GUIDANCE NOTES
GD001-2026

INTERNATIONAL SHIP CLASSIFICATION

GUIDELINES FOR ONBOARD WASTE HEAT RECOVERY POWER GENERATION SYSTEMS

2026

Effective from 1 February 2026

CONTENTS

Chapter 1 General

1.1 General provisions

1.1.1 The Guidelines are applicable to Waste Heat Recovery Power Generation systems (hereinafter referred to as WHG) installed on ships, which utilize Organic Rankine Cycle power, steam turbine power, and/or exhaust gas turbine power to recover waste heat resources on board for electricity generation. The WHG employing other types of power for waste heat recovery and power generation is to be implemented with reference to the Guidelines, but is to be given special consideration.

1.1.2 The Guidelines specify the requirements for the design, onboard installation and arrangement, control and monitoring, survey and testing, etc. of the WHG. The conventional ship systems and/or equipment used together with the WHG are to comply with the relevant requirements of the conventions, codes, and International Ship Classification (hereinafter referred to as ISC) rules.

1.1.3 In addition to the provisions of the Guidelines, the WHG is also to comply with the relevant requirements of ISC Rules for Classification of Sea-going Steel Ships (hereinafter referred to as the Rules) and/or other applicable rules, as well as the corresponding requirements of the Administration.

1.2 Objectives and functional requirements

1.2.1 The Guidelines are intended to provide standards for the design, installation and arrangement onboard, survey and testing, and operational control of the WHG to minimize the harm that the installation and operation of the WHG may cause to ships, crew, and the environment.

1.2.2 To achieve the aforementioned objectives, the design, onboard installation and arrangement of the WHG are to meet the following functional requirements:

(1) being adaptable to the environmental and working conditions of operations on board the ships;

(2) being capable of effectively utilizing waste heat from the heat supply system connected to it;

(3) minimizing the impact of WHG installation and operation on combustion plant, cooling systems, and ship's power plant as far as possible;

(4) the mechanical properties, chemical composition, manufacturing, and testing of the materials used are to meet the relevant requirements of ISC Rules for Materials and Welding, and anti-corrosion measures are to be considered (if applicable);

(5) preventing the accidental accumulation or diffusion of flammable, explosive, and toxic gases;

(6) preventing the leakage and diffusion of organic medias, lubricants, and other chemicals (if applicable);

(7) preventing damage to crew members or other system equipment caused by high temperature, high pressure, and running equipment;

(8) taking appropriate fire detection, prevention and extinguishing measures in response to potential fire risks;

(9) considering the impact of the installation, arrangement and operation of WHG on hull structures, stability, and load lines;

(10) taking appropriate control, monitoring, and safety protection measures to ensure the safe and reliable operation of the WHG;

(11) facilitating inspection, maintenance, and renewal of internal parts and components for relevant systems and equipment.

1.3 Definitions and abbreviations

1.3.1 Definitions applicable to the Guideline are as follows:

(1) **Waste Heat Recovery Power Generation System (WHG):** means a system that recovers and utilizes waste heat resources carried by high-temperature exhaust gases from onboard combustion plant during operation, steam/hot water generated by boilers, and cooling media (e.g., cooling water/oil) from heat exchangers, and converts the waste heat into electrical energy through a generator driven by Organic Rankine Cycle power, steam turbine power, or exhaust gas turbine power.

(2) **Combustion Plant:** means engines, boilers, and/or other combustion plant on board that use fuel.

(3) **Exhaust Gas Boiler:** means a boiler on board that utilizes waste heat from exhaust gases produced by combustion plant to heat medium such as water or thermal oil, thereby generating heating media like steam, hot water, or thermal oil.

(4) **Organic Rankine Cycle Power System:** means a power system that utilizes organic media circulating through four thermodynamic processes (heat absorption, expansion, heat rejection, and compression). The expansion of the organic media performs work, driving the expander to rotate, thereby converting thermal energy into rotational mechanical energy.

(5) **Steam Turbine Power System:** means a power system where steam drives a steam turbine to rotate, converting thermal and kinetic energy into rotational mechanical energy.

(6) **Exhaust Gas Turbine Power System:** means a power system where high-temperature exhaust gases directly drive an exhaust gas turbine to rotate, converting thermal and kinetic energy into rotational mechanical energy.

(7) **Evaporator:** means a device that facilitates the vaporization of a liquid substance into a gaseous state by absorbing heat through heat exchange.

(8) **Condenser:** means a device that cools the gaseous circuit media through heat exchange, causing it to condense into a liquid state.

(9) **Superheater:** means a device that further heats saturated steam (steam at its boiling point temperature) above its boiling point, converting it into "superheated steam".

(10) **Thermal Oil:** means an organic liquid media that can circulate stably within a closed thermal oil circulation system on board at relatively high temperatures and under certain pressures, used for heat transfer.

1.3.2 The abbreviations and symbols are explained as follows:

(1) **WHG** means Waste Heat Recovery Power Generation System.

(2) **ORC** means Organic Rankine Cycle.

(3) **EGC** means Exhaust Gas Cleaning.

(4) **SCR** means Selective Catalytic Reduction.

(5) **EGR** means Exhaust Gas Recycle.

(6) **MSDS** means Material Safety Data Sheet, a comprehensive technical document that provides information on the physicochemical properties, safety hazards, protective measures, and emergency treatment for a chemical substance.

(7) **OEL** means Occupational Exposure Limit, a time-weighted average concentration that can be

experienced over an 8-hour workday and 40-hour workweek, repeatedly, without adverse effects.
(8) **WCF** means Worst-Case Formulation, the most toxic or most flammable composition resulting from the use of nominal composition tolerances.
(9) **WCFF** means Worst-Case Fractionated Formulation, the composition that produces the strongest toxicity or highest flammability during the fractionation of the worst-case formulation.

1.4 Class notations

1.4.1 Ship installed with a Waste Heat Recovery Power Generation System and in compliance with the relevant requirements of Chapters 1 to 8 of the Guidelines are to be assigned the class notation WHG upon application and satisfaction survey.
1.4.2 WHG ready ships are to be assigned the class notations WHG Ready 1, WHG Ready 2 or WHG Ready 2(X) after it is confirmed that the ships are in compliance with the relevant requirements of Chapter 9 of the Guidelines, with the following specific meanings:
(1) WHG Ready 1: design and approval of principal drawings are carried out for a WHG ready ship to ensure that the ship is in compliance with the basic requirements for future installation of WHG, and that no equipment or systems related to WHG have actually been installed on board.
(2) WHG Ready 2: design and approval of detailed drawings are carried out for a WHG ready ship to ensure that the WHG ready design is in compliance with the relevant requirements of the Guidelines, and that no equipment or systems related to WHG have actually been installed on board.
(3) WHG Ready 2(X): on the basis of meeting the requirements of WHG Ready 2, the WHG related equipment and systems have actually been installed on board the ship. The symbol X represents one or more suffixes of the class notation, with the following specific meanings:

① the hull structures and related supporting structures at the WHG installation space have been strengthened, represented by the capital letter S;
② the intended heat source and cooling piping (if applicable) have been installed, represented by the capital letter P.

1.5 Plans and documents

1.5.1 For ships installed with WHG, in addition to the plans and documents required in the relevant requirements of ISC rules and guidelines, the following are also to be submitted to ISC for approval:
(1) Piping system related to WHG, mainly including:

① exhaust piping system (if applicable);
② steam/high-temperature hot water piping system (if applicable);
③ thermal oil circulation piping system (if applicable);
④ cylinder jacket cooling water piping system (if applicable);
⑤ WHG cooling water piping system (if applicable);
⑥ organic media circulation piping system (if applicable);
⑦ organic media filling/supply system piping system (if applicable);

(2) hazardous area divisions (if applicable);
(3) arrangement of electrical equipment in hazardous areas (if applicable);
(4) power load calculation sheet;
(5) arrangement of ventilation (if applicable);

(6) detailed list of monitoring, alarms, and safety protection;
(7) WHG electrical system;
(8) gas detection system and arrangement (if applicable);
(9) Final Loading Manual (including WHG).

1.5.2 For ships installed with WHG, in addition to the plans and documents required in the relevant requirements of ISC rules and guidelines, the following are also to be submitted to ISC for information:

(1) WHG design description, mainly including system working principles, design parameters, compatibility with the heat source for heat exchange, cooling water quantity (if applicable), detailed list of equipment, arrangement plan, etc.;
(2) risk assessment report;
(3) WHG operation and maintenance manual;
(4) steam consumption calculation sheet (if applicable);
(5) WHG arrangement.

1.5.3 Additional plans and documents are to be submitted if deemed necessary by ISC.

1.6 Risk assessment

1.6.1 The purpose of risk assessment is to assess the risks relating to the installation of WHG, so as to eliminate or mitigate all adverse effects on personnel on board, the environment, the structural strength and the ship's power plant.

1.6.2 The risks are to be analyzed using acceptable and recognized risk analysis techniques, and the following are to be taken into account:

(1) adaptability to environmental and working conditions;
(2) impact on the safe operation of combustion plant, its cooling systems, and the ship's power plant;
(3) accidental accumulation or diffusion of flammable, explosive, and toxic gases;
(4) leakage and diffusion of chemical substances;
(5) possible injuries to crew members or damages to other equipment caused by high/low temperatures, high pressure, and running equipment;
(6) potential fire risks.

1.6.3 In general, the risk assessment report is to address the following:

(1) standards and methods used for risk analysis;
(2) various assumptions and prerequisites provided during analysis;
(3) objects to be analyzed, such as system, equipment, operation, etc.;
(4) possible risks;
(5) causes for risks;
(6) potential impact of risks;
(7) measures taken to prevent or mitigate risks and the arrangements for their implementation.

1.7 Operation and maintenance manual

1.7.1 A WHG operation and maintenance manual that has been reviewed by ISC is to be available on board the ship. The manual is to address operation, safety, maintenance requirements and occupational and health risks related to the system.

1.7.2 The manual is to include the following, as a minimum:

(1) procedures and plans related to WHG operation, inspection, testing, and maintenance;
(2) procedures and plans related to regular testing and maintenance of monitoring systems and safety systems;
(3) special instructions on refueling, storage, and use of hazardous and non-hazardous chemicals intended for system operation;
(4) various conditions related to system operation, etc;
(5) emergency handling procedures, such as operating procedures for emergency shutdown, bypass and isolation of exhaust gas/steam/high-temperature hot water/thermal oil/cooling water, organic media leakage (if applicable), ventilation, and personnel protection, etc.;
(6) training and routine maintenance records, etc.

Chapter 2 System Design and Arrangement

2.1 General provisions

2.1.1 The machinery, electrical equipment and control systems,etc. constituting the WHG are to be designed, selected, and arranged in accordance with the environmental/operating conditions stipulated in PART THREE, PART FOUR, and PART SEVEN of the Rules, respectively.

2.1.2 The design of the WHG is to ensure the continuous and stable operation of shipboard equipment during transitions between various operating modes.

2.1.3 The WHG is to be provided with redundant safety protection measures, capable of preventing and handling accidental events.

2.1.4 Appropriate treatment measures are to be taken to address potential issues such as deposition and scaling that may occur during WHG operation.

2.1.5 Where other exhaust gas post-treatment units (EGC, SCR, EGR, etc.) are installed, their compatibility with the WHG is to be considered.

2.2 Ship arrangement

2.2.1 The spaces containing major WHG equipment are to be well ventilated. Spaces where flammable or toxic gases or vapors may accumulate are to comply with the ventilation requirements specified in 1.3.4, Chapter 1, PART THREE of the Rules.

2.2.2 Appropriate protective measures are to be provided in accordance with 1.3.6, Chapter 1, PART THREE of the Rules to prevent potential injury to personnel on board during WHG operation and maintenance.

2.2.3 The structural design and arrangement of the WHG are to facilitate installation, operation, and maintenance.

2.3 Strength and stability

2.3.1 Ships installed with a WHG are to meet the applicable requirements of longitudinal strength and local strength specified in the Rules.

2.3.2 When installing a WHG on a ship, consideration is to be given to its potential impact on the ship's stability, such as the lightship center of gravity, heel and trim, as well as the possible influence of changes in the ship's tonnage on the applicable statutory standards.

2.4 Compatibility with combustion plant

2.4.1 For a WHG utilizing exhaust gas waste heat, the following requirements are to be met:

(1) being adaptable to the working parameters (e.g., exhaust gas temperature, back pressure, and exhaust gas volume) of the connected combustion plant. Relevant operating conditions and limitations are to be clearly specified in the operation and maintenance manual;

(2) under all operating conditions, the exhaust gas back pressure is to be maintained within the range specified by the combustion plant manufacturer. If a fan is installed to maintain the required back pressure, measures are to be taken to ensure that the connected combustion plant can continue to operate even if the fan fails. For situations where multiple combustion plants are connected, the fan setup is to consider the back pressure requirements of all connected combustion plants, and appropriate measures are to be taken to reduce the risk of the fan (if provided) being affected by corrosion or blockage, which could impact its normal operation;

(3) normally, exhaust pipes from combustion plants are to be routed separately and not interconnected. However, interconnected exhaust piping systems to a common WHG unit may be accepted subject to the agreement of ISC if the designer takes full consideration of the potential risks and makes effective isolation arrangements preventing the exhaust gas from flowing back or leaking to the stopped combustion plants or other spaces.

2.4.2 A WHG utilizing cooling water waste heat is to adapt to the working parameters (e.g., temperature, pressure, and flow rate) of the cooling water from the connected heat source equipment. Relevant working conditions and limitations are to be clearly specified in the operation manual.

2.5 Bypass or equivalent measures

2.5.1 The design and arrangement of a WHG utilizing exhaust gas waste heat are to ensure that the combustion plants can still operate normally in the event of its failure or normal shutdown.

2.5.2 To reach the objective specified in 2.5.1, a bypass is to meet the following requirements:

(1) means are provided in local and remote control position to correctly indicate the working conditions;

(2) reliable operation, ensuring the safe operation of the combustion plant under any circumstances;

(3) a safety interlock device is to be provided between the bypass valve and the relevant WHG inlet valve to ensure that the exhaust gas of combustion plant can be smoothly emitted under any circumstances;

(4) the actions are to be automatically initiated according to the requirements of Table 7.2.4 in Chapter 7 of the Guidelines.

2.5.3 If no bypass is provided, it is to be ensured that the high-temperature exhaust gas passing through the WHG equipment can be emitted smoothly without causing damages to the WHG equipment and its components or affecting the continuous safe operation of the combustion plant. Furthermore, the design of the WHG is to fully consider risks such as the fire, soot accumulation, and carbonization due to direct erosion of the high temperature exhaust gas, and appropriate measures are to be taken to control such risks.

2.6 Electrical installations

2.6.1 Measures are to be provided to ensure that the WHG can be restored to or maintained in a safe state during shutdown operations or maintenance.

2.6.2 The enclosure protection type for electrical equipment related to the WHG is to be suitable for the installation location, and its minimum degree of protection is to meet the applicable requirements of Table 1.3.2.2, Chapter 1, PART FOUR of the Rules.

2.6.3 The system protection of the WHG is to meet the applicable requirements in 2.5, Chapter 2, PART FOUR of the Rules.

2.6.4 The power supply and distribution are to meet the following requirements:

(1) the WHG is not to serve as the sole main power supply for the ship;

(2) for the electrical energy supplied by the WHG to the ship's power plant, its voltage, frequency, and harmonics are to meet the relevant applicable requirements in 1.2.2, 1.2.3, and 2.4.4, PART FOUR of the Rules;

(3) in the event of a single fault, the design of the WHG is not to affect the normal operation of the ship's power plant;
(4) a disconnecting device is to be installed on the WHG output circuit for maintenance purposes, and contactors are not to be used as disconnecting devices;
(5) the electrical system of the WHG is to be compatible with the ship's power plant and to meet the applicable requirements in 2.4.1.1, PART FOUR of the Rules.
2.6.5 The WHG generator, together with the converter (if provided), may serve as a component of the ship's main power supply provided that the following requirements are met:
(1) it is to be capable of operating normally under all climatic conditions during navigation, operation, and berthing of the ship. Voltage fluctuations are to meet the applicable requirements in 3.2.7 and 3.2.8, PART FOUR of the Rules, and frequency variations are to meet the applicable requirements in 1.2.2.2, PART FOUR of the Rules;
(2) the WHG generator, together with the converter (if provided), are to possess the same level of safety, reliability, and independence as diesel generator sets. In the event of a fault of any single generator, the remaining part of the main power supply is still to meet the applicable requirements in 2.1.1.1(2), PART FOUR of the Rules;
(3) considering the selective protection of the power distribution system's protective devices, the short-circuit current of the WHG generator, together with the converter (if provided), are to be sufficient to trip the generator circuit breaker. Protective measures are to be provided to ensure that the WHG generator is not endangered in the event of a short circuit on the main busbar and can be reused after the fault is cleared;
(4) the automatic starting of the standby generator is to meet the applicable requirements in ② of 2.1.1.1(4),PART FOUR of the Rules;
(5) a single fault in the WHG is not to lead to blackout to the ship's essential equipment;
(6) if the WHG constitutes part of the main power supply, the safety, control, and alarm systems of the prime mover driving the generator are to be supplied by two independent power sources. The power supply sources and wiring are to be arranged to ensure that, in the event of a single fault, the applicable requirements in 2.1.1.1(2), PART FOUR of the Rules are met.
2.6.6 The WHG generator, together with the converter (if provided), may be used to supply power to electrical equipment necessary for the ship's normal operation and accommodation conditions during navigation, provided that the following requirements are met, but it is not to serve as a component of the main power supply:
(1) the power plant is to be provided with a backup power source of sufficient capacity (supplied from the ship's main power supply);
(2) when the frequency variation exceeds the following limits, the applicable requirements in ② of 2.1.1.1(4), PART FOUR of the Rules are to be met, and at least one generator (from the ship's main power supply) is to be automatically started:
Steady-state frequency fluctuation: ±5.5%
Transient frequency fluctuation: ±11% (5s);
(3) voltage fluctuations are to meet the applicable requirements in 3.2.7 and 3.2.8, PART FOUR of the Rules, and frequency variations are to meet the applicable requirements in 1.2.2.2, PART FOUR of the Rules;

(4) considering the selective operation of protective devices in the power distribution system, the short-circuit current of the WHG generator, together with the converter (if provided), is to be sufficient to trip the WHG generator's short-circuit protection device;
(5) the power plant is to be provided with an automatic load-shedding function that meets the applicable requirements in 2.5.7, Chapter 2, PART FOUR of the Rules.
(6) on ships provided with bridge room remote control for propulsion gears, measures or procedures are to be provided to ensure the supply of power to essential equipment during maneuvering conditions, thereby avoiding blackout of ships.

2.7 Explosion protection

2.7.1 For a WHG utilizing Organic Rankine Cycle power system, a safety data sheet (MSDS) for organic media is to be provided. Where the organic media emits flammable and explosive gases, hazardous areas are to be classified in accordance with the requirements in IEC 60079-10-1 "Explosive atmospheres - Classification of areas - Explosive gas atmospheres" and IEC 60079-502 "Electrical installations in ships - Tankers - Special features".

2.7.2 For electrical equipment installed in hazardous areas, the appropriate certified explosion-proof equipment is to be selected in accordance with the category of hazardous areas, and the explosion group and temperature class are to meet the safety data sheet of organic media.

Chapter 3 Organic Rankine Cycle Power System

3.1 General provisions

3.1.1 This chapter applies to the WHG powered by Organic Rankine Cycle power systems.

3.1.2 A warning sign stating "Ventilation Required Before Entry" is to be posted at the entrance of relevant enclosed spaces.

3.2 Expander

3.2.1 The design of the expander is to ensure that no critical speed occurs within its operating speed range.

3.2.2 The following parts and components of the expander are to undergo material tests in accordance with the relevant provisions in ISC Rules for Materials and Welding or recognized standards:

(1) shafts, discs, and blades;

(2) stationary parts such as casings, foundations, and bearing housings.

3.2.3 Rotating parts of the expander, including rotor shafts, rigid and flexible couplings, coupling bolts, blades (sampled), and other moving components, are to be subjected to non-destructive testing. The testing methods and results are to be evaluated by means acceptable to ISC.

3.2.4 Stationary parts of the expander, including castings of housings subjected to temperatures exceeding 230°C, and plates of housings subjected to temperatures exceeding 370°C or pressures greater than 4 MPa, are to undergo non-destructive testing. The testing methods and results are to be evaluated by means acceptable to ISC.

3.2.5 Pressure-containing components of the expander, such as the casing, are to be subjected to a hydraulic test at 1.5 times the design pressure and a tightness test at the rated design pressure.

3.2.6 Both the support bearings and thrust bearings of the expander are to be provided with temperature monitoring measures to trigger an alarm when bearing temperatures rise excessively.

3.2.7 The design and installation of the expander are to prevent the ejection of fragments in the event of rotor rupture.

3.2.8 The expander is to be provided with an overspeed protection device to prevent hazards caused by overspeed.

3.2.9 The rotor assembly of the expander is to be assembled with the driving part of the coupling to undergo a the dynamic balance test.

3.2.10 Temperature and pressure monitoring and alarms are to be provided at the expander’s circuit media inlet and outlet.

3.2.11 The expander is to be provided with an emergency shutdown device.

3.3 Circuit media circulation piping system

3.3.1 The circuit media circulation piping is to comply with the relevant provisions in Chapter 2, PART THREE of the Rules.

3.3.2 The circuit media circulation piping is not to pass through accommodation spaces, service spaces, or control stations.

3.3.3 Drain outlets for the circuit media are to be provided at appropriate locations on the circulation piping to facilitate the drainage of the circuit media from the piping during

maintenance and repair.

3.3.4 A liquid receiver tank is to be provided on the circuit media circulation piping, meeting the following requirements:

(1) it is to be designed, manufactured, installed, and tested in accordance with the relevant provisions in Chapter 6, PART THREE of the Rules;

(2) it is to be capable of containing the total volume of circuit media in the circulation system during maintenance and repair;

(3) level indicators are to be provided, and all level indicators are to be suitable for the maximum working pressure;

(4) a level alarm is to be provided;

(5) the filling open ends for the circuit media are to be provided;

(6) valves with shut-off functionality are to be provided at the circuit media inlet and outlet.

3.3.5 A pressure relief device is to be provided at appropriate locations wherever the pressure in the circuit media circulation piping may exceed its design pressure under any circumstances.

3.3.6 The circuit media compressor pump is to meet the applicable requirements for the circuit media circulation capacity, pressure, and temperature required by the system's rated generating capacity. A temperature alarm is to be provided at its inlet, and the presence of gaseous-phase circuit media is to be avoided.

3.3.7 The flow rate, pressure, and temperature of heat exchangers (such as condensers, evaporators, preheaters, etc.) are to meet the requirements for the system's rated generating capacity.

3.3.8 If the circuit media is highly toxic (OEL less than 300 ppm) and/or flammable (exhibiting flame propagation in WCF and WCFF tests conducted at 101 kPa and 60°C), valves with shut-off functionality are to be provided between the circuit media pump, heat exchangers, and the expander.

3.4 Heating piping system

3.4.1 The piping used for heating the circuit media is to comply with the relevant provisions in Chapters 2 and 4, PART THREE of the Rules.

3.4.2 A flow control valve is to be provided on the heating pipeline that serves as the primary heat source for the evaporator.

3.4.3 If the heat source is shared with other systems, the heating pipeline is to be provided with bypass measures to ensure that the WHG does not affect the normal operation of other systems.

3.4.4 An exhaust gas boiler independently installed for the WHG is to comply with the relevant provisions in Chapter 6, PART THREE of the Rules, and is to be provided with an exhaust gas bypass or dry-firing prevention function.

3.5 Cooling piping system

3.5.1 The piping used for cooling the circuit media is to comply with the relevant provisions in Chapters 2 and 4, PART THREE of the Rules.

3.5.2 The flow rate of the cooling medium is to meet the requirements of the rated generating capacity of the system.

3.5.3 Cooling pipelines connected from other cooling systems are to be provided with bypass to ensure that the operation of the WHG does not affect the cooling requirements of other systems.

3.5.4 A filtration device is to be provided on the cooling pipeline before entering the condenser.

3.5.5 If a cooling medium pump is independently provided for the condenser, redundant configuration is to be considered.

3.6 Special arrangement requirements

3.6.1 For circuit media with high toxicity and/or flammability, the space where the circuit media circulation piping system is installed is to be separated from accommodation spaces or other working spaces by gas-tight bulkheads and decks. The ventilation and lighting requirements for this compartment is to comply with the following:

(1) effective mechanical ventilation is to be provided. The capacity of the fan is to be sufficient to ensure an air change rate of not less than 30 changes per hour in the compartment;

(2) the suction piping of the ventilation system is to be made of steel or other equivalent materials. The outlet is to be located in an area on the ship where it will not create a hazard;

(3) the mechanical ventilation fan is to be controllable from two locations, one of which is to be situated at a suitable position outside the compartment;

(4) if the circuit media is flammable, the following additional requirements are to be met:

①the ventilation fan is to be of a non-sparking type. Its materials and design are to meet the applicable requirements in 3.3.5, Chapter 3, PART SIX of the Rules. If the fan is located within the ventilation duct, its motor is to be of an approved explosion-proof type;

② the waste heat power generation unit and the circuit media pump motor are to be of an approved explosion-proof type;

③a fixed fire detection and fire alarm system complying with the International Code for Fire Safety Systems (FSS Code) is to be provided;

④a fixed fire-extinguishing system compatible with the physical and chemical properties of the circuit media and complying with the FSS Code is to be provided;

(5) the compartment is to have adequate lighting. If the circuit media is flammable, the lighting fixtures are to be of an approved explosion-proof type;

(6) the discharge end of the pressure relief devices on the circuit media circulation piping is to be led to a safe location on the open deck;

(7) if the circuit media is highly toxic, in addition, no less than two gas masks are to be provided outside the entrance door of the installation space. The masks are to be stored in a clearly marked cabinet for immediate use when needed;

(8) the shut-off valves on the circuit media circulation piping are to be remotely operated valves and are to be equipped with a manual emergency operating mechanism.

3.6.2 For circuit media that are neither highly toxic nor flammable, the installation spaces of the circuit media circulation piping systems are generally not subject to restrictions.

Chapter 4 Steam Turbine Power System

4.1 General provisions

4.1.1 This chapter applies to the WHG powered by steam turbine power systems for electricity generation.

4.2 Steam turbine

4.2.1 The design, manufacture, installation, and testing are to comply with the relevant provisions for auxiliary steam turbines in Chapter 7, PART THREE of the Rules.

4.2.2 If steam could be led directly to the condenser during emergency operations, suitable arrangements and control measures are to be provided to prevent steam pressure and temperature from exceeding the values that the condenser can safely withstand.

4.3 Boiler

4.3.1 If an exhaust gas boiler cannot withstand dry operation, necessary dry-operation preventive measures (such as an exhaust gas bypass, etc.) are to be provided.

4.4 Feed water, blow-off and condensate of boiler piping system

4.4.1 The relevant provisions in Chapters 2, 6, and 7, PART THREE of the Rules are to be complied with.

4.4.2 For boilers dedicated exclusively to the WHG, the feed water pumps and piping systems may be exempted from redundancy.

4.4.3 At least two condensate pumps are to be provided, one of which could serve as a standby. A redundantly configured independent feed water pump may be utilized as the standby condensate pump.

4.5 Steam piping system

4.5.1 The relevant provisions in Chapters 2, 4, and 6, PART THREE of the Rules are to be complied with.

4.6 Cooling water piping system

4.6.1 Cooling Water Pumps:

(1) The capacity is to meet the operational requirements of the WHG system under rated conditions.

(2) Redundancy may be exempted for cooling water pumps dedicated exclusively to the WHG.

4.6.2 Piping and fittings are to comply with the relevant provisions in Chapter 4, PART THREE of the Rules.

4.7 Lubricating oil piping system

4.7.1 The relevant provisions in Chapters 2, 4, and 7, PART THREE of the Rules are to be complied with.

4.7.2 The lubricating oil pump is to be provided in accordance with the relevant provisions in Chapter 4, PART THREE of the Rules pertaining to auxiliary machinery for essential services and their transmission gearing.

Chapter 5 Exhaust Turbine Power System

5.1 General provisions

5.1.1 This chapter applies to the WHG powered by exhaust gas turbine power systems for electricity generation.

5.2 Exhaust gas turbine

5.2.1 The following parts and components of the exhaust gas turbine are to undergo material tests in accordance with the relevant requirements of the ISC Rules for Materials and Welding or recognized standards:

(1) shafts, discs, guide vanes, and blades of the exhaust gas turbine;

(2) stationary parts such as casings, foundations, and bearing housings.

5.2.2 Rotating parts of the exhaust gas turbine, including rotor shafts, rigid and flexible couplings, bolts, blades (sampled), and other moving components, are to be subjected to non-destructive testing. The testing methods and results are to be evaluated using approaches acceptable to ISC.

5.2.3 Stationary parts of the exhaust gas turbine, including castings of housings subjected to temperatures exceeding 230°C and plates of housings subjected to temperatures exceeding 370°C, are to undergo non-destructive testing. The testing methods and results are to be evaluated using approaches acceptable to ISC.

5.2.4 Both the support bearings and thrust bearings of the exhaust gas turbine are to be provided with monitoring measures for bearings temperature to trigger an alarm when bearing temperatures rise excessively.

5.2.5 The design and installation of the exhaust gas turbine are to prevent the ejection of fragments in the event of rotor rupture.

5.2.6 The exhaust gas turbine is to be provided with an overspeed protection device to prevent hazards caused by overspeed.

5.2.7 The rotor assembly of the exhaust gas turbine is to be assembled with the driving part of the coupling to conduct the dynamic balance test.

5.2.8 The exhaust gas turbine is to be provided with an emergency shutdown device, and its shutdown is not to affect the normal operation of the main engine.

5.2.9 The lubricating system of the exhaust gas turbine is generally to be independently configured. If an independent circulation system not directly driven by the exhaust gas turbine is adopted, a separate standby pump is to be provided. For lubricating oil systems provided with an emergency gravity tank, their structures and arrangements are to meet the applicable requirements in 1.2.1.1, PART THREE of the Rules.

5.2.10 Monitoring and alarms are to be provided in accordance with the provisions in Table 7.2.4.

5.2.11 The critical speed of the exhaust gas turbine rotor shaft is to be calculated. For a rigid rotor shaft, the critical speed is to be not less than 1.3 times its rated speed.

5.2.12 Pressure-containing components of the exhaust gas turbine, such as the casing, are to be subjected to a hydraulic test at 1.5 times the design pressure and a tightness test at the rated design pressure.

5.3 Exhaust gas piping

5.3.1 The exhaust gas piping is to comply with the relevant provisions in Chapters 2, 4, and 9, PART THREE of the Rules.

Chapter 6 Machinery and Equipment

6.1 Boilers and pressure vessels

6.1.1 Boilers and pressure containers are to be designed, manufactured, installed, and tested in accordance with the relevant provisions in Chapter 6, PART THREE of the Rules.

6.1.2 Heat exchangers and their accessories are to be designed, manufactured, and surveyed as pressure containers.

6.2 Gear transmission units and clutches

6.2.1 Gear transmission units are to be designed, manufactured, and tested in accordance with the provisions for the gear transmission unit of the auxiliary machinery for the generator in Chapter 10, PART THREE of the Rules.

6.2.2 Clutches are to be designed, manufactured, and surveyed according to recognized standards. The maximum torque transmitted by a clutch is generally to be not less than 1.5 times the rated transmission torque.

6.3 Shafting transmission units

6.3.1 Transmission shafts are to meet the applicable strength requirements for transmitting the rated torque and may be designed and manufactured in accordance with recognized standards.

6.3.2 Shafting transmission units are to be designed and manufactured in accordance with the relevant provisions in Chapter 11, PART THREE of the Rules.

6.4 Magnetic bearings

6.4.1 Bearing temperature monitoring and alarms are to be provided.

6.4.2 Bearing operating condition monitoring alarms (e.g., displacement monitoring alarms) and safety protection measures are to be provided.

6.4.3 An independent uninterruptible power supply is to be provided for magnetic bearings, with a duration of not less than 0.5 hour.

6.5 Generators

6.5.1 Where practicable, the performance of the prime mover and its governor for the WHG generator are to comply with the relevant provisions for auxiliary steam turbines in Chapters 7 and 8, PART THREE of the Rules.

6.5.2 Under the highest cooling air temperature conditions, the WHG generator is to be able to operate continuously at the rated output for a long period of time, and meet the applicable requirements regarding temperature rise limitations as specified in Table 3.2.3.1, Chapter 3, PART FOUR of the Rules.

6.5.3 The WHG generator is to withstand the following overcurrents without harmful deformation:

DC generators: 50% overcurrent for 15 seconds;

AC generators: 50% overcurrent for 30 seconds.

6.5.4 If the WHG generator is AC-equipped with an excitation system, it is to maintain at least 3 times the rated current for at least 2 seconds under steady-state short-circuit conditions.

6.5.5 The performance of the WHG generator, such as voltage, speed regulation, and load

sudden addition and removal,etc is to meet the applicable requirements in 3.2.7 and 3.2.8, Chapter 3, PART FOUR of the Rules.

Chapter 7 Control, Monitoring, Alarm and Safety System

7.1 General provisions

7.1.1 In addition to complying with the provisions of this Chapter, the WHG control, monitoring, alarm, and safety systems are also to conform to the relevant provisions in Chapters 1 and 2, PART SEVEN of the Rules. For ships with automation class notations, the relevant provisions in Chapters 3 and 4, PART SEVEN of the Rules are also to be met.

7.1.2 The computer system for control, monitoring, alarm, and safety protection of a WHG serving as part of the main power supply is to comply with the relevant provisions for Category-II computer systems in Section 6, Chapter 2, PART SEVEN of the Rules. For a WHG not serving as part of the main power supply, its computer system for control, monitoring, alarm, and safety protection may be regarded as a Category-I computer system and is to meet the relevant provisions in Section 6, Chapter 2, PART THREE of the Rules.

7.2 Control, monitoring and alarm system

7.2.1 To ensure that the operating parameters are always maintained within the specified range, the WHG is to have automatic control, monitoring, alarm, and safety protection functions, and be provided with manual operating devices.

7.2.2 The control system may be designed as an independent system or integrated into the ship automation systems. The system design is to ensure that a single failure of a component does not lead to a potential danger for the safety of ships and personnel.

7.2.3 For ships with periodic unmanned machinery spaces, the WHG monitoring and alarm system may be integrated with the centralized monitoring and alarm system of the ship.

7.2.4 The WHG monitoring, alarm and safety protection is to be determined based on the results of risk analysis. In general, corresponding monitoring, alarm and indication may be provided at the WHG remote control location (if provided) and local control positions as stipulated in Table 7.2.4. At the meanwhile, all alarms are to be extended to continuously manned positions in the form of single or combined alarms.

7.2.5 In case of failure of remote control system (if provided) or in emergency, the WHG is to be locally controlled and monitored. Key parameters required for system safe operation and working conditions of equipment are to be indicated at the local control position.

7.3 Safety system

7.3.1 Emergency shutdown device is to be provided at the WHG remote control (if provided) and local control stations to stop system operation and automatically initiate the bypass (if provided). The shutdown of WHG is not to affect the reliable operation of the main engine and other primary generators.

7.3.2 A safety system is to be provided and meet the following requirements:

(1) upon activation of the safety shutdown system, an audible and visual alarm is to be given at the remote control position and at the local control station. The alarm must clearly indicate the fault that caused the shutdown. In the event where shutdown by the safety shutdown system is activated the restart is not to occur automatically, until the system has been manually reset;

(2) safety shutdowns are to be automatically activated according to the requirements in Table 7.2.4.

7.4 Gas detection system

7.4.1 Based on the safety data sheet of the circulating circuit media, if the circuit media may release toxic, flammable, or explosive gases, a gas detection system is to be provided in spaces where such gases may leak or accumulate during WHG operation (including but not limited to spaces containing the circuit media circulation piping, circuit media storage tanks, etc.). Upon any alarm condition, audible and visual alarms are to be activated at least at the following locations:

(1) bridge room;

(2) relevant control station for recording the continuous monitoring of gas levels; and

(3) location of the gas detector's reading unit.

7.4.2 Gas detection system is to be continuous without delay and of the self-monitoring type. In the event that a system fault is detected by the self-monitoring functions, the output of the detection system is to be automatically disconnected such that the detector fault will not cause false emergency shutdown.

7.4.3 Gas detectors are to be designed and tested according to the standards accepted by ISC.

7.4.4 The number of gas detectors in each space is to be considered taking into account the size, layout and ventilation of the space. Gas detectors are to be located where gas/vapor may accumulate and/or in ventilation outlets. Gas dispersal analysis or physical smoke test can be used to find the best arrangement.

7.4.5 The gas detection equipment is to be designed so that it may be readily tested and calibrated.

7.4.6 In addition to the fixed gas detection system, at least one set of suitable portable gas detectors are to be provided on board the ship.

Monitoring, Alarm and Safety Protection **Table 7.2.4**

Category	Monitored parameter	Display	Alarm	Automatic shutdown or bypass*	Remarks
ORC	Pressure of circulating circuit media line	Pressure	High/low	Excessively high/excessively low	
	Inlet temperature of circuit media compressor pump	Temperature	High/low	Excessively high/excessively low	
	Inlet/outlet temperature of expander circuit media	Temperature	High/low	--	
	Inlet/outlet pressure of expander circuit media	Pressure	High/low	--	
	Level of circuit media storage tank	Level	High/low	--	
Exhaust gas turbine (for a V-type diesel engine with	Exhaust turbine speed	Speed	High	--	Applicable to diesel engines with an

Category	Monitored parameter	Display	Alarm	Automatic shutdown or bypass*	Remarks
one turbocharger per cylinder bank, the turbine stage is determined based on half of the diesel engine's rated power)					exhaust turbine and a rated power greater than 1000 kW
	Exhaust gas temperature of exhaust turbine inlet	Temperature	High	––	Applicable to diesel engines with an exhaust turbine and a rated power greater than 1000 kW
	Lubricating oil temperature of exhaust turbine outlet	Temperature	High	––	(1) Applicable to diesel engines with an exhaust turbine and a rated power greater than 2500 kW; (2) Not applicable to magnetic bearing scenarios; (3) If it is not a forced circulation system, the lubricating oil temperature near the bearing is

Category	Monitored parameter	Display	Alarm	Automatic shutdown or bypass*	Remarks
					to be measured.
	Lubricating oil pressure of exhaust turbine inlet	Pressure	Low	--	(1) Applicable to diesel engines with an exhaust turbine and a rated power greater than 1000 kW; (2) Not applicable to magnetic bearing scenarios; (3) Applicable to forced circulation systems only.
General	Cylinder jacket water inlet temperature of main engine/auxiliary engine	High/low	Excessively high		
	Cylinder jacket water outlet temperature of main engine/auxiliary engine	Temperature	High/low	--	
	Cylinder jacket water inlet line pressure of main engine/auxiliary engine	Pressure	Low	--	
	Cylinder jacket water outlet line pressure of main engine/auxiliary engine	Pressure	Low	--	

Category	Monitored parameter	Display	Alarm	Automatic shutdown or bypass*	Remarks
	Cooling water inlet temperature of main engine air cooler	Temperature	High/low	Excessively high	
	Cooling water inlet line pressure of main engine air cooler	Pressure	Low	––	
	Inlet temperature of thermal oil	Temperature	High	Excessively high	
	Inlet line pressure of thermal oil	Pressure	Low	––	
	Inlet temperature of excess steam of exhaust gas boiler	Temperature	High/low	Excessively high	
	Inlet line pressure of excess steam of exhaust gas boiler	Pressure	Low	––	
	Outlet temperature of preheater	Temperature	High/low	––	
	Outlet temperature of overboard seawater	Temperature	High	––	
	Inlet temperature of seawater	Temperature	High/low	––	
	Inlet line pressure of seawater	Pressure	Low	––	
Prime mover	Bearing temperature of prime mover	Temperature	High	––	
	Speed of prime mover	Speed	--	Overspeed	
	Radial vibration of prime mover bearing	Vibration	High	Excessively high	
	Axial/radial displacement of prime mover rotor	––	Large	Excessively large	
WHG generator	Voltage of WHG generator	Voltage	High/low	––	Read all phases
	Frequency of WHG generator	Frequency	High/low	––	For AC generators only
	Current of WHG generator	Current	––	––	Read all phases
	Power of WHG generator	Power	––	––	

Category	Monitored parameter	Display	Alarm	Automatic shutdown or bypass*	Remarks
	Stator winding temperature of WHG generator	Temperature	High	––	Read all phases: Generator power greater than 500 kW.
	WHG generator main switch open/close	Open/close	––	––	
	Operation of WHG generator	Running	––	––	
	Failure of WHG generator	––	Failure alarm	––	
	Failure of WHG generator cooling pump or fan	––	Failure alarm	––	If applicable
	Excitation voltage and current of WHG generator	Voltage/current	––	––	If an electric excitation system is provided
WHG generator converter	Voltage of WHG generator converter (output)	Voltage	––	––	
	Current of WHG generator converter (output)	Current	––	––	
	Overload of WHG generator converter (high current)	––	High current	––	Alarm before the protection device operates
	Cooling medium temperature of WHG generator converter	Temperature	High	––	If applicable
	Failure of cooling pump or fan of WHG generator converter	––	Failure alarm	––	If applicable
	Temperature of inter-phase reactor	Temperature	High	––	
	Protection trip of filter	––	Trip	––	

Category	Monitored parameter	Display	Alarm	Automatic shutdown or bypass*	Remarks
	circuit				
Miscellaneous	Power supply of control, monitoring, alarm and safety system	Voltage	Failed	--	The presence of voltage can be indicated by a signal indicator.
	Sensor status	--	Failed	Failed	Sensors for triggering automatic stop and bypass functions
	Pump in WHG in operation	Running	Failed	--	
	Fan specified in 3.6.1, Chapter 3 of the Guidelines	Running	Failed	Failed	
	Emergency shutdown of WHG	--	At runtime	At runtime	
	Circuit media gas detection concentration	Gas concentration	High	High	

The symbols and their meanings in the Table are as follows:

--: Not required;

*: Applicable to the bypass provided according to 2.5.2 of the Guidelines.

Chapter 8 Surveys

8.1 General provisions

8.1.1 In addition to the provisions of this Chapter, the survey of the WHG is to comply with the relevant requirements of the Rules and other applicable sections of the Guidelines.

8.1.2 The WHG survey categories are to include product survey, survey during construction and survey after construction.

8.2 Plan approval

8.2.1 Before the commencement of construction, the applicant is to submit the plans and documents specified in 1.5 of the Guidelines to ISC for approval.

8.3 Product surveys

8.3.1 Components and parts of key equipment, piping, and valves related to the WHG are to meet the applicable certification requirements specified in Appendix 1A, Chapter 3, PART ONE of the Rules. Welding, heat treatment, and non-destructive testing for piping systems and pressure vessels (if any) are to be carried out in accordance with the relevant documents approved by ISC.

8.4 Surveys during construction

8.4.1 Before the construction/retrofitting of the WHG, the applicant is to submit a written application for construction survey/in-service surveys to ISC or sign a survey contract.

8.4.2 Design review and survey are to be carried out for the manufacturer's self-manufactured equipment in accordance with the provisions for product surveys in 8.3 of the Guidelines. When the equipment is assembled, the ISC field surveyors are to inspect the equipment assembly, pipelines, and electrical installations according to the approved drawings and test procedures, and witness the pressure and functional tests of the relevant equipment or pipelines.

8.4.3 Before the commencement of construction/retrofitting, ISC field surveyors are to inspect and confirm the relevant preparations, e.g.: construction work plan, construction/welding procedures, welder/non-destructive testing personnel qualifications, list of marine product certificates, welding specifications, non-destructive testing plan, tightness test plan, inspection/test items, and necessary technical information, i.e. plans and documents before commencement of construction. For individual projects that do not affect the commencement of construction, ISC field surveyors may carry out inspection and confirmation case by case before the relevant construction/retrofitting stage.

8.4.4 ISC field surveyors are to approve the construction procedures and test programs, and carry out surveys according to the approved drawings, documents, procedures and test programs.

8.4.5 The as-built documents are to include installation reports, test reports and equipment delivery certificates.

8.4.6 The installation of the WHG is to be checked whether it is in compliance with the drawings so as to verify its performance and operation meet the design requirements.

(1) Pumps

① visual inspection;

② the safety device alarm and shutdown functional test is satisfactory;

③ starting and shutdown test;

④ check the parameters of pumps.

(2) Heat exchangers (evaporators, condensers, preheaters (if applicable), etc.)

① visual inspection;

② inlet and outlet pressure and temperature of heat exchangers are in compliance with the design requirements.

(3) Pressure vessels

① visual inspection and internal inspection;

② the pressure, temperature, and level alarms, along with the shutdown protection measures, are to be tested by means of simulation.

(4) Gas detection system

① confirm the installation of gas detection system meeting the relevant requirements in 7.4 of the Guidelines;

② confirm that the gas detectors have been calibrated by the qualified firms;

③ confirm that the gas detection system has been commissioned and meet the requirements.

(5) Circuit media circulation, heating and cooling piping systems

① visual inspection;

② check for leaks and looseness at the connections of flanges, valves, and accessories;

③ hydraulic test;

④ safety alarm and shutdown functional test are satisfactory.

(6) Other specialized equipment such as the exhaust gas boilers, steam turbines, exhaust gas turbines and generators, etc. are to be installed and surveyed in accordance with the requirements of the Rules.

8.4.7 An operation and maintenance manual for the WHG is to be available on board.

8.4.8 After the WHG is installed on board, an effectiveness test is to be conducted to verify that the relevant systems and equipment function normally and operate stably, with key operating parameters maintained within the design range. The test is to consider various operating conditions and load conditions. Test items are to include the implementation measures of risk analysis, as well as the control, monitoring alarms, and safety protections related to the system operation.

8.4.9 If other post-treatment systems (e.g., EGC, SCR, EGR) are installed in the exhaust system in addition to the WHG, compatibility between these systems is to be checked during the test.

8.5 Surveys after construction

8.5.1 Annual survey, intermediate survey and special survey are to be carried out for WHG:

(1) The survey items for annual and intermediate survey include visual inspections and operational record verification;

(2) In addition to meeting the requirements in (1), the special survey is to comply with the relevant provisions in 8.4.6 and 8.4.7 of the Guidelines.

8.5.2 Where a WHG is retrofitted, renewed, damaged or repaired that may affect the system and/or the safety of the ship, an application for occasional survey is to be submitted to ISC in a timely manner.

Chapter 9 WHG Ready Technology Requirements for Shipborne

9.1 General provisions

9.1.1 This Chapter applies to WHG Ready ships which are intended for WHG installation in future. Such ships are also to meet the applicable requirements of the relevant Administrations.

9.1.2 This Chapter provides the requirements of design, arrangement, space reservation, structural strengthening and survey for the WHG Ready ships.

9.1.3 This Chapter intends to clarify the WHG Ready requirements and provides technical guidance for the subsequent installation of WHG onboard the ships.

9.2 Ready requirements

9.2.1 The WHG Ready is to meet the following functional requirements:

(1) the layout and design of WHG Ready are to reduce the probability and consequences of risks related to WHG to a minimum level;

(2) if the WHG equipment is installed, necessary safety measures are to be initiated in the event of its failure, taking into account that these measures will not cause unacceptable power loss to the ship;

(3) the WHG Ready is to be arranged by taking the consideration to minimize the potential risks that may affect the safety of ships, personnel, and equipment on board the ships.

9.2.2 Ships applying for the class notation WHG Ready 1 are to comprehensively consider the space required for installation and maintenance, as well as the potential impact on ship layout, equipment, electrical load, structural strength, stability, tonnage, and deadweight capacity.

9.2.3 Ships applying for the class notation WHG Ready 2 are to meet the relevant requirements of the class notation WHG in the Guidelines, in addition to the requirements in 9.2.2 of the Guidelines. The installation of WHG-related equipment and systems on board may be exempted.

9.2.4 Ships applying for the class notation WHG Ready 2(X) are to meet the relevant survey requirements related to the suffix "X", in addition to the requirements in 9.2.2 and 9.2.3 of the Guidelines.

9.3 Plans and documents

9.3.1 In addition to submitting plans and documents in accordance with the relevant requirements of ISC rules and guidelines, ships applying for the class notation WHG Ready 1 are also to provide:

(1) The followings are to be submitted for approval, as a minimum:

① General Arrangement, including the reserved layout of WHG;

② Power Load Calculation sheet.

(2) The followings are to be submitted for information, as a minimum:

① WHG Ready and layout instructions;

② WHG steam consumption calculation sheet (if applicable);

③ Longitudinal Strength Calculation sheet (taking into account the impacts of WHG on ship weight distribution).

9.3.2 Ships applying for the class notations WHG Ready 2 or WHG Ready 2(X) are to submit the plans and documents in accordance to the requirements in 1.5 of the Guidelines.

9.4 Surveys

9.4.1 Ships applying for the class notation WHG Ready 2(X) are to be surveyed in accordance with the applicable requirements in Chapter 8 of the Guidelines.