the lubricating oil of main engines are to be monitored.
- (7) Condition monitoring and diagnostic systems are to have functions for monitoring combustion conditions in each cylinder, the condition of parts around combustion chambers as well as the condition of each main bearing and turbochargers based on data from those sensors specified in (1) through (5) above and the condition of those lubricating oils specified in (6) above.
- (8) Condition monitoring and diagnostic systems are to have functions for diagnosing combustion conditions in each cylinder, the condition of parts around combustion chambers as well as the condition of each main bearing and turbochargers based on the information described in (7) above.

3.2.4 Condition Monitoring and Diagnostic Functions for Turbines used as Main Propulsion Machinery*

Condition monitoring and diagnostic functions for turbines are, at the very least, to comply with the following requirements (1) through (5):

- (1) Condition monitoring sensors are to be provided for temperature, pressure and other operating parameters given in [Table 3.2](#).
- (2) Sensors for directly and suitably monitoring the condition of rotor shaft bearings are to be provided.
- (3) Condition of the lubricating oil of turbines is to be monitored.
- (4) Condition monitoring and diagnostic systems are to have functions for monitoring the conditions of turbine rotors and rotor bearings based on data from those sensors specified in (1) and (2) above and the condition of those lubricating oils specified in (3) above.
- (5) Condition monitoring and diagnostic systems are to have functions for diagnosing the conditions of turbine rotors and rotor bearings based on the information described in (4) above.

3.2.5 Condition Monitoring and Diagnostic Functions for Power Transmission Systems*

Condition monitoring and diagnostic functions for power transmission systems are, at the very least, to comply with the

following requirements (1) through (4):

- (1) Sensors for directly monitoring the condition of thrust bearings of propulsion shafting systems and each bearing of reduction gear installations are to be provided.
- (2) Condition of the lubricating oil of power transmission systems is to be monitored.
- (3) Condition monitoring and diagnostic systems are to have functions for monitoring the conditions of power transmission systems based on data from those sensors specified in (1) above and monitoring the temperatures of stern tube bearings.
- (4) Condition monitoring and diagnostic systems are to have functions for diagnosing the conditions of power transmission systems based on the information described in (3) above.

3.2.6 Condition Monitoring and Diagnostic Functions for Prime Movers Driving Generators *

Condition monitoring and diagnostic functions for prime movers driving generators are, at the very least, to comply with the following requirements:

- (1) Reciprocating internal combustion engines driving main generators
 - (a) Condition monitoring sensors are to be provided for temperature, pressure and all other operating parameters given in **Table 3.3**.
 - (b) Condition of the lubricating oil of engines is to be monitored.
 - (c) Condition monitoring and diagnostic systems are to have functions for monitoring the condition of engines based on data from those sensors specified in (a) and the condition of those lubricating oils specified in (b) above.
 - (d) Condition monitoring and diagnostic systems are to have functions for diagnosing the condition of engines based on the information specified in (c) above.
- (2) Turbines driving main generators
 - (a) Condition monitoring sensors on temperature and pressure items etc. given in **Table 3.3** are to be provided.
 - (b) Condition monitoring sensors for rotor bearings, lube oil temperatures of rotor bearings, rotor and casing vibrations, and axial displacements of rotors are to be provided.
 - (c) Condition of the lubricating oil of steam turbines is to be monitored.
 - (d) Condition monitoring and diagnostic systems are to have functions for monitoring the condition of steam turbines of driving main generators based on data from those sensors specified in (a) and (b) above and the condition of those lubricating oils specified in (c) above.
 - (e) Condition monitoring and diagnostic systems are to have functions for diagnosing the condition of steam turbines for driving main generators based on the information described in (d) above.

3.3 Preventive Maintenance Management Systems

3.3.1 General

Preventive maintenance management systems are to comply with following requirements (1) through (4):

- (1) Preventive maintenance management systems are to have functions to draw up plans for inspection, maintenance and inspection timing for each item of equipment and equipment components subject to preventive maintenance schemes according to those inspection and maintenance time intervals recommended by manufacturers and those survey intervals specified in **Part B of the Rules for the Survey and Construction of Steel Ships** in consideration of the operation schedules of ship.
- (2) Preventive maintenance management systems are to have functions to update and coordinate predetermined preventive maintenance plans based on diagnostic information from condition monitoring and diagnostic systems.
- (3) The following forms and records are to be able to be produced:
 - (a) List of items for regular maintenance service and overhaul inspections
 - (b) Records of regular maintenance services, overhaul inspections and damage/failure/repair records
- (4) Preventive maintenance planning management systems are to have functions to store and manage condition monitoring and diagnostic information as well as to output all of the various information needed for acceptance surveys, inspection results and condition monitoring data.

Table 3.1 Reciprocating Internal Combustion Engines used as Main Propulsion Machinery (and Gearing)

Monitored Variables	Remarks
Temperature	
Cylinder cooling water outlets for each cylinder	cooling water common outlets for cylinders when individual stop valves are not provided for each cylinder.
Piston coolant outlets for each cylinder	for crosshead engines.
Fuel valve coolant outlets	
L.O. inlets	
L.O. camshaft inlets	for crosshead engines with independent L.O. systems.
Thrust bearings or L.O. thrust bearing outlets	for engines with thrust bearings.
L.O. turbocharger bearing outlets	when it is not possible to measure the relevant temperature, continuous monitoring of inlet pressures and inlet temperatures in combination with bearing inspections conducted at specified intervals deemed appropriate by Society, etc. may be accepted as an alternative measure.
L.O. reduction gear inlets	for engines with independent L.O. systems.
F.O. injection pump inlets	or viscosity, applicable in cases where viscosity control of F.O. is performed
Exhaust gas outlets for each cylinder	not required for trunk piston engines of max. continuous power not exceeding 500kW/cylinder
Exhaust gas deviation for cylinder outlets	
Exhaust gas in turbocharger inlets	
Exhaust gas in turbocharger outlets	
Air in Scavenge air boxes	for crosshead engines (fire sensors may be accepted as an alternative)
Air cooler air outlets	applicable when an automatic temperature control device is provided
Pressure	
Cylinder cooling water inlets	
Piston coolant inlets	for crosshead engines
Fuel valve coolant inlets	
L.O. main bearing and thrust bearing inlets	
L.O. crosshead bearing inlets	for crosshead engines with independent L.O. systems
L.O. camshaft inlets	
Pressure differences between L.O. strainer inlets and outlets	
L.O. turbocharger inlets	for independent L.O. systems
L.O. reduction gear inlets	
F.O. injection pump inlets	
Common accumulator fuel oil pressure	for electronically-controlled engines (only when they have common accumulators)
Common accumulators or high pressure pipe hydraulic oil pressure	for electronically-controlled engines
Starting air engine inlets	Not required in cases where indicators are provided to show whether intermediate valves or automatic starting valves are open or closed
Cooling sea water	
Low temperature cooling water	when central cooling systems are adopted
Others	

Monitored Variables	Remarks
Oily contamination of cylinder cooling water	when cylinder cooling water is used in F.O. or L.O. heat exchangers
Piston coolant flow rate for cylinder outlets	for crosshead engines Non-flows may be accepted. Other alternative means may be accepted when it is impracticable to monitor piston coolant flows due to engine design.
Flow in each cylinder lubricator outlet	non-flows may be accepted
Scavenge air receiver water levels	alternative means may be accepted
Oil mist concentrations in crankcases	or bearing temperatures; however, not required for engines with maximum continuous outputs less than 2,250kW and cylinder diameters of 300mm or less

Table 3.2 Steam Turbines used as Main Propulsion Machinery (and Gearing Condensers)

Monitored Variables	Remarks
Temperature	
L.O. inlets	
Rotor bearings or L.O. outlets	
Rotor thrust bearings or L.O. outlets	
Reduction gear bearings or L.O. outlets	
Thrust bearings or L.O. outlets	
Pressure	
L.O. inlets	
Main condenser vacuums	
Gland steam	
Cooling sea water	or flow
Others	
Levels in main condensers	Applied in cases where main condensers are situated on the same horizontal plane as turbines
Rotor vibrations or casing vibrations	sensors for safety systems may be used
Rotor axial displacements	

Table 3.3 Prime Movers Driving Generators

Monitored Variables	Remarks
Reciprocating internal combustion engines driving generators	
Temperature	
L.O. inlets	
Cooling water or air outlets	
Exhaust gas for each turboblower inlet or each cylinder outlet	Required for each cylinder outlet for engines with max. continuous power exceeding 500kW/cylinder
F.O. injection pump inlets	or viscosity, applied in cases where viscosity control of F.O. is performed
Pressure	
L.O. inlets	
Common accumulators fuel oil pressure	for electronically-controlled engines (only when they have common accumulators)
Common accumulators or high pressure pipe hydraulic oil pressure	for electronically-controlled engines
Cooling water inlets	or flow, or high temperature of cooling water outlets
Starting air	
Other	
Oil mist concentrations in crankcases	or bearing temperatures; however, not required for engines with maximum continuous outputs less than 2,250kW and cylinder diameters of 300mm or less
Steam turbines driving generators	
Temperature	
L.O. inlets	
Pressure	
L.O. inlets	
Steam inlets	In the cases of ships in which steam turbines are used as main propulsion machinery (excluding electric propulsion ships), applied in cases where extracted steam is used
Exhaust steam	

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GUIDANCE FOR PREVENTIVE MACHINERY MAINTENANCE SYSTEMS

Chapter 1 GENERAL

1.1 General

1.1.2 Equivalency

“Provided that they are deemed by the Society to be equivalent to those specified in the Rules” includes any condition monitoring and diagnosing, based on data transmitted from ships, conducted by facilities located on shore.

1.1.4 Modification of Requirements

“In cases where considered appropriate” specified in [1.1.4 of the Rules](#) means those cases where examinations are carried out in accordance with measures specially approved by the Society. However, this regulation is not to be applied to surveys required by international regulations or the requirements of flag states.

Chapter 2 SURVEYS

2.1 General

2.1.2 Survey Intervals

The wording “the Society may approve the survey methods which it considers to be appropriate.” in **2.1.2-2(3) of the Rules** means survey methods which the Society considers to be able to obtain information equivalent to that obtained through traditional ordinary surveys where a surveyor is in attendance.

2.2 Registration Surveys

2.2.2 Shop Tests

1 Preventive machinery maintenance systems used under special environmental conditions are to be subjected to the following tests in cases where relevant according to their respective service environments, in addition to those tests specified in **2.2.2 of the Rules**.

- (1) Tests for the degree of protection of enclosures
- (2) Tests in explosive mixtures

2 Test procedures for environmental tests are to be in accordance with **Chapter 1, Part 7 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

3 The wording “the Society may approve other survey methods which it considers to be appropriate” in **2.2.2 of the Rules** means survey methods which it considers to be able to obtain information equivalent to that obtained through traditional ordinary surveys where the Surveyor is in attendance. Tests conducted in addition to items specified in **2.2.2 of the Rules** in accordance with **-1**, are to be comply with **-3**.

2.2.3 Sea Trials

The wording “the output ranges of main engines” specified in **2.2.3-1(1) of the Rules** means one chosen either from 50% or 70% of main engine maximum continuous output, normal service output and 100% of main engine maximum continuous output.

2.3 Registration Maintenance Surveys

2.3.1 Special Surveys

“General examination and performance tests” described in **2.3.1-1 of the Rules** includes the following confirmatory tests:

- (1) Self-monitoring systems of condition monitoring and diagnostic systems are to function properly, and alarm devices are to operate in abnormal conditions.
- (2) Condition monitoring and diagnostic systems are to be capable of outputting those results of condition monitoring specified in **3.2.1(3) of the Rules**.
- (3) Preventive maintenance management systems are to be capable of outputting those documents and records specified in **3.3.1(3) of the Rules**.

2.3.3 Occasional Surveys

The wording “the Society may approve the survey methods which it considers to be appropriate.” in **2.3.3 of the Rules** means survey methods which the Society considers to be able to obtain information equivalent to that obtained through traditional ordinary surveys where a surveyor is in attendance.

Chapter 3 PREVENTIVE MACHINERY MAINTENANCE SYSTEMS

3.2 Condition Monitoring and Diagnosis Systems

3.2.1 General

The wording “each output range” used in **3.2.1(3)(c) of the Rules** means 50%, 70%, normal service output and 100% of the maximum continuous output of main engines are to be regarded as the standard.

3.2.3 Condition Monitoring and Diagnostic Functions for Reciprocating Internal Combustion Engines used as Main Propulsion Machinery

1 The wording “Sensors for suitably monitoring the condition of cylinder liners and piston rings” used in **3.2.3(3) of the Rules** refers to temperature sensors unless specified otherwise. However, if the condition of piston rings can be monitored by monitoring the ferrous particle density of cylinder drain oil or of lubricating oil in 4 stroke-cycle engines then such alternative means may be accepted.

2 The wording “Sensors for suitably monitoring the condition of the main bearings” in **3.2.3(4) of the Rules** refers to temperature sensors unless specified otherwise.

3 The wording “Sensors for suitably monitoring any deterioration in the performance of turbochargers” used in **3.2.3(5) of the Rules** refers to those sensors that measure physical data needed for calculating the efficiency of turbochargers. These are to be pressure sensors and temperature sensors provided at exhaust gas sides and inlets/outlets of suction sides unless specified otherwise.

4 The wording “Conditions of lubricating oil of main engines are to be monitored” used in **3.2.3(6) of the Rules** means that deterioration trend data is to be confirmed by periodical analysis of the properties of lubricating oil.

5 In those diagnostic function specified in **3.2.3(8) of the Rules** functions for indicating the degree of abnormalities or the next time for maintenance of the equipment or equipment components specified in **3.2.2(1) of the Rules** are to be included.

3.2.4 Condition Monitoring and Diagnostic Functions for Turbines used as Main Propulsion Machinery

1 The wording “Sensors for directly and suitably monitoring the condition” used in **3.2.4(2) of the Rules** means vibration sensors and axial displacement sensors are to be regarded as the standard.

2 The wording “Condition of the lubricating oil of turbines is to be monitored” used in **3.2.4(3) of the Rules** means that deterioration trend data is to be confirmed by periodical analysis of the properties of lubricating oil.

3 In those diagnostic functions specified in **3.2.4(5) of the Rules**, any functions for indicating the degree of abnormalities or the next time for maintenance of the equipment or equipment components specified in **3.2.2(2) of the Rules** are to be included.

3.2.5 Condition Monitoring and Diagnostic Functions for Power Transmission Systems

1 The wording “Sensors for directly monitoring” used in **3.2.5(1) of the Rules** means temperature sensors are to be regarded as standard.

2 The wording “Condition of the lubricating oil of power transmission systems is to be monitored” stipulated in **3.2.5(2) of the Rules** means that deterioration trend data is to be confirmed by periodical analysis of the properties of the lubricating oil.

3 In those diagnostic function specified in **3.2.5(4) of the Rules**, any functions for indicating the degree of abnormalities or the next time for maintenance of the equipment or equipment components specified in **3.2.2(3) of the Rules** are to be included.

3.2.6 Condition Monitoring and Diagnostic Functions for Prime Movers Driving Generators

In those diagnostic functions specified in **3.2.6 of the Rules**, the functions for indicating the degree of abnormalities or the next time for maintenance of those equipment or equipment components specified in **3.2.2(4) of the Rules** are to be included.