GUIDANCE NOTES
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INTERNATIONAL SHIP CLASSIFICATION

GUIDELINES FOR APPLICATION OF EXHAUST GAS RECIRCULATION (EGR) SYSTEMS ONBOARD SHIPS

2020

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INTRODUCTION

The requirements of international conventions, relevant regions and countries on marine diesel engine NOx emission control are becoming more and more stringent, thus prompting the industry to study and apply a variety of emission reduction technologies to reduce NOx emissions from ships.

In order to meet the Tier III NOx emission standard in Regulation 13 of MARPOL Annex VI, three major technologies are currently available on ships, namely:

(1) Selective Catalytic Reduction (SCR);

(2) Exhaust Gas Recirculation (EGR);

(3) Clean alternative fuel.

EGR is a technology adopted to reduce NOx emission from diesel engines or for other purposes.

For a diesel engine using EGR emission reduction technology, generally part of the exhaust gas is bypassed, which will then enter the cylinder after being treated and mixed with fresh air, to reduce the oxygen concentration and combustion temperature in the combustion chamber, thus reducing the NOx production in the cylinder. During the operation of the ship, the working mode can be changed according to the emission requirements of the actual operating area, such as Tier III mode and Tier II mode. Before the recirculated exhaust gas enters the cylinder, it is generally required to be subject to treatment such as cooling, cleaning, desulfurization (when the sulfur content of the fuel used is high), etc. For this purpose, additional auxiliary systems such as washwater circulating, alkali supply (if needed), washwater treatment, etc. are also required.

When the EGR technology is applied onboard a ship, operation of the relevant systems and equipment, changeover of diesel engine working mode, and the use of chemicals, etc. may affect safe operation of the ship, therefore, risk identification and assessment is needed to be carried out and appropriate measures are to be taken to control those risks, in order to prevent unacceptable harm on the safety of ships, essential equipment (such as diesel engines) and persons onboard ships.

From the perspective of ship safety, the Guidelines provide the design, manufacture, installation, arrangement, control, monitoring, survey and test requirements for relevant systems and equipment when the EGR technology is applied onboard ships to meet NOx emission requirements. As a supplement to the Rules, the Guidelines aim to provide guidance for ship design, construction, survey and test, etc.

CHAPTER 1 GENERAL

1.1 Application

1.1.1 The Guidelines apply to exhaust gas recirculation systems (hereinafter referred to as EGR systems) and related auxiliary systems installed to reduce NOx emissions from marine diesel engines.

Note: For EGR systems and related auxiliary systems of novel design or that are installed for other purposes, the applicable requirements in the Guidelines may be determined based on the specific design.

1.1.2 The Guidelines specifies the requirements for the design, manufacturing, installation and arrangement, control and monitoring, and testing and survey of the EGR systems and auxiliary systems.

1.1.3 The requirements of the Guidelines are only supplementary to ISC rules. EGR systems and auxiliary systems, in addition to satisfying the requirements of the Guidelines, are also to comply with the relevant requirements of ISC Rules for Classification of Sea-going Steel Ships (hereinafter referred to as ISC Steel Ship Rules) or other applicable Rules.

1.1.4 If an auxiliary system for treating recirculated exhaust gas is installed to ensure the normal operation of an EGR system, any discharge water from the EGR auxiliary system is to comply with the provisions of the 2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-off Water (Resolution MEPC.307 (73)).

1.1.5 The EGR system is to be subject to validation test together with the diesel engine.

1.1.6 Where ISC is authorized by the Administration to issue the IAPP certificate specified by MARPOL Annex VI, emission compliance verification in accordance with the ISC Guidelines for Testing and Survey of Emission of Nitrogen Oxides from Marine Diesel Engines is also to be carried out.

1.2 Class notation

1.2.1 Ships installed with EGR systems and related auxiliary systems for reduction of NOx emission may be assigned with NEC (EGRS) notation upon satisfactory survey provided that these systems are designed, manufactured, installed, arranged and tested according to the applicable requirements of the Guidelines and are verified for NOx emission compliance according to the Guidelines for Testing and Survey of Emission of Nitrogen Oxides from Marine Diesel Engines, and the discharge water is in compliance with the 2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-off Water .

1.3 Definitions and abbreviations

1.3.1 Definitions

(1) **Exhaust Gas Recirculation** means a process of introducing part of the exhaust gas from the diesel engine back to the cylinder in order to reduce NOx emission from the diesel engine or other purposes.

(2) **Exhaust Gas Recirculation System** means the relevant equipment, components and systems additionally installed or modified on a diesel engine to achieve the purpose and process defined in (1) above, generally including the EGR unit, valves, EGR blower(s) and control, monitoring and alarm system, etc., collectively referred to as the EGR system, as shown in Figure 1.3.1 (1).

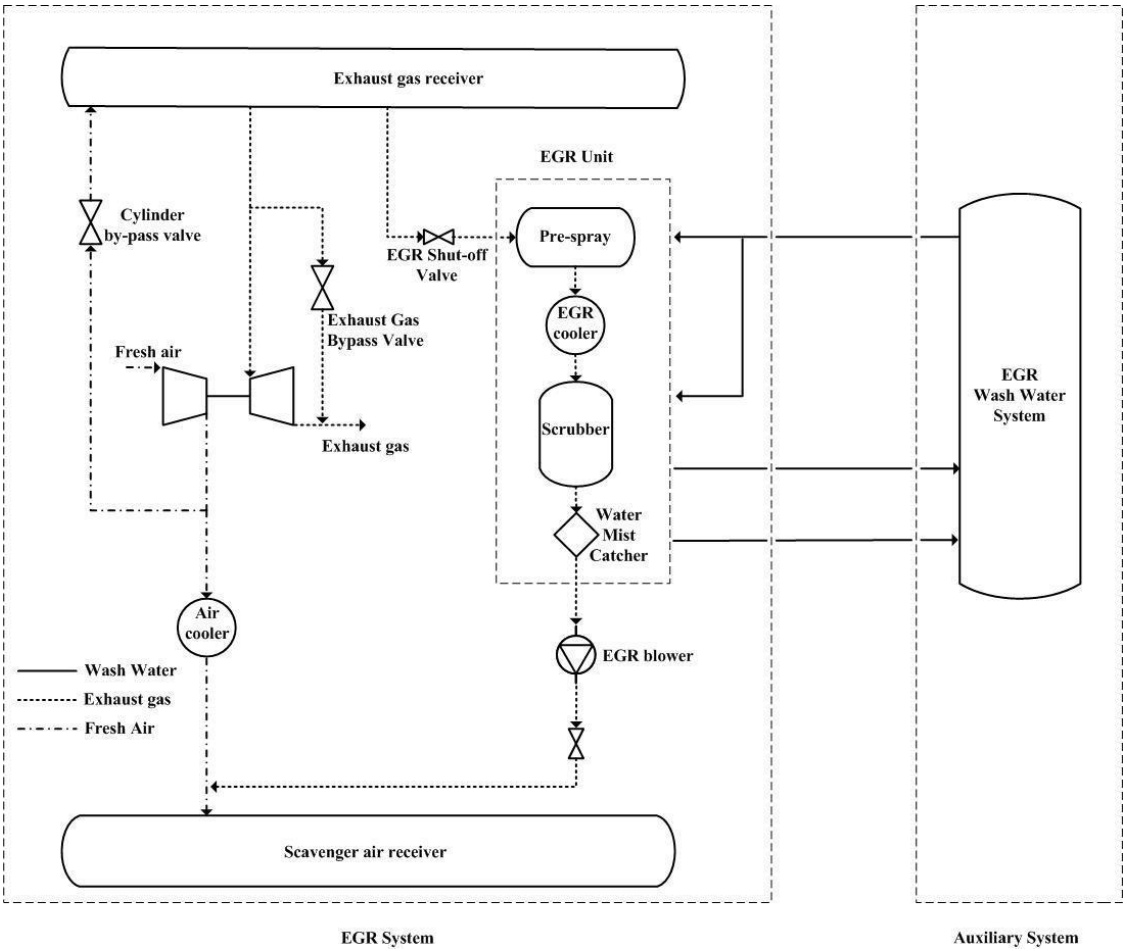

Figure 1.3.1(1) Typical EGR system and auxiliary system diagram

(3) **Auxiliary System** means the relevant systems and equipment provided for treating recirculated exhaust gas, as shown in Figure 1.3.1 (2), normally including wash water, Alkali solution supply, discharge water, residue, seawater/fresh water, control, monitoring and alarm system, etc.

Note 1: Diesel engines using different types of fuel and of different sulfur content will pose different requirements for recirculated exhaust gas treatment, and the auxiliary systems used for exhaust gas treatment may be of different design to satisfy those exhaust gas treatment requirements. In this case, the applicable requirements of auxiliary systems to be satisfied may be determined according to the actual design.

Note 2: In the Guidelines, the alkaline chemical added for recirculated exhaust gas desulfurization usually means NaOH, and are generally stored and used on board ships in aqueous solution of a certain concentration. The relevant requirements in the Guidelines are provided based on the characteristics of NaOH solution. If another alkaline chemical is used, the applicant is to assess the characteristics of the chemical, identify the possible risks of storage and use of such chemical, and submit relevant information for consideration by ISC.

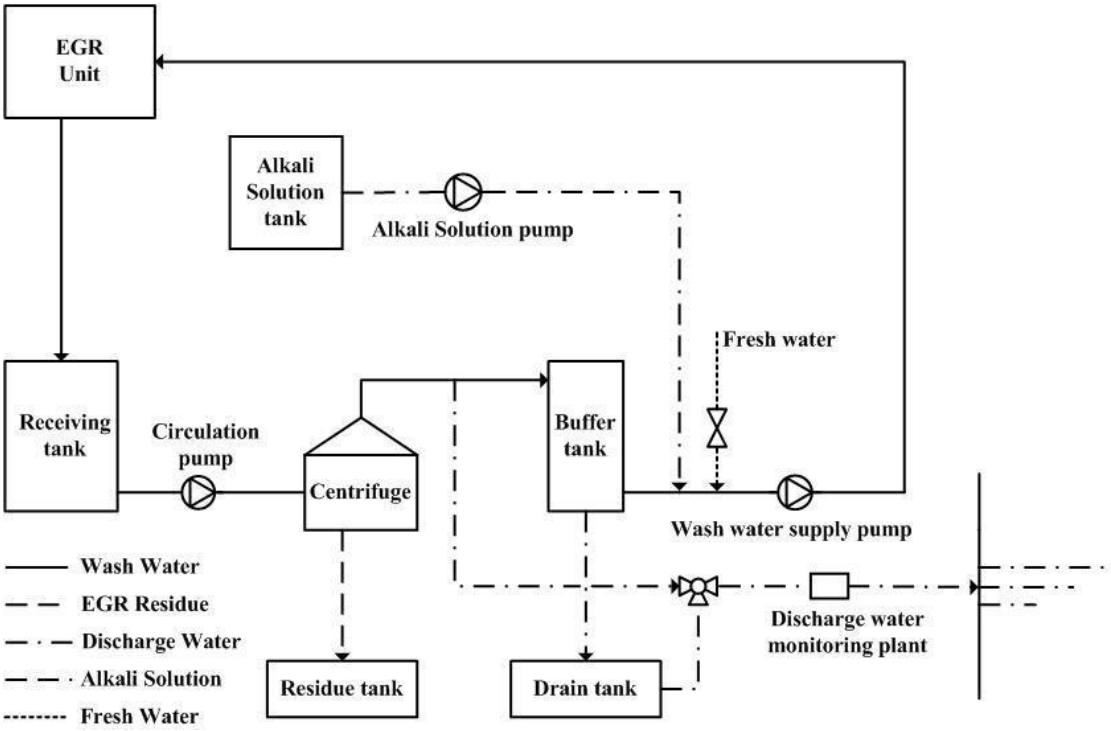

Figure 1.3.1(2) Typical EGR auxiliary system diagram

(4) **EGR Unit** means a unit used for mixing recirculated exhaust gas with washing water to conduct exhaust gas treatment processing, including cooling, washing and desulphurization (if applicable), etc. It generally includes parts or equipment such as pre-spray, cooler, main scrubber, gas-liquid separator, etc.

(5) **Washwater** means cleaning medium introduced to remove SOx, soot, particulates, etc. from exhaust gas.

(6) **Discharge Water** means any water from an EGR auxiliary system to be discharged overboard.

(7) **Washwater Treatment Plant** means a plant used to purify washwater to make it suitable for recirculated exhaust gas treatment or to meet the discharge criterion for discharge water.

(8) **EGR Residue** means material removed from the washwater or the bleed-off water by a treatment system or discharge water that does not meet the discharge criterion, or other residue material removed from the EGR.

(9) **Alkali Solution** means NaOH solution.

(10) **EGR Blower** means a blower provided for the flow of recirculated exhaust gas.

1.3.2 Abbreviations and symbols

(1) EGR: Exhaust Gas Recirculation;

(2) NOx: Nitrogen oxides;

(3) SOx: Sulphur oxides;

(4) NaOH: Sodium hydroxide.

1.4 Goals and functional requirements

1.4.1 The Guidelines are intended to provide standards for the design, manufacturing, arrangement, installation, survey and testing of EGR systems and related auxiliary systems, so as to minimize

the unacceptable hazards to the ship, essential equipment and personnel onboard due to the installation and operation of EGR systems and related systems.

1.4.2 To achieve the above mentioned goals, the design, manufacturing, installation and arrangement of EGR systems is to comply with the following functional requirements:

(1) Adapting to the environmental and working conditions of ship operation;

(2) EGR systems are to be compatible with diesel engines to ensure that NOx emission from a diesel engine installed with EGR meets regulatory requirements and that the installation and operation of the EGR system will not affect the safety of diesel engines, or appropriate measures can be taken to eliminate/reduce these impacts;

(3) The material used is to be suitable for the medium coming into contact with them and working environment;

(4) It is to be considered that the continuous and reliable operation of diesel engines will not be affected in all kinds of working modes and under all kinds of circumstances;

(5) Minimizing potential risks caused by the use of chemical substances;

(6) Preventing the backflow of washwater to diesel engines;

(7) Avoiding harms to the crew or other equipment due to high temperature, running equipment, etc.;

(8) Avoiding the accidental accumulation or spread of inflammable, explosive, toxic gases;

(9) Taking appropriate controls, monitoring and safety protection to ensure its safe and reliable operation;

(10) Appropriate fire protection, fire detection and fire extinguishing measures are to be taken in response to the potential fire risk;

(11) Facilitating inspection, maintenance and internal parts replacement of related systems and equipment.

1.5 Risk analysis

1.5.1 A recognized method for risk analysis/assessment (such as IEC/ISO 31010) is to be used to analyze and evaluate the safety issues in relation to the design, arrangement and operation of EGR systems and auxiliary systems and appropriate measures are to be taken to control the identified risks.

1.5.2 The following possible risks are generally to be taken into account during risk analysis:

(1) adaptability to the environmental and working conditions;

(2) impacts on the safe operation of diesel engines;

(3) accidental accumulation or spread of inflammable, explosive and toxic gases;

(4) leakage and spread of chemical substances;

(5) harms to the crew or other equipment due to high temperature and running equipment, etc.;

(6) potential fire risks.

1.5.3 The risk analysis report is generally to include the following aspects:

(1) standards and methodology for risk analysis;

(2) assumptions and prerequisites of the analysis;

(3) analysis objects, such as the system, equipment and operation, etc.;

(4) potential risks;

(5) causes for the risks;

(6) possible effects of the risks;

(7) measures taken to prevent or reduce the impacts of risks and implementation.

CHAPTER 2 SYSTEM DESIGN AND ARRANGEMENT

2.1 General requirements

2.1.1 The machinery, electrical equipment and controls systems comprising an EGR system and auxiliary systems are to be designed, type selected and arranged in accordance with the environmental/working conditions specified in PARTs THREE, FOUR & SEVEN of ISC Rules for Classification of Sea-going Steel Ships respectively.

2.1.2 Appropriate protective measures are to be provided in accordance with 1.3.6, Chapter 1, PART THREE of ISC Rules for Classification of Sea-going Steel Ships to prevent injury to persons on board that might be caused by the operation and maintenance of the system.

2.1.3 Where soot sediment and deposit may occur during the operation of the system, appropriate measures are to be taken to control those risks.

2.1.4 The EGR system is to be designed by the diesel engine manufacturer, the designer or an authorized body.

2.1.5 Necessary measures are to be taken to ensure that the diesel engine can run continuously when the EGR system is not in operation.

2.1.6 The design of the system is to ensure that the diesel engine can run continuously and stably under the applicable working mode and during the change-over of working mode.

2.1.7 Shaft vibration of diesel engines installed with EGR systems is to comply with the relevant provisions of Chapter 12, PART THREE of ISC Rules for Classification of Sea-going Steel Ships, and the applicable working mode is to be considered.

2.1.8 The installation and arrangement of the system is to facilitate operation and maintenance.

2.2 Compatibility with diesel engines

2.2.1 The EGR system is to be compatible with the diesel engine to be installed without any adverse effect on the safety of the diesel engine.

2.2.2 The fuel requirements applicable to the system are to be specified, such as fuel type, sulfur content, etc., and are to be included in the EGR technical specification and the operation manual.

2.2.3 The adjustment range of the recirculated exhaust gas is to be able to ensure that NOx emission of the diesel engine continuously meets the requirements of the regulations.

2.2.4 If an auxiliary system is provided for the treatment of recirculated exhaust gas, its treatment capacity is to be able to adapt to the amount of recirculated exhaust gas and the working parameters under various working conditions.

2.3 EGR systems

2.3.1 The exhaust piping before the entry of exhaust gas into the EGR unit is to meet the following requirements:

(1) The material, design, manufacture, installation and arrangement are to meet the requirements for the diesel engine exhaust system in PART THREE of ISC Rules for Classification of Sea-going Steel Ships;

(2) A recirculated exhaust gas shut-off valve is to be provided and the action of the valve is to be automatically controlled through the EGR control system. The provided shut-off valve is to meet the following requirements:

①It is to be able to adapt to the characteristics of exhaust gas from the diesel engine under various

working conditions, such as exhaust temperature, dust, SOx, etc.

②The working state of the valve is to be monitored and the position of the valve is to be indicated correctly.

③Measures are to be taken to prevent failure such as valve seized due to dust accumulation.

④Measures are to be taken to prevent the leakage of exhaust gas;

⑤It is to be fail-safe type. In case of a failure, continuous operation of the diesel engine is to be ensured.

2.3.2 Before the recirculated exhaust gas and air are mixed and introduced into the cylinder, necessary cooling, desulfurization and dehumidification, etc. are to be carried out as required to ensure that the diesel engine and its system and components will not be damaged.

2.3.3 If washwater is used to treat the exhaust gas, effective measures are to be taken to prevent washwater from entering the diesel engine.

2.3.4 The EGR unit for exhaust gas treatment is to be designed in accordance with the relevant requirements in 3.1, Chapter 3 of the Guidelines.

2.3.5 The exhaust gas temperatures before and after the EGR unit and the pressure drop of the exhaust gas through the EGR unit are be monitored.

2.3.6 Effective measures are to be taken to prevent supercharged air from flowing back to the exhaust gas side of the diesel engine through the EGR loop.

2.3.7 Measures are to be taken to ensure that the recirculated exhaust gas is fully mixed with the supercharged air.

2.3.8 The exhaust piping and components after the EGR unit are to be considered for possible corrosion risk.

2.4 Supercharging-scavenging system for diesel engines

2.4.1 The supercharging-scavenging system of a diesel engine is to be able to work steadily and reliably when the diesel engine runs under various working modes and during the change-over of the working modes, so as to ensure the normal operation of the diesel engine.

2.4.2 If the supercharging-scavenging system is provided with exhaust bypass valves and pressurized air bypass valves, the operation of these valves is to be automatically controlled by the control system.

2.4.3 The exhaust gas bypass valves and the pressurized air bypass valves are to be fail-safe. In case of a failure, the diesel engine is to be able to operate safely. The working state of the valves is to be monitored and the working position of the valve is to be properly indicated.

2.4.4 The oxygen content of the mixture of the exhaust gas and supercharged air is to be measured, and the oxygen content measurement sensors are be redundant to ensure that even if one of the sensors fails, the remaining sensors can still accurately output oxygen concentration parameters for the control of the EGR system.

2.4.5 If onboard compressed air is used for oxygen sensor calibration, the air used is to meet the relevant requirements of the equipment manufacturer.

2.5 Washwater system

2.5.1 For the collection tank (if fitted), piping and its fittings forming the washwater system, appropriate material is to be selected according to the temperature, pH and other characteristics of the contact medium. If plastic pipes are used, they are to meet the requirements for exhaust gas cleaning system effluent line in 2.4.3 and Appendix 1 of Chapter 2, PART THREE of ISC Rules for Classification of Sea-going Steel Ships.

2.5.2 The capacity of the washwater collection tank is to be sufficient to collect all washwater in the EGR unit and piping.

2.5.3 Washwater collection tank isto be provided with liquid level indication device.

2.5.4 A necessary washwater cooling system is to be provided if needed by exhaust gas treatment. Washwater inlet temperature of the EGR unit is to be monitored.

2.6 Discharge water system

2.6.1 Overboard discharge of discharge water is to meet the requirements of the IMO 2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-off Water.

2.6.2 The overboard discharge water system of the EGR auxiliary system is not to be interconnected to other systems except the ship exhaust gas cleaning system. The discharge pipelines, valves and fittings are to take into account the corrosion-resistant means. Where dissimilar metals are used, consideration is to be given to galvanic corrosion.

2.6.3 It is to be ensured that the overboard discharges are always below the overboard water level in normal draught and inclining conditions (including ballast conditions) and measures are to be taken to prevent backflow of the overboard water.

2.6.4 The overboard discharges are to be away from the sea suctions in so far as practicable and to take into account the vessel propulsion features to prevent corrosion to the propellers, thrusters or shell platings. Overboard discharge piping is to be provided with necessary sampling positions, the arrangement of which is to enable safe sampling of discharge water.

2.7 Alkali Solution system

2.7.1 Suitable stainless steel or other anticorrosive material is to be selected or suitable anticorrosive coatings are to be applied for the piping systems, tanks and drip trays related to the storage, filling and transfer of alkali or any other components which may come into contact with the alkali solution. Aluminum, zinc, brass, or galvanized steel components are not to be used. The alkali solution piping is to meet the relevant requirements for class I piping.

2.7.2 The capacity of the alkali solution tank is to be determined by considering the intended operation route of the ship, the sulfur content of fuel oil intended to be used, the amount of the recirculated exhaust gas and other factors.

2.7.3 Considering that too high or too low temperature may adversely affect the characteristics of the alkali solution, the necessary heating and/or cooling systems are to be provided for the alkali solution storage tanks according to the ship's route or operating area and the applicable range of alkali solution storage temperatures.

2.7.4 The arrangement of the alkali solution storage tanks is to take into account the impacts of heat transfer from other heated tanks or facilities, to be away from boilers, steam piping, exhaust piping and other heat sources as far as possible, so that when spillage or leakage occurs, the solution will not fall onto heated surfaces.

2.7.5 Air pipes, overflow pipes and sounding devices are to be provided for alkali solution storage tanks in accordance with Section 10, Chapter 3, PART THREE of ISC Rules for Classification of Sea-going Steel Ships. The outlets of air pipes and sounding pipes (if provided) are to be led to a safe location on the open deck and necessary measures are to be taken to prevent harms to the personnel. The spilled alkali is to be led to appropriate overflow tanks or other tanks.

Where high level alarms are provided instead of overflow pipes for alkali solution storage tanks, the following requirements are to be complied with:

(1) the design pressure of the alkali solution storage tanks is to take into account the hydrostatic pressure generated by the height from the tank bottom to the air pipe outlet; and

(2) suitable alkali coamings is to be provided below the air pipe outlet.

2.7.6 The alkali solution storage tanks are to be provided with local temperature and level indicators and the alkali temperature and liquid level in the storage tanks is to be indicated at the EGR operating position.

2.7.7 In the alkali solution system, drip trays are to be provided where leakage may be expected to prevent the alkali leakage from falling onto or spreading to other structures or equipment and therefore causing damages.

2.7.8 Drip trays are to be provided with drainage arrangements draining alkali in the trays to the overflow tank or other appropriate tanks. The drain line is to be fitted with a non-return valve. Alternatively, leakage monitoring devices and quick-closing valves are to be fitted which can cut off alkali automatically and quickly when leakage occurs. When this design is adopted, the capacity of the drip tray is to be sufficient to hold possible leakage.

2.7.9 The alkali bunker station(s) is to be located on the open deck away from sources of ignition and arranged such that a spill at a bunker station would not result in alkali contacting or mixing with other incompatible materials. Alternatively, closed or semi-enclosed bunker stations may be accepted subject to the provision of effective ventilation. Drip trays are to be provided according to the requirements of 2.7.7 and 2.7.8 of this Chapter at bunkering joints or other locations where spillage may occur. Necessary measures are to be taken at bunkering joints to prevent splashing of alkali.

2.7.10 Every pipe emanating from a storage tank, which, if damaged, would allow alkali to escape from the tank, is to be provided with a quick closing valve located directly on the tank. The valve is to be operable from a readily accessible safe location in addition to be able to be closed locally.

2.7.11 An alkali storage tank is not to be located in control stations, accommodation and service spaces. If the storage tank is installed in a separate space, the space is to be served by an effective mechanical ventilation system of extraction type providing not less than 6 air changes per hour which is independent from the ventilation systems of control stations, accommodation and service spaces. The ventilation system is to be capable of being controlled from outside the space, the ventilation outlet of which is to be as far away as possible from the ventilation inlets of control stations, accommodation and service spaces. A warning notice indicating “Ventilation is Required before Entering the Space” is to be provided outside the space adjacent to each point of entry.

If the alkali storage tank is located within the engine room, a separate ventilation system is not required when the general ventilation system for the space providing not less than 6 air changes per hour is arranged so as to provide an effective movement of air in the vicinity of the storage tank and is maintained in operation continuously except when the storage tank is empty and has been thoroughly ventilated.

The enclosed compartment adjacent to the alkali storage tank and frequently visited by persons is also to meet the above requirements if there is a risk of alkali leakage into the enclosed compartment.

2.7.12 If the alkali storage tank is arranged adjacent to the fresh water tank, boiler water tank, fuel oil tank and lubricating oil tank, they are to be separated by cofferdams.

2.7.13 The supply of alkali is to be controlled automatically to ensure that the desulfurization efficiency of the system satisfies the design requirements continuously.

2.7.14 The alkali system is to be independent of other piping systems onboard and is not to be fitted in or through the accommodation, service spaces and control stations.

2.7.15 The alkali piping system is not to be arranged over boilers or in close proximity to steam piping, exhaust systems, hot surfaces required to be insulated, or other sources of ignition.

2.7.16 If the alkali pipelines passes through a low temperature area, measures are to be taken to prevent the lines from being blocked by alkali crystallization.

2.7.17 The joints of the alkali pipe lines are to be kept to a minimum. The direct connections of pipe lengths are to be all welded except for necessary flanged connections to valves and other

equipment for maintenance in order to minimize risk of leakage from the pipe lines.

2.7.18 The design and arrangement of alkali piping system is to be such that accumulation of alkali is to be prevented, and draining and flushing facilities are to be provided which drain and flush in a timely manner when the desulfurization system stops operation.

2.7.19 For the protection of persons onboard, the ship is to have on board suitable personnel protective equipment, consisting of protective clothing, boots, gloves and tight-fitting goggles or masks for chemical protection. The number of personnel protective equipment carried onboard is to be appropriate for the number of personnel engaged in regular handling operations or that may be exposed in the event of leakage of alkali; but in no case is there to be less than two sets available onboard. Protective equipment are to be stored in easily accessible lockers outside the accommodation.

Eyewash and safety showers are to be provided, the location and number of these eyewash stations and safety showers are to be derived from the detailed installation arrangements. As a minimum, the following stations are to be provided:

(1) In the vicinity of transfer or treatment pump locations. If there are multiple transfer or treatment pump locations on the same deck then one eyewash and safety shower station may be considered for acceptance provided that the station is easily accessible from all such pump locations on the same deck.

(2) An eyewash station and safety shower is to be provided in the vicinity of the alkali bunkering station on-deck. If the bunkering connections are located on both port and starboard sides, then consideration is to be given to providing two eyewash stations and safety showers, one for each side.

(3) An eyewash station and safety shower is to be provided in the vicinity of any part of the alkali system where a spillage/drainage may occur and in the vicinity of system connections/components that require periodic maintenance.

2.8 Residue system

2.8.1 The residues generated from the EGR treatment process are to be stored in a designated residue tank, arranged for discharge to appropriate shore reception facilities.

2.8.2 The residue tank is to be designed to facilitate cleaning. Where residue tanks are also used as the overflow tank for the alkali storage tank, the relevant requirements for the alkali storage tank are also to be complied with.

2.8.3 The material of the residue tank, residue piping and shore discharge equipment is to be selected based on the corrosive nature of the residue.

2.8.4 Residue tank capacities are to be designed according to the amount of residue expected to be produced, by considering the kinds and number of installed exhaust gas processing systems as well as the maximum number of days between ports where residue can be discharged ashore. In the absence of precise data, a figure of 30 days is to be used.

2.8.5 The residue tank is to be provided with air pipes and sounding devices in accordance with Section 10, Chapter 3, PART THREE of ISC Rules for Classification of Sea-going Steel Ships. The outlets of air pipes and sounding pipes, if fitted, are to be led to safe locations on the open deck.

2.8.6 The residue tank is to be provided with a high level alarm.

2.9 Seawater/fresh water system

2.9.1 The seawater and/or fresh water system serving the EGR system is to comply with the relevant requirements of Chapters 1, 2, 3, PART THREE of ISC Rules for Classification of Sea-going Steel Ships.

2.9.2 Where the seawater/fresh water system of the EGR system is interconnected with other

systems onboard, reliable means preventing backflow of water are to be provided.

2.9.3 The capacity of the seawater/fresh water system is to be sufficient to provide the EGR system with the required seawater/fresh water at the system's maximum working load without affecting normal operation of other essential auxiliary systems.

CHAPTER 3 SYSTEMS AND EQUIPMENT

3.1 EGR Unit

3.1.1 The EGR unit and its components are to be made of corrosion-resistant stainless steel or other corrosion-resistant materials to be capable of withstanding acid and alkali corrosion and temperature changes of the medium with which the unit and its components are likely to come into contact.

3.1.2 Appropriate measures are to be taken so that when EGR stops working, all of the washwater in the EGR unit can be drained.

3.1.3 Leakage of exhaust gas and/or washwater from the EGR unit into the space where the EGR unit is located is to be prevented.

3.1.4 Appropriate measures are to be taken to prevent the backflow of washwater from the EGR unit into the diesel engine.

3.1.5 Appropriate measures are to be taken to prevent forming of negative pressure in the EGR unit to ensure smooth discharge of wash water.

3.1.6 The EGR unit is to be provided with level indications and monitoring devices to give alarm when the level exceeds the limits.

3.1.7 Necessary inspection holes, passages and platforms are to be provided to facilitate replacement, inspection, repair, maintenance and cleaning of components.

3.1.8 The design and arrangement of the washwater spray system are to take into account the risks of deposit, clogging, abrasion and suitable flushing installation is to be provided.

3.1.9 Necessary cleaning facilities are to be provided to clean the EGR unit when EGR stops working to prevent deposit.

3.1.10 Necessary dehumidifiers are to be provided to prevent the desulfurized exhaust gas from leaving the EGR unit with droplets. The separated washwater is to be discharged into the designated collecting tank.

3.1.11 If the surface temperature of the EGR unit is likely to cause injury, it is to be protected by rails or enclosures. When the surface temperature of the EGR unit is likely to exceed 220 °C, the surface is to be provided with effective protective equipment to prevent the contact with combustible liquid and causing fire. If the surface of the insulation equipment is oil absorbent or is likely to be penetrated by oil, it is to be properly wrapped by steel plating or similar material.

3.2 Pressure vessels

3.2.1 Pressure vessels used in the EGR system are to be designed, manufactured, installed and tested in accordance with Chapter 6, PART THREE of the Rules for Classification of Sea-going Steel Ships.

3.3 Washwater treatment plants

3.3.1 If a washwater treatment plant is provided, the washwater after treatment is to meet the requirements of IMO 2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-off Water.

3.3.2 The washwater treatment capacity is to be able to meet the needs of normal operation of the EGR system under design conditions.

3.3.3 Discharge water monitoring systems are to be provided in accordance with IMO 2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-off Water.

3.3.4 The washwater treatment plants and their components are to be provided with suitable pressure release devices to prevent possible overpressure.

3.3.5 The installation and arrangement of the filters (if fitted) are to ensure continuous operation of the EGR system during cleaning and replacement.

3.3.6 Residues generated from washwater treatment are to be stored and treated in accordance with the provisions of 2.8 of Chapter 2 of the Guidelines.

CHAPTER 4 CONTROL, MONITORING AND SAFETY PROTECTION

4.1 General requirements

4.1.1 The control, monitoring and safety systems in relation to the EGR systems and auxiliary systems are to comply with the provisions of Chapters 1 and 2 of PART SEVEN of ISC Rules for Classification of Sea-going Steel Ships in addition to satisfying the requirements of this Chapter. For ships with AUTO class notations, the applicable requirements of Chapters 3 and 4 of PART SEVEN of ISC Rules for Classification of Sea-going Steel Ships are also to be complied with.

4.1.2 The computer systems used for control, monitoring, alarm and safety protection of EGR systems are to comply with the applicable requirements for computer system of category II in Section 6, Chapter 2, PART SEVEN of ISC Rules for Classification of Sea-going Steel Ships.

4.1.3 The electronic control system of the EGR system can be integrated into the diesel engine electronic control system, the electronic control system of the EGR auxiliary system can be integrated into the engine room control system, or it can be designed as a separate electronic control system.

4.1.4 When the diesel engine operates in non-EGR mode, the control, monitoring and safety protection systems related to EGR is still to work normally, unless the stop of these control, monitoring and safety protection systems will not affect safe operation of the ship and essential equipment.

4.1.5 In addition to being provided with monitoring, alarm and safety protection according to the requirements of 4.2 in this Chapter, the EGR system and auxiliary system is also to comply with the discharge water monitoring requirements of IMO 2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-off Water.

4.1.6 Where electronic record books are used, the requirements of MARPOL Annex VI and the Guidelines for the Use of Electronic Record Books under MARPOL (Resolution MEPC.312 (74)) are also to be complied with.

4.2 Control, monitoring and safety systems

4.2.1 The EGR system is to be capable of automatic control operation and be provided with means for manual operation to ensure the working parameters of the EGR system and relevant fuel oil units are maintained within the specified limits.

4.2.2 Monitoring, alarm and indication of the EGR system and the auxiliary system is to be provided generally according to the requirements of Table 4.2, or, specific monitoring, alarm and safety protection items may be determined through risk analysis according to the actual design. The control station of the EGR system is to be provided with relevant alarms and indications.

4.2.3 Emergency shutdown devices are to be provided in the local control station and central control room (if any) to stop the operation of the EGR system. The shutdown of the EGR system is not to affect the reliable operation of the diesel engine.

4.2.4 Where the remote control system (if any) fails, or in emergency, the EGR system is to be capable of being controlled and monitored locally. Important parameters required for the safe operation of the system as well as the working condition of the equipment are to be indicated in the local control station.

4.2.5 Upon activation of the safety shutdown system, alarms are to be given at the normal control position and at the local control position. Means are to be provided to indicate the parameters causing shutdown. In the event where shutdown by the safety shutdown system is activated, the restart should not occur automatically, unless after the system is manually reset.

4.2.6 For a ship with AUTO class notation(s), an EGR emergency shutdown device is also to be installed in the bridge and modes of alarms in the bridge control station are to be set according to the requirements in Table 4.2

Table 4.2 Monitoring, Alarm and Safety Protection of EGR-related Systems

Monitored Parameters	Display	Alarm activated	Automatic shutdown of EGR③	Modes of alarms⑤ in bridge control station
EGR fan	Running	Stop①		R④
EGR cutoff valve, exhaust bypass valve, pressurized air bypass valve, exhaust - air mixture valve (if provided)	Position			
Power source for EGR cutoff valve, exhaust bypass valve, pressurized air bypass valve, exhaust - air mixture valve (if provided)	Running	Failed	×	G_a
EGR unit exhaust inlet temperature	×	High		Y
EGR unit exhaust outlet temperature	×	High		Y
		Too high	×	G_a
Pressure drop of the exhaust gas through the EGR unit	×	High		Y
		Too high	×	G_a
Oxygen content of the diesel engine intake	×	Low/High		Y
		Too low/ too high	×	G_a
Failure of Scavenging box oxygen sensor		×		Y
Washwater pump and/or alkali solution pump	Running	Stop①		R④
Washwater and/or alkali supply pressure	×	Low①		R④
		Too low	×	G_a
Washwater and/or alkali supply temperature	×	High		Y
Water level in EGR unit (if applicable)	×	High		Y
		Too high	×	G_a
Alkali storage tank temperature	×	Low/High		Y
Alkali storage tank level	×	Low/High		Y
Alkali drip tray level (if applicable)	×	High②		Y
EGR Residue tank level	×	High		Y
Control, alarm and safety system power supply	Running	Failed		Y
EGR emergency shutdown	×	×	X	G_a

Notes: ×— Applicable.

① Standby fans and pumps are to be automatically started, where fitted, otherwise the EGR system is to automatically stop running and switch to Tier II mode automatically to ensure the continuous operation of the diesel engine;

② Alarm is to be given after alkali leakage is detected and the supply of alkali is to be cut off automatically;

③ The EGR system automatically stops running and switches to Tier II mode to ensure continuous operation of the diesel engine;

④ Standby fans and pumps are to be automatically started, where fitted, otherwise, G_a alarm is to be set;

⑤ Applicable to ships with AUTO class notations. The symbols in this column and their meanings are shown in 3.10.1.2, Chapter 3, PART SEVEN of ISC Rules for Classification of Sea-going Steel Ships.

CHAPTER 5 SURVEY AND CERTIFICATION

5.1 Plans and documents

5.1.1 The following plans and documents relating to the EGR system are to be submitted for approval or for information:

(1) Product technical specifications, including but not limited to the following

- EGR unit design treatment capacity;
- Working conditions and limitations, such as fuel type, sulphur content, applicable operating modes, operating mode changeover conditions and limitation, etc.;
- Main indicators, such as EGR rate, etc.

(2) General arrangement of the EGR system;

(3) EGR unit structural drawing and details, including joints, opening, nozzle, packing, dehumidification and other structural arrangement, etc.;

(4) EGR operating principle, flow chart and descriptions of the EGR system;

(5) Material details of the main components (including corrosion assessment of the materials used for contact media);

(6) Diagram and description of control, monitoring and safety protection system, including basic control strategy, setting, oxygen concentration monitoring position, etc.;

(7) Electrical systematic drawing;

(8) Test program;

(9) Risk analysis report (as specified in 1.5 of Chapter 1 of the Guidelines, for information);

(10) Operation manual (as specified in Chapter 6 of the Guidelines, for information);

(11) Calculations (for example, calculation of cooling and desulfurization capacity for recirculated exhaust gas, for information);

(12) Other drawings and documents as deemed necessary by ISC.

5.1.2 The following applicable drawings and documents relating to the installation of the EGR auxiliary system on board are to be submitted for approval or information:

(1) Arrangement plan, including bunker station, related systems and equipment, storage tank and information (for information);

(2) Detailed information on the chemicals used in exhaust gas treatment, including their corrosiveness, toxicity, flammability, chemical reactions, etc., as well as the relevant restrictions on their storage, transfer, treatment and usage (for information);

(3) Calculation of alkali storage tank capacity (for information);

(4) Arrangement of air pipes, sounding pipes and overflow pipes for the relevant tanks;

(5) Plans of main piping systems;

(6) Control, monitoring and safety protection system;

(7) List of alarm and display points;

(8) Shipboard test program;

(9) Other drawings and documents as deemed necessary by ISC.

5.1.3 In addition to the above requirements, the requirements for the submission of plans and documents in IMO 2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-off Water are to be complied with.

5.2 Surveys

5.2.1 The EGR system and the auxiliary system are generally to be subject to the following class surveys: product survey, initial survey and in-service survey in addition to the relevant statutory surveys as provided in 1.1.6 of Chapter 1 of the Guidelines.

5.2.2 **Product survey**. The first diesel engine installed with the EGR system and the auxiliary system (if applicable) are to be surveyed and tested in accordance with the provisions of 1.1.5 of Chapter 1 of the Guidelines, mainly including the following:

(1) Plans and documents are to be submitted to ISC for approval or for information in accordance with the requirements in 5.1.1 of this chapter.

(2) After installation of the EGR system and auxiliary system (if applicable), the relevant systems and equipment are to be tested to verify that they are in satisfactory function and stable operation, and the main working parameters are controlled within the design range. The testing is to take into account the intended fuel to be used, operating mode and operating conditions. The testing requirements are as follows:

①Testing is to be carried out in accordance with the provisions of 2.2, Appendix 4, Chapter 9, PART THREE of ISC Rules for Classification of Sea-going Steel Ships.

②Load tests are to be carried out in the applicable operating modes;

③Test of changeover between operating modes under different load conditions is to be carried out;

④Test is to be carried out to verify the specified minimum speed and governor in the applicable operating mode;

⑤Integration tests are to be carried out to verify that the response of all mechanical, hydraulic and electronic systems involved in the EGR system and the auxiliary system(if applicable) is as predicted for all intended operational modes. The scope of these tests may be determined based on the risk analysis result.

⑥After completion of the tests, in addition to dismantling the components and conducting examination according to the provisions of 2.3, Appendix 4, Chapter 9, PART THREE of ISC Rules for Classification of Sea-going Steel Ships, the EGR unit is also to be dismantled to examine the internal structure for scaling, fouling, corrosion and other conditions, including the washwater nozzle, heat exchanger (if provided), dehumidifier, etc.

Note: Emission compliance verification of a diesel engine installed with the EGR system is within the scope of statutory survey and is to be carried out in accordance with the requirements in 1.1.6 of Chapter 1 of the Guidelines.

(3) EGR version of diesel engines in subsequent production are to be subject to works acceptance test in accordance with the provisions of Appendix 6, Chapter 9, PART THREE of ISC Rules for Classification of Sea-going Steel Ships, and the following additional requirements are to be considered:

①All load tests are to be carried out in the applicable operating modes;

②Integration tests are to be carried out to verify that the response of all mechanical, hydraulic and electronic systems involved in the EGR system and the auxiliary system (if applicable) is as predicted for all intended operational modes. The scope of these tests may be determined based on the risk analysis result

5.2.3 **Initial survey.** After installation of the EGR system and the auxiliary system onboard the

ship but before its put into use, the initial survey is to be carried out to confirm that the certificate and related documents for each system are provided and complete, the system is installed in accordance with the approved drawings, and the performance of the system during operation is to be satisfactorily verified in accordance with the onboard test procedures. This survey mainly includes the following:

(1) Inspection of connections between the EGR system and ship structure;

(2) The associated piping systems are to be inspected in accordance with the requirements of Chapters 1, 2, 4 and 9 of PART THREE of ISC Rules for Classification of Sea-going Steel Ships and the Guidelines;

(3) It is to be verified that circuit continuity and installation is in compliance with relevant requirements;

(4) Inspection of instrumentation;

(5) Inspection of safety valves;

(6) Examination of effectiveness of the control system, monitoring, safety protection system and emergency shutdown device;

(7) It is to be verified according to the approved test program that after relevant systems and equipment are installed onboard the ship and properly connected, the systems are compatible with each other and work steadily, including the effectiveness of the functions of control, monitoring and safety protection systems;

(8) Onboard tests are to be carried out in accordance with the provisions of Appendix 6, Chapter 9, PART THREE of ISC Rules for Classification of Sea-going Steel Ships, and load tests are to be carried out under the applicable operating modes to verify the changeover between operating modes under different loads. The total test time of the applicable operating mode under each load point is not to be less than that specified in Appendix 6, Chapter 9, PART THREE of ISC Rules for Classification of Sea-going Steel Ships.

(9) Tests are to be carried out using the fuel with maximum sulphur content stated by the diesel engine manufacturer as far as possible to confirm that relevant systems and equipment can operate steadily and effectively. If the fuel with maximum sulphur content stated by the manufacturer is not available at the time of the test, a fuel with low sulphur content that is available is allowed for onboard test, provided that relevant evidences are submitted to demonstrate that the EGR-related systems and equipment can still operate steadily as expected by the design requirements even with the stated fuel with maximum sulphur content.

5.2.4 In-service **Survey.** As a part of ship survey, in-service survey of EGR related systems is to be carried out together with the ship to ensure the discharge and safety compliance of EGR related systems during ship operation. In-service survey includes annual survey, intermediate survey and special survey (The survey period is to meet the requirements of 5.2.1, 5.2.2 and 5.2.4 respectively of Section 2 of Chapter 5 of PART ONE of ISC Rules for Classification of Sea-going Steel Ships.

(1) The annual survey is at least to include the following items:

① Examination of documents. The EGR record book is to be examined to ensure the correct operation of the EGR system and the auxiliary system, etc. It is to be confirmed that the operation manual, and relevant documents required by IMO 2018 Guidelines for the Discharge of Exhaust Gas Recirculation (EGR) Bleed-off Water are kept onboard the ship.

② Examination of instrumentation, control, monitoring and safety systems. The instrumentation, control, monitoring and safety equipment (including emergency shutdown device, indicators and alarms) for the EGR system and the auxiliary system are to be confirmed in satisfactory operating conditions.

③Examination of Piping and Machinery for the EGR system. All piping and machinery related to exhaust gas recirculation (including all exhaust piping, fans, exhaust cut-off valves, exhaust

bypass valves (if fitted), pressurized air bypass valves (if provided) and other related remote control valves) are to be examined. Stopping of pumps and fans, etc. upon emergency shutdown of the system is to be confirmed. Where applicable, exhaust system bypass and isolation arrangements are to be examined. The integrity and effectiveness of insulation arrangements is to be confirmed.

④ Examination of washwater treatment, alkali solution and residue systems. All tanks, piping, hoses, pumps, strainers, separators, filtration units, dosing systems, and equipment associated with processing of washwater, injection of alkali or collection of residues are to be examined and verified to be in operational condition.

⑤ Examination of drip trays, overflow arrangements and insulation. Drip trays, overflow arrangements, shielding or insulation installed are to be examined for the protection of personnel or the vessel from the effects of hazardous or corrosive chemicals or system temperature.

⑥ Examination of electrical Equipment. Electrical equipment associated with the operation or monitoring of the EGR system and auxiliary system is to be examined for continued suitability for its intended service and installation area.

⑦Examination for deterioration or leakage (Insulation need not be removed):

a. External examination. External examination of all components of the EGR systems, including scrubbers, EGR coolers, piping, tanks, fans, insulation, valves, pumps, drip trays, foundations and attachments of essential components, etc.

b. Examination of equipment operation. Confirmation of correct operation of all rotating and reciprocating components, such as exhaust gas fans, water treatment pumps, ventilation fans, etc.

c. Examination of control valves. Verifying the correct operation of all remotely operated or automatically controlled valves in the exhaust or water treatment systems.

d. Examination of system operation. Examination of the EGR system and the auxiliary system during the working condition with maximum EGR rate. Multi-mode systems are to be tested in all operational modes as far as practicable.

⑧Examination of personal protective equipment. The required PPE equipment and facilities are to be confirmed as being onboard and in an operational condition.

⑨Examination of warning notices. The location of the applicable warning notices is to be confirmed.

⑩Examination of spare parts. Spare parts are to be verified as available onboard in consideration of the equipment redundancy arrangements.

(2) In addition to the items covered by the annual survey listed in 5.2.4(1), the **intermediate survey** is also to include the following:

①The EGR unit is to be opened for examination, as deemed necessary.

②Failure - safe valves are to be function-tested , as deemed necessary.

(3) In addition to the items covered by the annual survey listed in 5.2.4(1), the **special survey** is also to include the following:

①All bilge pumps, water treatment pumps and alkali pumps fitted for the EGR system are to be opened for examination, as deemed necessary.

②All blowers, essential fans and associated prime movers fitted for the EGR system are to be opened for examination, as deemed necessary.

③Overboard discharge valves for discharge water are to be opened for examination.

④Internal examination of the EGR unit.

⑤All remotely and automatically controlled valves are to be proven operable. Pressure relief valves, if fitted, are to be function-tested. A random selection of valves is to be opened for examination and adjusted.

⑥ Examination of *control actuators.* All mechanical, hydraulic, and pneumatic control actuators and their power systems are to be examined and tested as considered necessary.

⑦ E*xamination of electrical equipment.* Examination of electrical equipment is to include visual inspection of electrical cables and supports, together with insulation resistance testing of the windings of electrical control motors and actuators.

⑧Examination of instrumentation, control, monitoring and safety systems. Dock trials are to be carried out to verify correct operation of the automatic control functions, alarms and safety protection systems, mainly including the following: function test of the indication and alarm systems (including verifying 15PPM alarm function); function test of safety protection systems (emergency shutdown device), examination of manual control function; examination of automatic changeover function.

CHAPTER 6 OPERATION MANUAL

6.1 General requirements

6.1.1 The ship is to carry the operation manuals for the EGR system and the auxiliary system onboard specifying procedures and plans for system operation, inspection, maintenance, safety, etc.

6.1.2 The manual is generally at least to include the following aspects:

(1) procedures and plans related to the operation, inspection, testing and maintenance of the system;

(2) procedures and plans related to testing and maintenance of the monitoring and safety protection system;

(3) special notes related to the bunkering, storage and usage of the chemical substances intended to be used;

(4) working conditions and limitations related to the operation of the system;

(5) emergency procedures.

6.2 Emergency procedures

6.2.1 Emergency procedures corresponding to the failures likely to occur during operation of the EGR system and the auxiliary system are to be developed, such as operation procedures and responsible person in case of emergency shutdown, washwater/alkali leakage, etc., so as to reduce the impact on the safety operation of the ship and related diesel engine in so far as practicable.