

MARITIME SAFETY COMMITTEE
108th session
Agenda item 10

MSC 108/10/1
21 December 2023
Original: ENGLISH
Pre-session public release:

DOMESTIC FERRY SAFETY

Online training material on domestic ferry safety

Submitted by China

SUMMARY

Executive summary: This document provides the online training material on domestic ferry safety for consideration and review by the Committee.

*Strategic direction, 7
if applicable:*

Output: 7.31

Action to be taken: Paragraph 8

Related documents: MSC 101/21/20, MSC 101/23/1; MSC 102/8, MSC 102/8/1;
MSC 105/20 and TC 73/2/1

Background

1 The Maritime Safety Committee (MSC), at its 101st session, agreed to include an item on "Measures to improve domestic ferry safety" in the provisional agenda for MSC 102 under the existing output 7.31 (Finalization of a non-mandatory instrument on regulations for non-convention ships) and concurred with the recommended way forward in dealing with matters pertaining to domestic ferry safety as proposed in documents MSC 101/21/20 (China) and MSC 101/23/1 (Secretariat), including the development of an online training course on domestic ferry safety.

2 At MSC 102, the Secretariat reported on the progress made in relation to domestic ferry safety (MSC 102/8), and China submitted document MSC 102/8/1, proposing a draft outline for the online training course on domestic ferry safety, which was deferred for consideration to MSC 103. Following consideration, MSC 103 agreed that the content of the documents submitted should be taken into account when taking forward matters pertaining to domestic ferry safety.

3 MSC 105 invited the Technical Cooperation Committee (TC) to assist with the development of online training material on domestic ferry safety.

4 TC 73 noted and welcomed the information provided in document TC 73/2/1 (China) on the development of training material on domestic ferry safety and also noted that China would submit a full version to MSC 108 for detailed consideration. The annex to this document provides the full version of the online training material for consideration by the Committee.

Discussion

5 The online training material elaborates on how to improve ferry safety from four main aspects: ferry, cargo, crew and passenger, and covers the main content of the *Model Regulations on Domestic Ferry Safety* (resolution MSC.518(105)) in terms of safety culture, manning, education and training, safety management, occupational health and safety, communication equipment, cargo stowage and securing and the arrangement prior to departure/arrival.

6 The online training material comprehensively explains how to improve ferry safety by introducing ferry-related basic concepts, focusing on important safety-related aspects and taking into account accident cases. It aims to provide reference for the education and training of ferry crew, as well as for the officers of competent authorities and management personnel of ferry companies on how to improve ferry safety. It should be noted that the online training material is intended to supplement rather than replace the in-person training.

7 The online training material was developed by referring to the relevant provisions of the instruments developed by the Organization, drawing on the experience gained in ferry safety management worldwide, and sharing China's experience and efforts in the education and training of ferry crew. As circumstances vary among countries and regions and there is no one-size-fits-all solution, this online training material is expected to serve as a starting point and reference to improve domestic ferry safety. In this respect, inputs from other Member States are more than welcome to be included to meet different needs.

Action requested of the Committee

8 The Committee is invited to consider the draft online training material on domestic ferry safety as set out in the annex, and take action, as appropriate.

ANNEX

**ONLINE TRAINING MATERIAL ON
DOMESTIC FERRY SAFETY**

Foreword

Model Regulations on Domestic Ferry Safety (hereinafter referred to as the model regulations) adopted by the Maritime Safety Committee (MSC) of the International Maritime Organization (IMO) by resolution MSC.518(105) aim to improve domestic ferry safety by providing a set of recommendatory framework model regulations for consideration by Member States to incorporate relevant provisions into their national legislation. As stipulated in Article 10 of the model regulations, "Education and training of shore staff and domestic ferry crew may follow the training courses developed by the Organization or by the competent authority." To provide input to the training course, China developed the online training material on domestic ferry safety.

The textbook elaborates on improving ferry safety from four main aspects: ferry, cargo, crew and passenger. It covers the main contents of the model regulations in terms of safety culture, manning, education and training, safety management, occupational health and safety, communication equipment, cargo stowage and securing, the arrangement prior to arrival and departure. The textbook explains comprehensively to trainees how to improve ferry safety by introducing ferry-related basic concepts and focusing on important safety-related aspects. It aims to provide reference for the education and training of ferry crew and officers of competent authorities and management personnel of ferry companies and intended to supplement rather than replace the in-person training.

This book mainly consists of four parts: ferry, ferry safety management, ferry cargo operation and ferry passengers.

Part I is on ferries. Chapter 1 presents the basic knowledge of ferry and ferry transportation, including the concept, types and classification of ferry. Chapter 2 introduces the structural characteristics of a typical ferry, including high-speed ferry, ro-ro passenger ship and inland passenger ship. Chapter 3 covers fire protection on board ferries, including fire prevention and fire-fighting facilities and equipment. Chapter 4 is on life-saving on board ferries, including lifeboat, rescue boat and liferaft, marine evacuation systems and personal flotation devices. Chapter 5 describes navigation instruments, monitoring systems and remote-control systems. Chapter 6 discusses new technologies applied to ferries, including shore-based information autonomous monitoring technology, new life-saving equipment on board small ferries and hull colouring and marking.

Part II focuses on ferry safety management. Chapter 7 is on safety management, which briefs on human error and domestic ferry accidents, safety management codes, safety culture, risk management and the supervision and management of passenger ferries. Chapter 8 introduces the principle of the minimum safe manning of ferries, and discusses safe manning requirements during berthing in ports and the manning of domestic ferries. Chapter 9 presents crew training, including statutory training, training by shipping companies, onboard training and the application of lessons learned from marine casualties to crew training. Chapter 10 introduces emergency response procedures, including muster list, emergency card and other emergency response procedures. Chapter 11 is on crew health, including alcohol and drug control and related requirements on work and rest. Chapter 12 elaborates on the manoeuvring of ferries, including the operation of ferry upon arrival and departure in the port area, anchoring operation, manoeuvring in narrow water, as well as the key points and precautions for the operation of ferries in adverse weather. Chapter 13 focuses on navigation, including preparation of pre-departure, watchkeeping during navigation, collision avoidance and preparation of pre-arrival at ports, etc.

Part III focuses on the ferry cargo operation. Chapter 14 is on the stability of ferries, which introduces the concepts of stability, intact stability and damage stability and criterion.

Chapter 15 is on vehicle stowage and securing, including vehicle stowage and securing rules and methods for evaluating the effectiveness of vehicle securing. Chapter 16 is on cargo management, including vehicles, goods and dangerous goods.

Part IV is on ferry passengers. Chapter 17 is about embarking and disembarking passengers, including general requirements and safety instructions for embarking and disembarking passengers. Chapter 18 is about crowd management, which elaborates on the management of overcrowding in emergency situations, such as non-abandonment of ships and abandonment of ships, as well as the management of overcrowding to assist passengers in arriving at assembly stations. Chapter 19 concentrates on crisis management, including crisis management training, dealing with abnormal psychology and behaviour in emergency situations, and handling unexpected situations for passengers during transportation.

Last but not least, during the preparation of the textbook, Dalian Maritime University has received enormous support from home and abroad. The textbook would not have come into being without the great support and dedication of the Department of International Cooperation of the Ministry of Transport, the People's Republic of China (PRC), China Maritime Safety Administration, Guangdong Maritime Safety Administration, Fujian Maritime Safety Administration, Tianjin Maritime Safety Administration, Liaoning Maritime Safety Administration, and Embassy of the People's Republic of China in the United Kingdom, etc. Gratitude and appreciation also go to the IMO Secretariat, who provided many valuable and constructive suggestions and assistance for this textbook.

Contents

Glossary and Abbreviation	6
Part I Ferries	11
Chapter 1 Basic Ferry Concepts	11
Section 1 The Ferry and Ferry Transportation	11
Section 2 Ferry Types	12
Section 3 The Classification of ferry	14
Chapter 2 Features of the Typical Ferry Structure	18
Section 1 Structural Characteristics of High-Speed Ferry	18
Section 2 Structural Characteristics of Ro-Ro Passenger Ships	21
Section 3 Structural Characteristics of Inland Passenger Ships	23
Chapter 3 Ferry Fire Protection	25
Section 1 Ferry Fire Prevention	25
Section 2 Fire-Fighting Facilities and Equipment of Inland River Ferries	28
Section 3 Coastal Ferry Fire-Fighting Facilities and Equipment	39
Chapter 4 Ferry Life Saving	54
Section 1 Lifeboat and Liferaft	54
Section 2 The Marine Evacuation System	59
Section 3 Personal Floating Device	60
Chapter 5 Bridge Equipment and Navigation Instruments	65
Section 1 Navigation instruments	65
Section 2 Monitoring System and Remote-Control System	71
Chapter 6 New Technology and Application	76
Section 1 Shore-based Information Autonomous Monitoring Technology	76
Section 2 New Life-saving Equipment for Small Ferries	77
Section 3 Ferry Boat Hull Colouring and Marking	80
Part II Ferry Safety Management	84
Chapter 7 Safety Management	84
Section 1 Human Error and Domestic Ferry Accident	84
Section 2 Safety Management Codes	85
Section 3 Safety Culture	88
Section 4 Risk Management	89
Section 5 Supervision and Administration of Passenger Ferry	92
Chapter 8 Minimum Safe Manning	95
Section 1 Requirements of Minimum Safe Manning	95
Section 2 Safe Manning During Staying in Port	97
Section 3 The Manning of Domestic Ferries	98
Chapter 9 Crew Training	101
Section 1 Statutory Training	101
Section 2 Training Held by Ship Companies	102
Section 3 Onboard training	103
Section 4 Application of Lessons Learned from Marine Casualties in Crew Training	103
Chapter 10 Contingency Plan	105
Section 1 Muster List and Emergency Card	105
Section 2 Emergency Response Procedures	107
Chapter 11 Crew Health	112
Section 1 Medical Examination of Crewmember	112
Section 2 Alcohol and Drug Control	113
Section 3 Work and Rest	113
Chapter 12 Ship Maneuvering	115
Section 1 Vessels Entering and Leaving Port	115
Section 2 Anchoring Operation	116

Section 3 Ship Manoeuvring in Narrow Channel	117
Section 4 Ship Manoeuvring in Bad Conditions	118
Chapter 13 Navigation	123
Section 1 Preparation of Pre-Departure	123
Section 2 Watchkeeping of Navigation	124
Section 3 Avoiding Collision	128
Section 4 Preparation of Pre-Arrival	129
Part III Ferry Cargo Operation	131
Chapter 14 Stability, Trim, and Strength of Ferries	131
Section 1 Stability Concept	131
Section 2 Intact Stability	138
Section 3 Damage Stability and Criterion	142
Section 4 Trim and Strength	144
Chapter 15 Vehicle Stowage and Securing	147
Section 1 Vehicle stowage and securing rules	147
Section 2 Evaluation Method for Effectiveness of Vehicle Securing	150
Chapter 16 Cargo Management	156
Section 1 Management of Vehicles and Goods	156
Section 2 Management of Dangerous Goods	158
Part IV Ferry Passengers	161
Chapter 17 Embarking and Disembarking of Passengers	161
Section 1 General Requirements for Passenger Embarking and Disembarking	161
Section 2 Safety Instructions	164
Chapter 18 Management of the Crowds	168
Section 1 Management of the Crowd in Emergency Situations without Abandonment of Ships	168
Section 2 Management of the Crowd in Emergency Situations in Case of Ship Abandonment	169
Section 3 Management of Crowds to Assist Passengers Arriving at Assembly Stations	171
Chapter 19 Crisis Management	175
Section 1 Crisis Management Training	175
Section 2 Management of Abnormal Psychology and Behaviour of People in Emergency Situations	176
Section 3 Handling Accidents Occurred during Transportation	179
Bibliography	181

Glossary and Abbreviation

Abandon ship. Abandon ship means to leave a ship quickly, because it is sinking or in great danger.

Accommodation spaces. Those spaces used for public spaces, corridors, lavatories, cabins, offices, hospitals, cinemas, game and hobby rooms, barber shops, pantries containing no cooking appliances and similar spaces.

Aids to navigation. Any device external to a vessel specifically intended to assist navigators in determining their position or safe course, or to warn them of dangers or obstructions to navigation.

AIS. Automatic Identification System. AIS is an automated tracking system that displays other vessels in the vicinity. The broadcast transponder system operates in the VHF mobile maritime band.

Assembly station. Place on deck, in mess rooms, etc., assigned to crew and passengers where they have to meet according to the muster list when the corresponding alarm is released or announcement made.

Atriums. Public spaces within a single main vertical zone spanning three or more open decks.

Basic safety training. The training in personal survival techniques, basic fire prevention and fire fighting, elementary first aid, personal and social responsibilities received by crew before serving on board.

Bulkhead deck. The uppermost deck up to which the transverse watertight bulkheads are carried.

CCTV. Closed Circuit Television. CCTV refers to a system in which video cameras are used to transmit signals to a specific set of monitors or recording devices, forming a closed circuit.

CMSA. Maritime Safety Administration of the People's Republic of China. CMSA is a governmental agency responsible for maritime safety and supervision of maritime activities within China.

Competency training. The training acquired by the crew before obtaining the certificate to provide the crew with the professional technical knowledge and professional techniques required to adapt the rank, including crews competency training for ranks and crew' competency training for techniques.

Competent authority. A government entity responsible for the implementation of these regulations.

Crew. Any person including the master working on or operating the domestic ferry.

Crisis management. An organization's process and strategy-based approach for identifying and responding to a threat, an unanticipated event, or any negative disruption with the potential to harm people, property, or business processes. Being prepared for any event to become a crisis requires a crisis management plan.

Crowd management. The systematic process of planning, organizing and monitoring large gatherings of people with the objective to establish a safe and secure environment and maintaining a minimum level of space to avoid panic and rapid crowd movements.

CS. Calculated Strength. The term "CS" typically refers to the determined or computed measure of the strength of a material or structure through mathematical or analytical methods.

CSS Code. The Code of Safe Practice for Cargo Stowage and Securing. The CSS Code provides guidelines and recommendations for the safe stowage and securing of cargo on various types of vessels.

Damage control. Temporary fixing of bomb or explosive damage. Simple measures may stop flooding, such as: locking off the damaged area from other ship's compartments.

Damaged stability. The stability of ship after it is damaged and flooded.

Deck department. One department of a ship which includes crew members who are responsible for navigating the vessel and handling its cargo, etc.

Domestic ferry. A craft of any type and construction, using any means of propulsion, intended for the carriage of passengers and their belongings, including accompanied or unaccompanied

freight units, over water only within domestic waters and certified as such by the competent authority.

Domestic waters. Waters in which domestic ferries may operate, clearly identified, designated and promulgated as such by the competent authority.

Dynamic stability. The stability that takes into account angular velocity and angular inertia during ship heeling.

Emergency exit. A special exit for emergencies such as a fire or other emergencies; the combined use of regular and special exits allows for faster evacuation, while it also provides an alternative if the route to the regular exit is blocked.

Emergency instruction card. A document instructing crewmembers and passengers on a ship about the procedures for dealing with various emergency conditions that might arise.

Emergency response plan. An emergency response plan is a document that lays out the series of steps your organization will take during a critical event, such as a fire or active shooter threat, to ensure employees' safety and minimize the impact on critical operations.

Engine department. An organizational unit aboard a ship that is responsible for the operation, maintenance, and repair of the propulsion systems and the support systems for crew, passengers, and cargo.

Fairway. Navigable part of a waterway.

Flying mooring (ordinary mooring). The anchoring method with two anchors paid out one after another, and the horizontal angle of the chain cable maintained at about 180°.

Free surface effect. The effect of a large surface of free-flowing liquid in partially filled tanks, and causes a loss of stability.

General emergency alarm. The General Emergency Alarm is used for all types of incidents, consisting of seven short blasts followed by one long blast.

Grounding. The impact of a ship on seabed or waterway side.

Heaving to. A navigating method in keeping the minimum speed and make the sea at an angle of 20~30° on the port or starboard bow.

Heavy weather. Stormy conditions, including rough, high seas and strong winds, probably uncomfortable or dangerous.

Human error. Human error can be defined as wrongful decisions, mistakes, blunders, carelessness, miscalculations or negligence made by or on the part of human beings.

IMLA. International Maritime Lectures Association. IMLA is an organization focusing on providing lectures, seminars, or educational content related to the maritime industry.

IMO. International Maritime Organization. IMO is a specialized agency of the United Nations responsible for regulating shipping on a global scale.

Inland waters. Any of the waters (as lakes, canals, rivers, watercourses, inlets, and bays) within the territory of a state as contrasted with the open seas or marginal waters bordering another state subject to various sovereign rights of the bordering state.

Inland ship (Inland waterway ship). A floating craft designed for the carriage of goods or public transport of passengers which navigates predominantly in navigable inland waterways or in waters within, or closely adjacent to sheltered waters or areas where port regulations apply.

Intact stability. The stability of a ship when all the compartments of the ship is intact.

International Life-Saving Appliance Code. The International Life-Saving Appliances Code (LSA Code) adopted by the Maritime Safety Committee of the Organization by resolution MSC.48(66), as it may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the present Convention concerning the amendment procedures applicable to the annex other than chapter I.

IS Code 2008. The Intact Stability Code 2008. The IS Code 2008 is a set of regulations and guidelines established by IMO to ensure the intact stability of ships.

ISM. International Safety Management Code. ISM Code is a set of international guidelines and regulations developed to ensure the safe operation of ships and the prevention of marine pollution.

Lie to. A navigating method that the ship stops the main engines and is drifting with the sea.

Lightest sea going condition. The loading condition with the ship on even keel, without cargo, with 10% stores and fuel remaining and in the case of a passenger ship with the full number of passengers and crew and their luggage.

Local strength. The ability of a component or part of a hull structure to withstand corresponding loads.

Longitudinal strength. The ability of the entire hull to resist generally longitudinal deformation and damage.

Machinery spaces. Spaces containing propulsion machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces.

Main vertical zones. Main vertical zones are those sections into which the hull, superstructure and deckhouses are divided by "A" class divisions, the mean length and width of which on any deck does not in general exceed 40 metres.

Marine casualty. Marine casualty means a collision, grounding or stranding of a vessel or other incident of navigation, or other occurrence on board a vessel, or external to it resulting in material damage or imminent threat of material damage to a vessel or cargo.

Marine incident. An event, or sequence of events, other than a marine casualty, which has occurred directly in connection with the operations of a domestic ferry that endangered, or, if not corrected, would endanger the safety of the domestic ferry, its occupants or any other person or the environment.

Minimum safe manning certificate. An appropriate document issued by the administration as evidence of the minimum safe manning considered necessary to comply with the related regulations.

MLC 2006. maritime Labour Convention 2006. MLC 2006 is an international labour standard adopted by the International Labour Organization (ILO) to establish comprehensive and enforceable regulations governing the working and living conditions of seafarers.

MSL. Maximum Securing Load. MSL refers to the maximum force or load that a structure, device, or system can withstand while being safely secured or restrained.

Muster list. A list of the functions each member of a ship crew is required to perform in case of emergency.

Narrow channel. an area of the sea where the width of the safely navigable waterway is small relative to the ability of a vessel to manoeuvre.

NSM Code. The Safe Operation and Pollution Prevention Management Rules of the People's Republic of China.

Onboard training. Practical training on board training vessel or merchant ship in operation, as part of an approved training, carried out under the direction of a qualified person in accordance with an approved programme.

Onboard training record book. This record book is to provide verifiable documentary evidence that a cadet has gained the knowledge, understanding and proficiency required in compliance with the related domestic regulations.

Open mooring. The ship paying out the two anchors and the chain cable maintaining a certain horizontal angle is called open mooring.

Passenger department. An organizational unit aboard a ship that is responsible for the services to the passengers.

Passenger ferry. Inland passenger ships with a length overall of 5 metres or more but less than 20 metres.

Public spaces. those portions of the accommodation which are used for halls, dining rooms, lounges and similar permanently enclosed spaces.

Relieving Officer. The Officer who intends to take over the duty from the Officer on watch.

Riding to a single anchor. A ship uses a single anchor to ride in the anchorage.

Riding to both anchors. The anchoring method with two anchors paid out at the same time.

Riding to two anchors. A ship uses two anchors to ride in the anchorage.

Risk assessment. The process of analysing and identifying the risks, indicating the causes, hazards, possibilities and consequences of the identified risks, and determining the measures to control the risks.

Risk management. An emerging management science, which is used to study the law of risk occurrence and risk control technology.

Ro-Ro passenger ship. A passenger ship with Ro-Ro spaces or special category spaces.

Ro-Ro spaces. Spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the ship in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded normally in a horizontal direction.

Safety culture. A "Safety Culture" represents attitudes of employees about an organization's approach to safety, their perceptions of risk, their beliefs on responding to and controlling risk, and engagement in activities that represent (and reinforce) a safety culture.

Safe speed. A speed less than the maximum at which the operator can take proper and effective action to avoid collision and stop within a distance appropriate to the prevailing circumstances and conditions.

Seagoing ship. A ship other than a ship which navigates exclusively in inland waters or in waters within, or closely adjacent to, sheltered waters or areas.

Seamanship. The art or practice of managing a ship or boat at sea; the skill of a good seaman.

Seaworthy. Seaworthy means fit to undertake the intended voyage without danger to the domestic ferry, environment or persons and complying with the provisions of these regulations in all aspects.

Service spaces. Those spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, storerooms, workshops other than those forming part of the machinery spaces, and similar spaces and trunks to such spaces.

SF. Safety Factor. It is defined as the ratio between the strength of the material and the maximum stress in the part.

Ship stability. The ability of a ship to heel under external forces without capsizing, and to automatically return to its original equilibrium position after the external forces disappear.

Ship strength. The ability of the ship structure to withstand various external forces without causing destructive deformation.

Special category spaces. Those enclosed vehicle spaces above and below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access. Special category spaces may be accommodated on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.

Static stability. The stability of a ship that does not take into account angular velocity and angular inertia during the process of ship's inclination.

Survival craft. A craft capable of sustaining the lives of persons in distress from the time of abandoning the ship.

The Officer to be relieved. The Officer who will be relieved by the relieving Officer.

Vehicle spaces. Cargo spaces intended for carriage of motor vehicles with fuel in their tanks for their own propulsion.

Torsional strength. The ability of the entire hull to resist torsional deformation and damage.

Trim. The difference between the forward draft and the aft draft.

UKC. Under Keel Clearance. UKC is the vertical distance between the lowermost point of a floating vessel and the nearest fixed physical feature underneath the water at a certain point in time.

Voyage planning. Utilizing a navigational plan to ensure the safety and predictability of a voyage.

VTS. Vessel Traffic Service System. VTS is a shore-side system which ranges from the provision of simple information messages to ships, such as position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway.

Weather deck. A deck which is completely exposed to the weather from above and from at least two sides.

"Z" navigation method. Navigating with the angle of 10-30° between the direction of sea and the ship's heading for a distance, and then changing course to make the sea on another side of 10-30°.

Part I Ferries

The ferry, a convenient means of transporting domestic goods and passengers by water, has become an essential part of the public transportation system of many coastal countries to connect various ports and ferries along the seacoast and rivers in the domestic water. Ferries are usually scheduled services, travelling back and forth between established ports according to scheduled timetables and fixed routes. Meanwhile, ferries can also provide excursions and are widely used for sightseeing, fishing and recreational facilities. Unlike other means of water transportation, ferries offer more unique services. It is a prerequisite to know the ferry and understand its types and characteristics to manage it effectively and ensure the safety of ferry transportation.

The ferry, a convenient means of transporting domestic goods and passengers by water, has become an essential part of the public transportation system of many coastal countries to connect various ports and ferries along the seacoast and rivers in the domestic water. Ferries are usually scheduled services, travelling back and forth between established ports according to scheduled timetables and fixed routes. Meanwhile, ferries can also provide excursions and are widely used for sightseeing, fishing and recreational facilities. Unlike other means of water transportation, ferries offer more unique services. It is a prerequisite to know the ferry and understand its types and characteristics to manage it effectively and ensure the safety of ferry transportation.

Chapter 1 Basic Ferry Concepts

This chapter expounds on ferry-related knowledge, including the concept and types of ferries, the classification of ferries in different water areas, and corresponding domestic technical specifications.

Section 1 The Ferry and Ferry Transportation

Whether explained in dictionaries or defined in industry rules, the concepts of ferry and ferry transportation can clearly reflect their essential attributes.

1. The definition of the ferry

The International Ferry Association defines a ferry as "A ferry is a vessel used to transport passengers and/or vehicles across a body of water on a regular, frequent basis. Ferries can range from small boats carrying passengers across a harbour, lake or river, to large seagoing ships carrying passengers, cars, trucks and other heavy cargo across longer distances where overnight sleeping accommodations are required." At the same time, the International Ferry Association excludes the following vessels from the definition of ferries: "vessels that do not operate on a regular schedule; vessels that normally carry only unaccompanied freight vehicles, e.g., Ro-Ro freight vessels; vessels that operate on routes greater than 48 hours in duration; and vessels whose main purpose is not the transport of passengers/vehicles from one place to another."

When IMO MSC Secretariat proposed *Model Regulations on Domestic Ferry Safety*, a clear definition for domestic ferry was given: "Domestic ferry means a craft of any type and construction, using any means of propulsion, intended for the carriage of passengers and their belongings, including accompanied or unaccompanied freight units, over water only within domestic waters and certified as such by the competent authority."

From the origin of the name of the ferry and the international definition of the ferry, the ferry refers to the ship transporting passengers and their accompanying articles (including vehicles). It cannot be called a ferry if it only carries vehicles or goods. Therefore, domestic ferry transport should be classified as a passenger water transport business in domestic water area.

2. Definition of ferry transportation

The IMO's definition of "domestic waters" in resolution MSC.518(105) (adopted 28 April 2022) *Model Regulations on Domestic Ferry Safety* refers to "waters in which domestic ferries may operate, clearly identified, designated and promulgated as such by the competent authority". Therefore, domestic ferry transport limits ferry navigation to domestic waters rather than international routes. The *Model Regulations on Domestic Ferry Safety* also make it clear that States can open cross-border ferry transportation through bilateral or multilateral agreements, and the cooperative parties shall manage the safe operation of ferries in their own waters.

Section 2 Ferry Types

Considering the differences in ship type, ship operation scope and water area, as well as accident risk and safety management, concerning regulations of domestic ferries administration in China, the tutorial firstly divides domestic ferries into two categories: coastal passenger ships and inland river passenger ships. In China, the management and operation of coastal passenger ships shall comply with the relevant requirements of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* as amended. The management and operation of inland river passenger ships shall comply with the relevant requirements of the *Technical Rule for the Statutory Survey of Inland ships 2019* as amended. In addition, there are a large number of small inland river passenger ships used only for short trips within a specific water area are regulated separately in accordance with the *Technical Rule for Survey of Small Inland ship* and the *Regulations on the Safety Management of Inland Waterway Ferry*. Therefore, the small inland river passenger ships whose length is greater than or equal to 5 metres and less than 20 metres are classified as the third category of domestic ferries in this tutorial, i.e., the "inland water passenger ferry".

1. Coastal passenger ship

From a practical perspective, most States coastal water passenger transportation has the nature of a ferry, which simultaneously transports personnel, their belongings and accompanying vehicles. Therefore, the so-called coastal passenger ships in this tutorial are coastal passenger ferries. Unlike ordinary passenger ships, the primary purpose of coastal passenger ferries is to carry passengers and their accompanying articles, including small motor vehicles or large trucks to cross a strait, or to and from the main coastal ports along a State's coastline.

Coastal passenger ferries have developed various ferry types based on ship types and service needs. For example, to ensure sufficient stability and significantly reduce travel time, high-speed passenger ferries, including catamaran and multihull boats, are often used. To facilitate the rapid turnover of vehicles, multiple layers of car decks that run through the fore and after of the ship are equipped with ramps to form a typical ro-ro passenger ship. The laying of railway tracks on the lower deck, with hatch doors at forward and/or both sides of the ship, facilitates the connection of railway tracks at the dock and the special passenger ferries of boarding and disembarking of trains.

2. Inland passenger ship

Inland passenger ships refer to passenger ships navigating on inland waters such as rivers, lakes, inland waterways, which use to transport passengers and also carry small amounts of goods. They are important waterborne transportation for domestic passengers. The Chinese Yangtze River passenger ship is a typical inland passenger ship.

1) Classification according to the navigation area and sailing time

The inland passenger ships are divided into five categories according to their navigation area and sailing time.

Type I: the long-distance passenger ships, from the port of departure to the port of destination, the continuous sailing time against the current is more than 24 hours;

Type II: interval passenger ships, from the port of departure to the port of destination, the continuous sailing time against the current is more than 12 hours but less than 24 hours;

Type III: short-distance interval passenger ships, between designated ports, the continuous sailing time against the current is more than four hours but less than 12 hours;

Type IV: short-distance passenger ships, within adjacent ports or intraregional transportation, the continuous sailing time against the current is more than 0.5 but less than four hours;

Type V: cross-river ferries, which have a sailing time not exceeding 30 minutes. For the purposes of this tutorial, this type of inland passenger ship is grouped into the third category of domestic ferries, i.e., inland water passenger ferries.

For the Type III short-distance passenger ships, if the sailing time against currents between each terminal does not exceed two hours, with the local authority's consent, the ship can be classified as a Type IV passenger ship. The above-mentioned "continuous sailing time" includes the stopover time.

2) Classification according to the gross tonnage

Inland passenger ships can be further divided into three categories based on ship tonnage. Large passenger ships refer to passenger ships of 1,000 gross tonnage or upwards; Medium passenger ships refer to passenger ships of more than 200 gross tonnage but less than 1,000 gross tonnage; Small passenger ships refer to passenger ships of equal to or less than 200 gross tonnage.

3. Inland Water Passenger Ferry

An inland passenger ship, the term inland water passenger ferry refers to small inland river ferries only used to cross rivers or lakes. Technical requirements and management regulations for inland water passenger ferries differ from those of conventional inland passenger ships. Due to the different ship types, tonnage and propelling modes, there are more diverse types, such as the double-ended ferry, hydrofoil ferry, cable ferry, inland water passenger Ro-Ro ferry launch, etcetera.

1) Double-ended ferry

The double-ended ferry has two steering systems located in the bow and stern. The two steering systems are interchangeable, so the ferry can sail back and forth without requiring a return.

2) Hydrofoil craft

Hydrofoil craft (hydrofoils) have the advantage of speed, which makes commuting faster and more convenient. A hydrofoil craft is a 'sliding boat' that has almost zero displacement once the hull is mounted on the hydrofoil. When sailing, the hydrofoil craft is at a certain speed, the lift produced by the hydrofoils equals the sum of the boat and cargo weights. Therefore, the hull comes out of the water. In this case, the higher the boat's speed, the faster the hull can be lifted on the hydrofoil plate. Only the wing lifting area is submerged when the hull is lifted off the water. At this point, the hull friction disappears, and the buoyancy is eliminated. The fluid power supports the boat on the water wing.

Over time, hydrofoil ferries are being replaced by catamarans because the latter are faster, have the potential for greater payloads and can carry cars. Even so, hydrofoils are still used in some areas because they are more practical, efficient, and relatively economical in certain waters.

3) Cable ferry

A cable ferry is a short-distance ferry. Typically, it is guided and propelled to cross rivers or other large water bodies by cables connecting both banks. There are two commonly used cable ferries: reaction ferry, which uses the reaction of the river current against a fixed tether to drive the ferry across the river. The other is a power-driven cable ferry, which uses an engine or an electric motor to wrap around a wire cable for the crossing.

3) Inland water passenger Ro-Ro ferry launch

The passenger Ro-Ro ferry launch usually has a flat bottom, which services only in the inland waters, especially in shallow water. Similar to landing crafts, the passenger Ro-Ro ferry launch is equipped with a large bow ramp for loading and unloading both passengers and cars.

Section 3 The Classification of ferry

For the classification of domestic ferries, each State may adopt criteria that are in line with its own geographical environment and operational capabilities, considering its national conditions. With reference to the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* and the *Technical Rule for the Statutory Survey of Inland ships 2019* by the Maritime Safety Administration of the People's Republic of China, this chapter gives a demonstrative introduction to the criterion for classifying domestic passenger vessels, both in coastal and inland waters, based on the navigable waters and applicable ship types. Additionally, an overview of the specific implementation of these standards in China will be introduced as an example. This information can serve as a useful reference for other countries in formulating their own classification criterion for domestic ferry services, taking into consideration their respective national conditions.

The passenger ships mentioned in the Regulations are those whose length is greater than or equal to 20 metres, sailing at sea or in inland waters (including rivers, rivers, lakes and reservoirs) and the river-sea confluence area.

1. The classification of navigation areas for domestic ferries

1) Regulation for navigable waters in the *Model Regulations on Domestic Ferry Safety*

Provisions of the *Model Regulations on Domestic Ferry Safety* shall apply to domestic ferries which operate in domestic waters as identified by the competent authority.

As an integral part of the Regulation, an annex shall be included, in which the competent authority shall insert certified copy of the chart of the domestic waters of the country concerned with coordinates clearly shown, and certified copy of the domestic ferry navigational area chart with coordinates clearly shown.

2) Principles for the classification of domestic navigation areas

The following factors should be considered in the classification of navigation areas.

(1) meteorological conditions, sea conditions, capability to forecast bad sea conditions and severe weather;

(2) shore-based or island-based rescue capability;

(3) the communication capacity of the ship to shore or island;

(4) the navigation distance or time for the ship to return to the nearest refuge to avoid a severe sea state and bad weather at sea;

(5) the ability of the mainland or the island coast to shelter a ship from the severe sea state and bad weather conditions;

(6) safety navigation records or accident statistics from vessels sailing in the sea area for no less than 20 years.

3) Criteria for the classification of navigation area for domestic ferries

According to principles for the classification of domestic navigation areas, the navigation areas for domestic ferry can be divided into four categories:

(1) Ocean navigation area: the sea area where the domestic navigation exceeds the offshore navigation area.

(2) Offshore navigation area: the sea area within 200 nautical miles of the shore.

(3) Coastal navigation area: the waters off the mainland coast that are not more than 20 nautical miles. A sea area no more than 20 nautical miles away from islands with shelter conditions and rescue capabilities. However, for the above-mentioned islands that are more than 20 nautical miles away from the coast, the authority will appropriately reduce the distance from the island in the surrounding waters according to the actual situation.

(4) Sheltered navigation area: the sea area within offshore navigation area with better shelter conditions surrounded by coast and islands, or among islands. The distance between islands or between islands and the coast shall not exceed 10 nautical miles.

4) Criteria for the classification of inland waterway navigation areas

The navigation areas of inland waters and related river and sea boundary waters are divided into three levels: A (including equivalent A level), B, and C, based on the significant wave height corresponding to a 5% guarantee rate, as shown in Table 1-1.

The "equivalent A level" is the navigation area that meets the corresponding conditions in Table 1.1 and simultaneously meets two conditions for the water area at the river and sea boundary waters: first, it must be located in the river estuary; and second, it must be a body of water shaped like a river; or a water body is shaped like a lake within a closed water area with a small discharge opening; or a body of water within a certain distance from the shore.

Among them, some areas are further divided into rapid flow (rapids) segments (also known as J-class segments) based on the turbulent flow conditions, which are divided into J1 class and J2 class segments from high to low. Different rapids segments are subordinate to the navigation area level of the water area they are located in. The rapid flow segments are divided according to the flow velocity over the beach. The segment with a flow velocity exceeding 3.5m/s over the beach should be designated as the rapid flow segment, as shown in Table 1-2.

Table 1-1 Criteria of inland waterway navigation areas

Aviation area level	significant wave height H_s (m)
A level	$1.25 < H_s \leq 2.0$
B level	$0.5 < H_s \leq 1.25$
C level	$H_s \leq 0.5$
Quite A level	$H_s \leq 2.0$

Note: The significant wave height H_s (metres) in the table refers to the wave height obtained by ranking a certain number of wave heights measured within a certain period in descending order, taking 1/3 of the maximum wave height and averaging it.

Table 1-2 Criteria for rapid flow segments

Section level	Over beach velocity V (metres/second)
J ₁ level	$5 < V \leq 6.5$
J ₂ level	$3.5 < V \leq 5$

2. The classification of domestic passenger ships in China as examples

1) Classification criteria for domestic seagoing passenger ships (including Ro-Ro passenger ships)

According to section three of chapter one of part four of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020*, passenger ships (including Ro-Ro passenger ships) in China are classified into Class I, II and III based on the distance from China's sea area, navigation area, and route to the sheltered area, as shown in Table 1-3.

Take the following routes as an example:

(1) The following routes are Class I: Yantai-Dalian route; Shanghai-Dalian (Qingdao) route; Shanghai-Xiamen (Guangzhou) route; Haikou-Guangzhou route, etcetera.

(2) The following routes are Class II: Shanghai-Ningbo route; Haikou-Zhanjiang route; Haikou-Beihai route, etcetera.

(3) The following passenger ships are Class III: Haikou-Haian route; covered route in Zhoushan sea area; Xiangshan Bay route; Penglai-Long Island route, etcetera.

Take the navigation area as an example:

(1) The passenger ships sailing in the offshore navigation area and the far sea navigation area are Class I passenger ships;

(2) Passenger ships sailing in coastal navigation areas shall be Class I or II according to the distance from the refuge;

(3) The passenger ship sailing in the covered navigation area is a Class II passenger ship.

Table 1-3 Classification of Passenger Ships

Passenger ship class	Navigation restrictions		
	Navigation zone	Sea area	Distance between the route and the shelter

I	Ocean, Offshore	----	----
II	Coastal	Yellow Sea, East Sea, Northern Gulf, Bohai Bay, Qiongzhou Strait, Leizhou Peninsula east and West coast	≥10 nautical miles
		Taiwan Strait, east coast of Taiwan Island, east and south coast of Hainan Island, South Sea	≥5 nautical miles
III	Coastal	Yellow Sea, East Sea, Northern Gulf, Bohai Bay, Qiongzhou Strait, Leizhou Peninsula east and West coast	<10 nautical miles
		Taiwan Strait, east coast of Taiwan Island, east and south coast of Hainan Island, South Sea	<5 nautical miles
	Sheltered waters	----	----

Note: Unless otherwise stipulated, the provisions of part four of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* on increasing the safety requirements with the increase of the number of passengers do not change the class.

2) Criteria for the classification of inland waters passenger ship

According to the general provisions of the *Technical Rule for the Statutory Survey of Inland ships 2019*, the relevant definitions and standards for passenger ship navigating in inland waters are as follows.

(1) Passenger ships — refers to ships carrying more than 12 passengers.

(2) Tourist ships — refers to passenger ships with a sightseeing area and sleeping cabin to provide passengers with tourism, sightseeing, entertainment, accommodation and other services.

(3) Sightseeing ships — refers to passenger ships with sightseeing areas, sailing in urban areas, reservoirs, parks, scenic spots and other waters, to provide passengers with sightseeing, entertainment, catering and other services.

(4) Passenger ferries — refers to passenger ships that travel between ports (urban and rural ferries), with a one-way against water continuous sailing time (excluding stopover time) of no more than two hours or a one-way sailing distance of no more than 20 kilometres, carrying passengers or cargoes.

(5) Ro-Ro passenger ships — refers to passenger ships (excluding passenger ferries barge) with Ro-Ro facilities. Including: type I Ro-Ro passenger ships and type II Ro-Ro passenger ships.

(6) Ordinary passenger ships — refers to passenger ships other than passenger ferries, tour ships, tourist ships, Ro-Ro passenger ships and passenger ferries.

(7) Type I Ro-Ro passenger ships — refers to passenger ships (excluding type II Ro-Ro passenger ships) with the enroute time against current for more than two hours from the port of origin to the port of destination and being equipped with roll on-roll off facilities.

(8) Type II Ro-Ro passenger ships — refers to passenger ships with the enroute time against current continuously for more than two hours from the port of departure to the port of destination, and only load trucks carrying self-consumed fuel oil with a flash point greater than 60°C (closed cup test) in the fuel tank (excluding trucks carrying dangerous goods), and carrying more than twelve truck drivers and their companions on board.

(9) Passenger ferries barge — refers to passenger ships (including ships that only carry cars, but not including ships that only carry commercial vehicles) that have a continuous sailing time against water of no more than two hours from the port of origin to the port of destination and being equipped with Ro-Ro facilities to carry cars and passengers.

3. Suggestion on the classification of domestic ferry

For the division of domestic ferry classes, it is suggested to divide domestic ferries into classes I, II and III according to the passenger ship navigation area and the distance between

the route and the shelter, as shown in Table 1-4. Different classes of ferries have different requirements for fire protection and life-saving equipment. This standard framework is reflected in the definition and classification standards of navigation waters and applicable ship types for domestic passenger ships and inland passenger ships in China, and has achieved good practice results. States can choose or refine it according to their actual national conditions.

Table 1-4 Suggested Classification of Domestic Ferries

Ship Class	Navigation restrictions		
	Navigating zone	Sea area	Route distance from the shelter
I	Ocean area, Offshore area	-	greater than or equal to 20 nautical miles
II	Coastal area	coastal open waters; a wide and large strait	greater than or equal to 10 nautical miles
		narrow channel waters susceptible to strong winds	greater than or equal to 5 nautical miles
III	Coastal area	coastal open waters; a wide and large strait	less than 10 nautical miles
		narrow channel waters susceptible to strong winds	less than 5 nautical miles
	Shelter area	inland river; lake	-

Chapter 2 Features of the Typical Ferry Structure

The design of ferries depends on various factors such as the required capacity for the design of ferries depends on various factors such as the required capacity for vehicles or passengers, travel distance, speed requirements, and the water conditions the vessel will encounter. From traditional monohulled ships to high-speed catamarans, hydrofoils, and hovercraft, each type of ferry has distinct design characteristics.

Ferries designed for long-distance travel incorporate many features similar to cruise ships to entertain passengers during the journey. For cargo and vehicle transportation, maximizing payload and providing reliable service have become primary goals. Due to regional operational needs, ferry operations vary in different locations.

Section 1 Structural Characteristics of High-Speed Ferry

The high-speed ferry meets the needs of a fast-moving society in providing regular schedules and an efficient delivery service. High speed vessels are becoming increasingly more popular among travellers due to their relatively short travel time. The high-speed ferries operate on a worldwide basis, not only from coastal ports but to and from river or canal locations and across inland waterways and lakes.

1. The definition of high-speed craft

According to IMO's *International Code of Safety for Highspeed Craft* (hereafter *Highspeed Craft Code*), "High-speed craft" is a craft capable of maximum speed, in metres per second (m/s), equal to or exceeding $3.7\sqrt{\nabla}^{0.1667}$, where ∇ refers to the volume of displacement corresponding to the design waterline(m³), excluding craft the hull of which is supported completely clear above the water surface in non-displacement mode by aerodynamic forces generated by ground effect.

The term "high-speed craft" now clearly excludes wing-in-ground effect craft but includes craft partially supported by aerodynamic forces provided the hull is not supported completely clear above the water at operational speed. Craft that can only operate at operational speed if appendages such as submerged foils or propulsions are immersed are considered to be high-speed craft.

2. Safety rules of high-speed craft

The *Highspeed Craft Code* shall be applied as a complete set of comprehensive requirements. It contains requirements for the design and construction of high-speed craft engaged on international voyages, the equipment which shall be provided and the conditions for their operation and maintenance. The basic aim of the Code is to set levels of safety which are equivalent to those of conventional ships required by the *International Convention for the Safety of Life at Sea, 1974*, as amended, (*SOLAS Convention*) and the *International Convention on Load Lines, 1966* (*Load Line Convention*) by the application of constructional and equipment standards in conjunction with strict operational controls.

According to the Code, high-speed passenger ships are divided into two categories.

(1) Category A craft

Class A high-speed boat is any high-speed passenger ship with a passenger capacity of no more than 450 people, which is operating on a route where it has been demonstrated to the satisfaction of the flag and port States that there is a high probability that, in the event of an evacuation at any point on the route, all passengers and crew can be rescued safely within the least of:

① The time to prevent persons in survival craft from exposure causing hypothermia in the worst intended conditions;

② The time appropriate with respect to environmental conditions and geographical features of the route, or

③ Four hours.

(2) Category B craft

Category B craft is any high-speed passenger craft other than a category A craft, with machinery and safety systems arranged such that, in the event of any essential machinery and safety systems in any one compartment being disabled, the craft retains the capability to navigate safely.

3. Common structure characteristics of high-speed ferries

High-speed ferries are ferries with relatively small displacement and higher speed, compared to a traditional passenger ship. They have different forms and various kinds. However, for various forms of high-speed ferries, in order to achieve their high-speed and efficient transportation purposes, they all have the following characteristics.

(1) They are very sensitive to the weight of the hull. Because the resistance of ships is roughly proportional to the displacement, according to statistics, the displacement of a high-speed ferry needs 20~35kW. Therefore, under the condition of satisfying the safety and applicability, the deadweight should be reduced as far as possible to achieve the purpose of improving the economy. Given that it is difficult to significantly reduce the weight of equipment such as the main engine, significantly reducing the self-weight of the hull structure has become the goal pursued by high-speed ship designers. Therefore, most high-speed ships are built with aluminium alloy and fibre-reinforced plastic (FRP). Even if they are made of steel, most ships use calculation methods for reasonable design to reduce the size of plate and bone as far as possible under the condition of meeting the strength.

(2) The steady-state and non-stationary forces borne by the structure are greater than those of conventional ships. The former is mainly due to the high power of the main engine of high-speed ships, which are all high-speed engines. The increase of speed will lead to the intensification of the propeller cavitation phenomenon, resulting in a significant rise in propeller pulsation pressure. The latter is mainly caused by strong waves hitting ships during high-speed navigation.

4. High-speed passenger ship classification and its characteristics

In addition to the mono-hull ferry under high speed, high-speed ferries also include many specific categories of vessels including Hydrofoil Craft, Hovercraft (or air cushion craft), and Multihull Catamarans.

1) Single-body high-speed passenger ship

The linear profile of the hull of a single-body high-speed passenger ship is often with a round bilge. Its ship type is designed so that the hull will be affected by hydrodynamic lift when the high-speed navigation reaches a certain speed. Therefore, from the perspective of navigation status, single-hull high-speed passenger ships are located between general displacement ships and skimming boats and belong to transitional high-speed ships. The characteristics of its ship type mainly include the following aspects.

(1) The length width ratio of a single-body high-speed ship is large, and the displacement length coefficient is small, which is conducive to reducing the residual resistance at high speed, so as to consider both the speed and wave resistance. The slender and thin ship is one of the remarkable characteristics of such high-speed ships.

(2) The hull section of single high-speed ship is mostly of round bilge type, the rear of the boat is in the shape of angle, and the whole ship profile is a mixed U-V section.

(3) The narrow bow of a single-body high-speed and the small flooding angle of the waterline can effectively reduce the resistance of the wave.

(4) In order to reduce the hull resistance during high-speed navigation, the stern shape is square, the lower end of the square stern is lower than the side water surface. The water flow forms a groove backward, which lengthens waterline, equivalent to lengthening the ship, so as to reduce the displacement length coefficient and the total resistance. However, the impact received by the square stern in the wave is large, which will cause the adverse impact on the propeller and even cause trim by head, resulting in the rapid instability of the high-speed ship in the wave.

2) Hydrofoil Craft

A hydrofoil is a ship with hydrofoil immersed in water at the bottom of the ship, which sails at a high speed by lifting all or part of the hull off the water surface due to the lift generated by

the hydrofoil. The profile shape and principle of action of the hydrofoil are similar to those of aircraft wings, but they are much smaller. The lift force it produces is related to the flow rate, hydrofoil, impulse angle, area and immersion depth. The hydrofoil does not produce lift when moored or sailing at low speeds. At this time, hydrofoils, like ordinary ships with displacement in water, rely on buoyancy. In high-speed movement, the hydrofoil generates lift, gradually lifting the hull, reducing the resistance of the hull to water. When the speed reaches a certain speed, the hydrofoil lift is greater than the weight of the hull, and the hull is lifted off the water surface, thus getting rid of the water resistance to the hull. Therefore, under the same main engine power, the hydrofoil is faster and can reduce the impact of waves on the hull. Hydrofoil has a shallow draft, low navigation resistance, and is suitable for inland water passenger transport.

There are many types of hydrofoils, primarily divided into two main categories: single hydrofoils and double hydrofoils, based on the number of foils. According to whether the hydrofoil can be retracted, it can be divided into fixed hydrofoils and retractable hydrofoils. According to its control method, it can be divided into self-control hydrofoils and non-self-control hydrofoils. According to the relative position between the hydrofoil and the water surface, it can be divided into cutaway hydrofoils and fully submerged hydrofoils. The cutaway hydrofoils are partially out of the water rather than cutting the water. Cutaway hydrofoils have self-stability, and do not need control equipment. They have simple structures, but are heavily affected by waves. They are suitable for hydrofoils operating in lakes and coastal areas. The fully submerged hydrofoils are completely submerged in the water during navigation. They have no self-stability and must have an automatic control system to maintain stability. This kind of water wings has deep draught, large width and needs a set of launching device. The structure is complex and needs high cost, but it has low interference from waves. It should be used for the ocean hydrofoil ship with high wave resistance requirements.

3) High-speed catamaran

High-speed catamarans have obvious advantages in terms of resistance, manipulation, stability and use performance, especially suitable for inland water shipping. Its structure and performance characteristics are mainly reflected in the following aspects.

(1) Good resistance performance. In particular, for the catamaran of ultra-slender concept, the peak resistance of the wave resistance is significantly reduced, which not only easy to improve the speed but also reduces the erosion of the river bank by wave washing and the impact on the small boats in the channel.

(2) Large deck area and good comfort. The effective deck area of a catamaran is more than 50% larger than that of a single-body ship. Because the stability of a catamaran is good, the number of deck layers can also be increased so that the deck area can be increased more. In addition, the catamaran can also arrange the engine-room in the separated ship bodies, increasing the effective space of the cabin, which can not only increase the load of passengers but also use the spacious deck cabin to arrange entertainment venues, increasing the tourism function of the ship.

(3) Good stability performance and more safety. Because the high-speed catamaran has two well-separated pieces, the transverse inertia moment of the waterline surface is greatly increased, and the righting moment is increased, so its stability is far better than that of the single body. It is safe and has a high sailing rate in bad weather.

(4) Excellent manoeuvrability and suitable for navigation in complex waters. Due to the spacing between the two hulls, the distance between the propeller and the rudder is increased so that the rotation radius of the ship is reduced, and the operation is better than that of the single-body ship. Good manoeuvrability enables the catamaran to more efficiently berth and unberth the dock and speed up the voyage turnover.

(5) The ship type is simple and easy to maintain. Unlike other types of high-speed ships, high-speed catamarans without hydrofoils, aprons, and other additional equipment will not affect the normal operation due to hydrofoils and apron damage. Therefore, the high-speed catamaran is more convenient to manage and operate, whilst its maintenance is the same as conventional ships.

(6) The ship with a shallow draft can be achieved. Adapting to shallow water operation is an indispensable prerequisite for inland water navigation. At the same time, catamaran can also be enlarged according to the actual demand to meet the demand for high-speed Ro-Ro passenger ships.

Section 2 Structural Characteristics of Ro-Ro Passenger Ships

A special purpose ship, the Ro-Ro ship has a tall superstructure and flat upper deck without sheer and camber, and no cargo hatch. The ship has a multilayer deck (generally 2~4 layers) with few pillars in the cargo compartment. The difference between Ro-Ro passenger ships and other conventional passenger ships is that it the Ro-Ro has a special vehicle loading and unloading space, that can allow motor vehicles carrying self-consumed oil fuel to drive on and off. Therefore, the special Ro-Ro equipment is a significant feature of Ro-Ro passenger ships.

1. Structural features of Ro-Ro passenger ships

1) The hull structure features

The passenger Ro-Ro ferry in the offshore navigation area is both a Ro-Ro ship and a passenger ship, with a fixed route and schedule. This kind of ship often sails between straits, from land to islands and among islands. Therefore, the ship structure has the following characteristics.

(1) The main scale of Ro-Ro passenger ship, such as ship length (L) and ship width (B), should be determined by the amount and arrangement of vehicle to be carried, which are generally required to be designed with the size of five-ton standard truck.

(2) The general layout of the vehicle passenger Ro-Ro ferry servicing in the offshore navigation area is divided from bottom to top for the main hull, vehicle loading area, passenger cabin and the wheel house. The advantages of this arrangement are to separate the vehicle and the passenger area, and to divert the vehicles and passengers by different decks, with their own independent passage, in order to ensure the principle of safety and comfort, but also to improve the efficiency of loading and unloading.

(3) In order to facilitate the entry and exit of vehicles and access to each deck, there are no transverse bulkheads in the cargo hold area, and local bulkheads or strong beams and frames are installed to ensure the transverse strength. Below the main deck is the double hull, which can be used as ballast tanks.

(4) In order to ensure the sufficient strength, stiffness and stability of the hull structure, the loading deck and hull bottom of the Ro-Ro passenger ship are both longitudinal frame type, and there are many pillars under the loading deck. The passenger deck is a mixed-frame type. This design not only ensures the deck strength, but also meets the net height requirements of the vehicle deck. In addition, the reinforced side structure also helps to avoid hull damage caused by frequent docking during operation.

2) Seakeeping and insubmersibility of the Ro-Ro passenger ship

Ro-Ro passenger ship design pays more attention to seakeeping and insubmersibility. At designing stage, the inherent period of the ship will be improved as much as possible, especially the inherent rolling period, so as to enhance the seakeeping of the ship.

The insubmersibility of the ship refers to the ability of the ship to maintain a certain floating state and stability after it is damaged and submerged. The unsinkability of the ship is guaranteed by reasonable subdivision of the ship. The hull bottom of the Ro-Ro passenger ship is a double hull structure. The internal hull structure includes horizontal bulkheads, and sometimes contains longitudinal bulkheads. These vertical and horizontal bulkheads divide the ship's internal arrangement into main engine-room, auxiliary engine-room, rudder engine-room, fore peak cabin, fresh water cabin, fuel tank, ballast tank and void space. At the same time, there are several transverse and longitudinal bulkheads between the ship floor frame and the vehicle deck to divide the hull into several functional compartments. This ensures that the ship has sufficient reserve buoyancy, and also ensures the unsinkable requirements of the ship.

2. Equipment of Ro-Ro passenger ships

The loading and unloading of cargoes on Ro-Ro passenger ships is carried out through the wheels of various loads (such as towing trailers, forklifts), or the cargo itself with wheels (such as cars, trucks, buses, trailers, or even industrial vehicles), directly from the dock to the special category spaces for horizontal loading and unloading. Common special Ro-Ro equipment includes ramps, internal ramps, elevator, movable decks, and various types of large-scale watertight equipment such as bow door, stern door, side door, corner door and bulkhead door.

1) External watertight door

The external watertight door located on the hull of a Ro-Ro passenger ship is mostly used as the entrance and exit point for vehicles. According to its installation parts, it can be divided into bow door, stern port, side port and corner door (quarter ramp).

The exterior watertight doors, as a part of the hull, are the weakest part of the overall structure. At sea, they often affected by the impact of wind and waves. In the dock, they are squeezed from time to time. In particular, the watertight door used as a ramp is also subject to the pressure caused by passing vehicles when loading and unloading goods, and the torque caused by the ship when listing. Therefore, it is often prone to deformation or damage without proper care and maintenance. If not maintained correctly, and severe sea conditions are encountered, seawater may leak into the cargo hold accumulating in the higher deck. As such, water flowing on the deck to form a large free surface effect, thus reducing the stability of the ship. In worse cases, if the door is damaged by waves, it can cause a large amount of seawater to flood in, causing the ship to sink within a few minutes. Therefore, as an important equipment that directly affects the safety of the ship, the external watertight door is generally operated and managed by a special person on board. Before operation, the relevant instructions must be carefully read and the specified requirements in the instructions strictly followed.

2) Ramp

The ramp is an important part of the Ro-Ro equipment, which is a bridge between the ship and the dock for cargo loading and unloading. The ramps are divided into bow ramp, stern ramp, and side ramp according to its position on the ship. According to its form, it is divided into straight ramp, oblique ramp, rotating ramp, and semi-rotating ramp.

The ramps should have the proper scale and strength for the vehicles to drive on and off the ship. The ramps should be able to adjust the height difference between the ship and the wharf caused by the tidal range and the ship loading situation. Generally, the ramps should be always kept below 1:8, the working angle of the ramps should not be greater than $\pm 8^{\circ}\sim 10^{\circ}$, and the heeling angle should not be greater than $\pm 4^{\circ}$. In the offshore navigation area, direct ramps (the centre of the ramp is consistent with the centre line of the ship), which have simple structure, light weight and low cost, are mostly adopted. The ramp mostly adopts the electric hydraulic pressure locking mechanism. The front ramp should be protected by the bow door. In addition to aesthetics, it functions to improve wave resistance and protect the ramps.

3) Internal ramps and elevators

An internal ramp is a board frame installed between the upper and lower decks, connecting the traffic between the decks. It is divided into two types: fixed and movable. The internal ramp with both ends fixed and welded to the two decks is called a fixed ramp. A ramp that can move up and down at one or both ends is called a movable ramp. The slope of a ramp is generally 1:8~1:10, so the length of the ramp depends on the height between decks. The higher the height between decks, the longer the ramp length.

4) Movable vehicle deck

The movable vehicle deck is a deck or part of the deck that can move and change the position. It can divide the car cabin into two layers in the horizontal direction to increase the utilization rate of the cargo hold capacity and adapt to the requirements of loading small vehicles. The front and last pieces of the movable deck are commonly used as the internal ramp. When the movable deck is properly placed, the vehicle loading and unloading can be completed through it. The movable deck can be divided into either a lifting type or flipping type according to its activity mode, and can be divided into top collection type and side collection type according to the collection mode.

5) The bulkhead door

The hull structure of the Ro-Ro passenger ship mostly adopts a large cargo hold structure, especially above the freeboard deck, which generally adopts all-through hold structure. However, according to anti-sinking requirements, a corresponding number of watertight bulkheads must be set below the freeboard deck to ensure that the ship will not sink once one or two compartments are flooded. The installation of watertight bulkhead doors on the transverse bulkhead not only ensures necessary water tightness but also meets the requirements for personnel and vehicle passage. At the same time, it helps with fire fighting and exhaust removal. Bulkhead doors are generally divided into sliding type, containing manual sliding doors, hinge type, containing hinged doors, and power plus manual sliding doors. Watertight doors installed under the freeboard deck are generally in a sliding mode.

Section 3 Structural Characteristics of Inland Passenger Ships

Inland passenger ships mainly undertake the tasks of carrying passenger along rivers or lakes within the country, generally with a large passenger capacity, various cabins classes and frequent stops. Taking into account the small wind and waves in inland waters, it is easier to get shore-based assistance in case of accidents, and the contingency response is more convenient, so the structural strength of inland passenger ships is relatively weak and the safety requirements are low.

1. Classification of inland passenger ships

According to the size of inland passenger ships, they can be divided into the following three categories.

(1) Passenger ships with a length more than 50 metres are referred to as large inland passenger ships. The draft is about 1.2 to 4.0 metres, and the ships have three to four decks. They are usually used on the main stem of rivers with a speed of 22 to 28 kilometres per hour;

(2) Passenger ships with the length in a range of 30 to 50 metres are referred to as medium-sized inland passenger ships. The draft is about 1.2~2.0 metres, and the ships have three decks including the bilge compartment. They are usually used on the main stem of a river within a region with the speed of 18~25 kilometres per hour;

(3) Passenger ships with a length of 30 metres or less are known as inland river small passenger ships. The draft is less than 1.2 metres. They can be used in various navigational areas, including the main stem or the tributaries of the river within a region.

2. Common structure characteristics of inland passenger ships

The main structure of inland passenger ship is relatively thin, unless there is a water with a current greater than three metres per second on the section. The small inland passenger ship sailing in shallow rivers and lakes does not have a double lower hull. Generally, the freeboard is low, and the superstructure extends to the fore and aft and ship hull flares out to increase the passenger carrying area. At the same time, in order to reduce the air resistance, the superstructure is mostly stepped at the head and end, so that the solid side shape of the ship is enveloped in a smooth streamline.

3. Performance and structural characteristics of small inland passenger ships

Usually due to the restrictions of navigation water conditions and service demand, inland passenger ships are mainly small vessels. Compared with ordinary ships, small inland passenger ships have the following characteristics:

(1) Due to the small scale, small water passenger ships usually serve as regular ships of small waterways, which become the auxiliary force of public transportation, and are widely used in more remote areas.

(2) Generally, no cargo or very small cargo, cabin ceiling can accommodate passenger luggage.

(3) There is only one layer of continuous deck, and the larger one can be divided into upper and lower cabins, and the smaller one is only one floor, which is mainly a through-cabin style. For those who need to travel for a long time, a very small number of sleepers can also be set up, and the seating arrangement is generally similar to that of the train.

(4) Most of the main dimensions such as the length of the ship and draft are restricted by the channel, and the design speed is 15~20 kilometres per hour. Due to the limitation of various conditions in the channel, only part of the time can sail at full speed. Therefore, there is a certain reserve in speed and power.

(5) The ratio of length to breadth (width) (L/B) is about 4.5~5.5, and the ratio of breadth to draft (B/T) is about 3.8~5.0. The characteristics of small L/B and large B/T reflect the reality that small inland passenger ships are restricted by waterways. Because of the many passengers and high centre of gravity, it also needs a larger ship width to ensure the stability.

(6) In order to adapt to the trapezoidal section of the inland waterway and to meet the needs of the layout, the inland passenger ships are usually equipped with overhanging decks. The shape of middle transverse section has certain bilge elevation and inclined side shell, and flares out above the waterline. Although this structure increases the deck area, it will cause the centre of gravity to increase, which is not conducive to the stability of the ship.

Chapter 3 Ferry Fire Protection

As specialized vessels frequently crossing main waterways and transporting vehicles and passengers on short routes, ferries are prone to accidents such as collisions, hazardous material leaks, fuel spills, grounding, and hull damage. These accidents can lead to fires in vehicle compartments and passenger cabins, posing a serious threat to the safety of passengers and the vessel itself. With regard to the prevention of fire on ships, IMO has given detailed regulations and requirements on structural fire prevention, fire detection and fire-extinguishing of international ships in Section 2 of Chapter II of the *SOLAS Convention*.

Based on the overview of the characteristics of ferry fire, this chapter expounds the fire protection structure and fire protection equipment requirements applicable to coastal passenger ships and inland river passenger ships according to the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* and the *Technical Rule for the Statutory Survey of Inland ships 2019* respectively. Considering the varying applicability of statutory inspection technical rules for vessels of different ages, this material does not provide specific details. Existing ships should refer to the provisions of the statutory inspection technical regulations for sea or river ships and their amendments which are in force when the ship is laid with a keel or in a similar construction stage.

Section 1 Ferry Fire Prevention

1. Ferry fire prevention features

A special purpose passenger ship, especially when carrying cars or trains simultaneously, a ferry is a ship that carries both passengers and cargo. A ferry fire has the basic characteristics of difficult fighting, great danger, major loss and significant impact. The reasons for those are the narrow ship space (confined area), high fire incidence, strong heat conductivity, the difficulty of fire fighting, the large number of combustible materials, the speed of spread, the large number of passengers, and the large impact of accidents, to name but a few.

The vehicle cargo loaded on the Ro-Ro passenger ship is large in size, heavy in weight and easy to move. Each vehicle has a fuel tank with fuel oil and its own electrical equipment. Once a vehicle moves due to the rolling and pitching motion caused by the wind and waves, it may collide with other vehicles, generate sparks, and if the fuel tank is damaged, so that the fuel of the vehicle leaks and is ignited, it is easy to cause fire and explosion. In the design of the vehicle loading area, due to the convenience of the vehicle stowage and the effective utilization of the hold capacity, the transverse and longitudinal bulkheads are usually not installed in the vehicle loading area. Once a fire occurs, it is easy to cause the fire to spread, and it is difficult to control and fight the fire.

Compared with traditional ships, the huge garages or vehicle decks of Ro-Ro ships not only require a large amount of gas to make the fixed gas fire-extinguishing system effective, but also have more stringent requirements for space sealing and gas volume control. Water spray systems can be very effective, but can bring problems associated with water accumulation and free liquid surface on vehicle decks. Especially after a fire, the burning residue will block the drainage system, causing drainage difficulties.

Once the Ro-Ro vehicle loading area is on fire, the effect of lashing for the vehicle will be greatly weakened due to the burning and leaking of vehicle tyres. If the carrying vehicle moves, there is likely to be a "domino effect" with other vehicles nearby, especially in bad weather conditions. The space may also produce harmful gases from the burning of plastic or other similar synthetic materials or cargo combinations, although these materials are not inherently dangerous.

2. Structural fire prevention requirements for inland water ferries

The structural fire protection of inland ferry should meet the requirements of heat resistance and structural separation for inland passenger ships. The main vertical area of inland passenger ships must comply with the following structural requirements.

(1) For tourist ships, Ro-Ro passenger ships with a single deck passenger area of more than 800 square metres, and ordinary passenger ships with sleeper cabins, the hull, superstructure and deckhouse in the accommodation and service spaces, shall be subdivided into several main vertical zones by "A-60" class divisions. Steps shall be kept to a minimum, but where they are necessary, they shall also be "A-60" class divisions. If the space on one side of the main vertical division is an open deck space, as well as spaces with minimal or no fire hazards such as empty spaces and public restrooms, the standard may be reduced to "A-0";

(2) As far as practicable, the bulkheads forming the boundaries of the main vertical zones above the bulkhead deck shall be in line with watertight subdivision bulkheads situated immediately below the bulkhead deck. The length and width of main vertical zones may be extended to a maximum of 48 metres in order to bring the ends of main vertical zones to coincide with watertight subdivision bulkheads or in order to accommodate a large public space;

(3) Such bulkheads shall extend from deck to deck and to the shell or other boundaries;

(4) Where a main vertical zone is subdivided by horizontal "A" class divisions into horizontal zones, the divisions shall extend between adjacent main vertical zone bulkheads and to the shell or exterior boundaries of the ship. The insulation value of the horizontal separation shall comply with the relevant provisions of the main vertical area in (1) above.

For bulkheads other than the main vertical boundary, "A" class and "B" class separated bulkheads shall extend from deck to deck and to the shell or other boundary. Bulkheads required to be "B" class divisions, except corridor bulkheads, where a continuous "B" class ceiling or lining is fitted on both sides of a bulkhead which is at least of the same fire resistance as the adjoining bulkhead, the bulkhead may terminate at the continuous ceiling or lining.

In the requirements for the fire integrity of the bulkheads and decks of passenger ship, it is necessary to distinguish between tourist ship, Ro-Ro passenger ship and ordinary passenger ship with sleeping cabins, from car and passenger ferries, passenger ferries with a length greater than or equal to 30 metres, tourist ship with a length greater than or equal to 30 metres and ordinary passenger vessels with a length greater than or equal to 30 metres (except ordinary passenger vessels with sleeping cabins).

For car and passenger ferries, passenger ferries with a length greater than or equal to 30 metres, pleasure vessels with a length greater than or equal to 30 metres and ordinary passenger vessels with a length greater than or equal to 30 metres (except ordinary passenger vessels with sleeping cabins), the minimum fire integrity of the bulkheads and decks separating adjacent spaces shall comply with the following requirements:

(1) The bulkheads and decks between the spaces of important machines and adjacent control stations, corridors, living places, stairs and accommodation spaces of fire risk shall be "A-15" separated structures;

(2) The bulkheads and decks of other machines and accommodation, corridors, stairs, accommodation spaces of fire risk and control stations with fire danger shall be separated by "A-0" class;

(3) The bulkheads and decks between the accommodation spaces of fire risk and adjacent control stations, corridors, accommodation, stairs and important machinery spaces shall be separated by "A-15" class structure;

(4) When there is a ceiling under the deck separating the adjacent living places, the continuous ceiling shall be composed of the structure of non-combustible materials;

(5) The bulkhead between the living space and the corridor or stairway shall be a class "B-0" class separated structure, except for the above-mentioned passenger ships whose voyage time does not exceed 2 hours or whose one-way voyage does not exceed 20 kilometres;

(6) The bulkheads and decks between the special category spaces and Ro-Ro space of the adjacent important machinery spaces, accommodation spaces, service spaces, control stations and other spaces shall be separated by "A-15" class. The bulkheads and decks

between the Ro-Ro spaces on the open deck and adjacent spaces can be divided into "A-0" class structures.

3. Structural fire protection requirements for coastal ferry

The structural fire protection of coastal ferries should first meet the requirements of the corresponding class of passenger ships, and at the same time meet the additional safety requirements of Ro-Ro passenger vessels.

A passenger roller vessel of any class with a lifeboat/raft (other than a jettied liferaft) and evacuation arrangement on an open or open deck and open Ro-Ro space shall have no fixed openings on the lower side walls of the arrangement to a trim of 10° and the side. Windows below the boarding area of the lifeboat shall have fire integrity equivalent to class A-0 at least.

The structure-fire prevention, fire detection and fire fighting for the Class I Ro-Ro passenger ship shall also meet the following requirements.

(1) The accommodation space, service space and storage spaces of Ro-Ro passenger ship shall generally not be located on a Ro-Ro deck, but where the actual arrangement requires to be located on a Ro-Ro deck, the boundary facing the Ro-Ro space shall be at least "A-60" class.

(2) In special category spaces and open-type Ro-Ro spaces where passengers can enter, the number and layout of escape routes above and below the bulkhead deck shall meet the same regulations as passenger ships of the same level. Such spaces should also have several special aisles with a width of not less than 600 millimetres on the horizontal side of the vehicle deck to avoid risks, and the spacing between the horizontal special aisles should not exceed 40 metres. The width of the special aisles and the protected work patrol channels on both sides should not be less than 600 millimetres, which should be combined. It can provide the layout of the escape route. The above-mentioned special aisles and work patrol passages should be clearly marked. The parking arrangement of vehicles should make these aisles unobstructed at all times.

(3) In order to prevent the ignition of flammable steam in the closed Ro-Ro space, the water outlet shall not lead to the machine place or other places where the ignition source may exist. The layout of the deck drainage system should not cause mutual interference between the two sides or the water on one side, and should be able to quickly and timely drain the accumulated water in the area. Special attention shall be paid to the design and layout of the drainage outlet (or suction outlet), that is, considering sufficient circulation area and measures to prevent blockage by debris or rapid blockage.

(4) The anti-collision guard plate on the side wall of the Ro-Ro space and the anti-skid coating on the deck shall be made of non-combustible materials that do not produce smoke, toxic substances or explosion risks at high temperature.

(5) Protection requirements for the elevator enclosure trap. If the elevator for the accommodation and service spaces passes through the multilayer deck and opens for the special category spaces and roll-off spaces, it shall meet the following requirements: ① in any case, the ventilator in the elevator trap shall be kept ventilated with a minimum positive pressure 25 Pascals (Pa) (wind speed close to 3.5 metres per second). The fan should work continuously and at least meet the ventilation frequency for loading and unloading vehicles in special areas and roll on/roll off areas. ② to prove that flammable vapour has been eliminated in the special category spaces and roller, a portable combustible gas detector should be provided.

(6) Unsealed vehicle spaces and Ro-Ro spaces shall be equipped with a fixed water-based fire-extinguishing system suitable for the rolling off spaces, which shall protect any deck and all parts of vehicle platform. The nozzle of the water-based fire-extinguishing system is not less than 0.5 metres from the roof height, and it has a sufficient number of nozzle spare parts.

(7) Considering that a large amount of water accumulates on one or several decks during the operation of a fixed pressure water mist system, which can seriously weaken stability. A drainage hole should be installed above the bulkhead deck to ensure that this water can be quickly discharged overboard, and measures should be taken to prevent blockage of the

drainage port. When the ship shall keep the valve of the drainage hole open, the discharge system shall meet the requirements of the corresponding load line.

(8) For Ro-Ro passenger ships equipped with fixed pressure water mist systems, in addition to meeting the general requirements of the ship's bilge drainage system, additional bilge pumps and drainage facilities need to be installed below the bulkhead deck. In this case, the drainage system shall be no less than 125% of the combined capacity of the mist system pump and the required number of fire hoses. The valves of the drainage system shall be operated from the outside of the protected position close to the control of the fire-extinguishing system. The sewage well shall have sufficient capacity and shall be arranged on the side of the ship in each watertight compartment, and the distance between each other shall not exceed 40 metres.

The following Ro-Ro passenger ships shall meet the corresponding requirements of the higher level:

(1) Class II Ro-Ro passenger ships carrying 500 passengers or more shall meet the corresponding requirements of Class I Ro-Ro passenger ships;

(2) Class III passenger rolling vessels carrying 500 passengers or more shall meet the corresponding requirements of Class II passenger rolling vessels;

(3) Class III Ro-Ro passenger ships carrying 1,000 passengers or more shall meet the corresponding requirements of Class I Ro-Ro passenger ships.

Train ferries carrying passenger shall not only have public address systems or other effective communication facilities generally installed in accommodation, service spaces, control stations, and open decks, but also be coordinated with the public address systems of the passenger trains they carry.

Section 2 Fire-Fighting Facilities and Equipment of Inland River Ferries

1. Fire detection and alarm system

The ferry shall refer to the relevant equipment standards of IMO *International Code for Fire Safety Systems* and be equipped with fixed fire detection and fire alarm systems that meet the requirements of the competent authorities. The fixed fire detection system shall be able to detect the occurrence of the fire quickly. The type of detector and its spacing and location shall consider the influence of ventilation and other related factors and meet the relevant requirements of the competent authorities. After the system is installed, it shall be tested under normal ventilation conditions, and the overall system response time shall be reported to the competent authorities.

1) Setting requirements of fixed automatic fire detection and fire alarm system

Tourist ships, Ro-Ro passenger ships, and other passenger ships with the length of the boat greater than or equal to 30 metres shall be equipped with manual alarm devices for personnel to immediately notify the driver's cabin or duty room when a fire is discovered.

The ship spaces where a fixed automatic fire detection and fire alarm system should be set up. This includes accommodation spaces, service spaces, and control stations (including corridors and stairways) for tourist ships, Ro-Ro passenger ships, and other passenger ships with berths or the length of the boat greater than or equal to 50 metres. And the main propulsion machinery spaces that are not continuously manned during ship navigation. The bathroom in the guest room does not need to be equipped with smoke detectors. In places with minimal or no fire risk, such as empty cabins, public restrooms, carbon dioxide rooms, and similar spaces, it is not necessary to install fixed automatic fire detection and alarm systems.

The manual alarm button of the manual alarm device shall be filled with the accommodation, service spaces and control station. A manual alarm button shall be installed at the exit of each passage. In the corridor of each deck, the manual alarm button shall be easy to reach, and the walking distance from any position in the corridor to any manual alarm button shall not exceed 20 metres.

The fire indication device shall be located in the cab or the place of the crew on duty to ensure that the cab or the crew on duty can hear and see the alarm signal. When the fire

indication device is installed in the place of duty crew, there shall be communication facilities between the place and the cab.

The entire main vertical area of the passenger ship containing an atrium should be protected by a smoke detection system according to its overall scope.

The construction of passenger ship ceilings and bulkheads should enable fire patrol personnel to detect hidden and inaccessible smoke sources without reducing their fire safety efficiency, except in cases where it is deemed that there is no risk of fire.

2) Performance requirements for fixed automatic fire detection and fire alarm systems equipped on inland water vessels

All required fire detection and fire alarm systems shall operate normally during all operating hours of the ship. The performance design of the alarm system, the environmental conditions and working conditions of the equipment shall meet the relevant requirements. When any detector or manual alarm button moves, the auditory and visual alarm signals should be sent on the fire alarm indication device. The indicating device should indicate the area where the detector or manual alarm button that has been activated is located.

The automatic fire detection system shall not be used for any other purpose except to close the fire door on the control board and have similar functions.

The fire detection and fire alarm system shall be able to carry out regular functional tests, and shall be able to resume normal work without replacing any parts. Spare parts and appropriate instructions shall be provided for testing and maintenance on board the ship.

The arrangement of detectors for fixed automatic fire detection and fire alarm systems shall meet the following requirements.

(1) All stairs, corridors and escape routes in the accommodation shall be equipped with smoke detectors, and the living cabin may be equipped with detectors of smoke or temperature.

(2) The setting of detectors in the machinery space of the main engine that is not continuously manned during the voyage of the ship should be able to quickly detect signs of fire at any location and under any normal conditions of mechanical operation and possible changes in environmental temperature range that require ventilation. It is not allowed to set up a fire detection system that only uses temperature detectors, except for places with height restrictions and those that are particularly suitable for use.

(3) The detector shall be installed in the position with the best function. Location close to the beam and ventilation duct, or other locations where the airflow affects the detector performance, or the potential for impact or physical damage should be avoided. The detector shall be located at the top of the detector. The distance of the detector from the bulkhead is at least 0.5 metres, except in the corridor, small storage room and stairs.

(4) The protection area and the maximum installation spacing of the detectors shall comply with the provisions of Table 3-1. According to the test data confirming the characteristics of the detector, other spacing can be selected.

Table 3-1 The protective area and the maximum installation spacing of the detectors

Type of detector	Maximum floor area per detector (meters ²)	Maximum distance apart between centres (metres)	Maximum distance away from bulkheads (metres)
Heat	37	9	4.5
Smoke	74	11	5.5

2. Water fire-extinguishing system

1) Fire pump

The number of fire pumps equipped on inland passenger ships shall not be less than the quantity listed in Table 3-2, and the driven mode of fire pumps shall meet the requirements in Table 3-2.

Table 3-2 Requirements for quantity and driven mode of fire pumps for inland passenger ships

The length of passenger ships	Quantity (number of fire pumps)	Driven mode
The length ≥ 50 metres	Two	Independent power
The length > 30 metres; and < 50 metres	One	Independent power
The length < 30 metres	One	Independent power or driven by main engine

One independent power unit should be added for the passenger ferry, which has the length equal to or more than 50m and the sailing time more than 0.5 hours, if its fire pump is driven by one independent power unit or only by main engine.

If the sanitary pumps, ballast pumps, bottom pumps or general pumps meet the relevant requirements of the fire pumps, they are allowed to be used as fire pumps without affecting the ability of pumping the water under the tank. The general pumps shall not be used for pumping and transporting oil when used as fire pumps.

The capacity and water pressure of fire pumps shall meet the requirements as following.

(1) On the fire hydrant on the highest deck, the capacity of one water pump should meet the water outlet requirements specified in Table 3-3, and the range should not be less than 12 metres (the pressure and flow rate of the fire nozzle can refer to Table 3-4). The Ro-Ro passenger ships should be able to obtain three streams of water with a range of no less than 12 metres from the fire hydrant at the Ro-Ro space at the capacity of one water pump;

(2) Amount of water required for fixed deck foam fire-extinguishing system (if provided and supplied by fire pumps).

Table 3-3 Effluent requirements of fire pumps for inland passenger ships

Fire nozzle calibre \ Length	19 millimetres	16 millimetres	13 millimetres
The length ≥ 50 metres	At least two water streams		
The length ≥ 30 metres And < 50 metres		At least two water streams	
The length < 30 metres			At least one water stream

Table 3-4 Pressure and rate of flow requirements of nozzle

Effective firing range	Nozzle pressure and flow at different calibre					
	Nozzle diameter is 13 millimetres		Nozzle diameter is 16 millimetres		Nozzle diameter is 19 millimetres	
	pressure (kPa)	rate of flow (L/s)	pressure (kPa)	rate of flow (L/s)	pressure (kPa)	rate of flow (L/s)
12	186.32	2.6	171.61	3.8	166.71	5.2
12.5	210.84	2.7	191.22	4.0	181.42	5.4
13	235.35	2.9	215.74	4.2	201.03	5.7

For a Ro-Ro passenger ship and a passenger ship with a length greater than or equal to 50 metres, at least one fire pump can be started remotely outside the exit of the cab or the important machine place or at the fire control station (if provided) to ensure timely water supply.

2) Emergency fire pump

For a Ro-Ro passenger ship and a passenger ship with a length greater than or equal to 100 metres, there shall be an emergency fire pump driven by fixed independent power.

The capacity of the emergency fire pump shall not be less than 25 metres³ per hour, and the range of two water streams at any hydrant is not less than 12 metres. If the emergency fire pump is used as the water supply pump for the pressure water mist fire-extinguishing system where the important machine is used, the water quantity required by the system should also be increased in its total displacement.

Any diesel-driven power source for the pump shall be capable of being readily started in its cold condition down to the temperature of 0° Celsius by hand (manual) cranking. Other starting devices, such as compressed air, electricity or other stored energy sources, including a hydraulic accumulator or a cartridge as a starting device, may also be permitted. These starting devices shall be able to start the diesel engine at least six times in 30 minutes and at least two times in the first 10 minutes. The stored fuel shall be able to operate the pumps at full load for at least three hours.

The emergency fire pump and its power source should be located in a safe position and easy to reach. Its layout should not be affected by the fire where the main fire pump is located. The place where the emergency fire pump is located shall not be adjacent to the place of the important machines or the place where the main fire pump is located. If it cannot be done, the adjacent limit interface shall be separated by "A-60" class fire resistance.

The power source of the emergency fire pump should be provided by the emergency power supply for lighting and have good ventilation. If mechanically ventilated, it should be powered by an emergency power source. Ventilation should be arranged so as to prevent smoke from entering or being sucked into the machine space in case of fire.

No opening or direct passage is allowed between the main fire pump and its power source and the emergency fire pump and its power source, but the entrance protected by air lock facilities or watertight doors is acceptable. The operation of air lock facilities or watertight doors should be unobstructed in the event of a fire in these areas.

3) Fire pipe

The fire hose shall be arranged in such a way as to ensure that the fire pump can at least draw water from the submarine valves located on both sides of the ship. The fire main and fire hose should meet the maximum water output required by the fire pump working at the same time.

The laying of fire water pipes should be avoided through the cargo holds, accommodation and wet place. The layout of fire water pipes shall be used to avoid damage when loading goods or vehicles. In order to prevent the possible freezing of the fire pipe, the discharge valve can be set at the lowest point of the pipe.

For ships with emergency fire pumps, the isolation valve shall be set up to separate the fire main pipe from the fire main pipe outside the spaces in the location that is easily accessible to the machine spaces where the main fire pump is located. When the isolation valve is closed, except for the fire hydrants in the place, other fire hydrants should be supplied by the emergency fire pump.

The emergency fire pump and its seawater inlet, water suction and drainage pipe and valve parts shall be located on the outside of the place where the main fire pump is located. The arrangement shall meet the emergency fire pump to obtain the required water at any time under the most unfavourable ship draft conditions. If the pipeline cannot be arranged outside the place where the main fire pump is located, the water can be absorbed through the sea valve box in the place where the main fire pump is located. However, the suction pipe should be as short as possible, and it should be possible to remotely operate the valves on the seawater inlet pipeline in the place where the emergency fire pump is located. When the main fire pump is on fire, the normal operation of the valve parts shall not be affected. A small portion of the suction pipe and drainage pipe may run through the spaces where the main fire pump is located, but it should be wrapped in a strong steel coat, or insulated to the "A-60" class. The pipe shall be thickened and all joints of the pipe shall be welded except some special circumstances.

4) Drainage system

There shall be sufficient deck drain outlets above the freeboard deck. Power drainage facilities shall be provided below the freeboard deck. The outlet of the drainage pipe shall not lead to the machine places or other places where there may be ignition sources. The layout of the deck drainage system shall not cause mutual interference of the water between the two sides or one side, and can discharge the water in the place quickly and timely. The layout of drainage outlet (or suction outlet) should prevent debris blockage and facilitate rapid plugging. The port outlet of the drainage pipe should generally be located at the appropriate height above the full load waterline, and the closed valve parts should not be set on the drainage pipe.

The drainage of the Ro-Ro space installed with the fixed pressure water mist system shall meet the following requirements in addition to the above.

(1) For areas below freeboard deck, bilge pumps and piping shall be provided in addition to a bilge system. The capacity of the attached bilge pump and the size of the bilge water pipe shall be able to discharge no less than 125% of the combined capacity of the water supply pump for water mist system and the required number of fire hoses. The valves of the bilge water system shall be capable of operation from the outside of the protected spaces close to the control of the water mist system. The volume of the bilge well shall not be less than 0.15 meters³, and shall be arranged on the sides of the ship, in each watertight compartment. The distance between each other shall not exceed 40 metres.

(2) For spaces above the freeboard deck, each port drain pipe and suction port shall have 1.25 times the maximum capacity of the water fire-extinguishing system (including pressure water mist system and water fire protection system). Generally, a drainage pipe with a spacing of about 9 metres and a diameter of no less than 150 millimetres can be set on both the port and starboard sides of the space, or other effective drainage measures such as the ship side scupper can be adopted.

5) Fire hydrant

The number and arrangements of fire hydrants shall be ensured that at least two water pillars not fired from the same fire hydrants can reach any part of the protective places, and one of them can only use a fire hose. For ships requiring only one fire jet of water, the number and layout of fire hydrants shall ensure that only one fire hose brings the fire jet of water to any part of the protection spaces. Fire hydrants shall be provided at the entrance and exit of the protected spaces. At least one fire hydrant should be set on each side near the exit of the important machines. The position of the fire hydrant should be easy to connect to the fire hoses, and it should be easy to approach. The layout of fire hydrants should prevent possible freezing and avoid collision damage. Each fire hydrant shall be composed of an internal buckle joint suitable for connecting the fire hoses, a stop valve and a protective cover. The inner buckle joints and stop valves shall be made of non-ferrous metals or other flame-resistant and corrosion-resistant materials.

6) Fire-fighting hoses and fire nozzles

The fire hoses shall be made of approved corrosion-resistant materials, and each fire hose shall be of sufficient length, but shall not exceed 20 metres. Each fire hose coupling and each fire nozzle should be used interchangeable, otherwise each fire hydrant on the ship should be equipped with one fire hose and one fire nozzle. Each fire hose shall be equipped with one fire nozzle and necessary joints, and shall be stored in the obvious place near the fire hydrant for use at any time.

Fire-fighting hoses shall be configured according to the following requirements:

① Passenger ships and Ro-Ro cargo ships are equipped with one hose for each fire hydrant;

② Vehicle and passenger ferries with a length of 50 metres and above, the number of fire hose should not be less than five. For vehicles and passenger ferries with a length less than 50m, the total number of onboard fire hoses should not be less than three.

Within the scope of this section, the diameter of the standard fire nozzle shall be 13 millimetres, 16 millimetres and 19 millimetres, or similar. Large-diameter fire nozzles may be permitted. The size of the fire nozzle of all kinds of ships may not be greater than the size listed

in Table 3-3. But in the accommodation and service place, it is not necessary to use the fire nozzles greater than 13 millimetres. In the machine and the external places, the size of the fire nozzles should be able to obtain the maximum water output from the two jets of waters according to the range specified in Table 3-4.

All fire nozzles shall be of an approved type. The fire nozzle used in the machine space and Ro-Ro space shall be a dual-use type with switch. (i.e., jet/spray type).

3. Fixed fire-extinguishing system

1) Requirements for fixed fire-extinguishing system equipment for inland passenger ships

The fixed fire-extinguishing system of a river passenger ship shall be equipped according to the requirements shown in Table 3-5.

Table 3-5 Requirements for fixed fire-extinguishing system for inland passenger ships

The length of passenger ships	Dry cargo cabin	Important machine spaces	Living and service spaces
The length ≥50 metres	1. Water 2. Carbon dioxide	1. Water 2. One of the following fixed fire-extinguishing systems: ① carbon dioxide ② pressure water mist ③ aerosol ④ sevoflurane	water
The length <50 metres	water	water	water

2) General requirements for pressure water mist fire-extinguishing systems

The pressure water mist system shall be able to effectively extinguish the oil flame in the protected place. The system shall be equipped with an independent water pump, which shall not be the fire pump. The fire pump can be connected with the pressure water mist system as a backup pump, but there shall be a one-way valve to prevent back flow to the fire line.

The water pump should be able to simultaneously supply water to all sections of the system in any protected space at the required pressure. The water pump and its control equipment should be installed outside the protected space, and the system should not become ineffective due to a fire in the protected area of the pressure water mist system. If the water pump is powered by an emergency generator, the arrangement of the generator should be able to automatically start when the main power fails, so that the water pump can immediately obtain power. If the water pump is driven by an independent diesel engine, its location should not affect the air supply to the diesel engine in the event of a fire in the protected area.

The fixed pressure water mist fire-extinguishing system required by the protected place shall be equipped with an approved water spray nozzle. The number and arrangement of nozzles shall ensure that at least five litres per minutes per metre square (L/min·m²) of water volume is effectively and evenly distributed in the protected place. If it is considered necessary to increase the effluent rate, the consent of the ship inspection agency shall be obtained.

The system may be divided into several areas, and its distribution valve shall be able to operate from an easily accessible part outside the protected spaces, and shall not be cut-off by a fire in the protected spaces. The pipeline of the system should be tested in the workshop at 1.5 times the design pressure, and the water spray test should be carried out after loading on the ship.

The pressure and water mist main pipe should be equipped with a pressure gauge. The pressure and water mist valve should be clearly marked with the places where it serves. Measures shall be taken to prevent the nozzle from being blocked by impurities in water or corrosion of pipes, nozzles, valves and pumps. The pipe system should be galvanized steel pipes both internally and externally.

Fixed pressure water mist system in the machine places shall maintain the required pressure. When the pressure in the system decreases, the water supply pump shall immediately and automatically supply water to the system. Nozzles should be installed in sewage ditches, top of tanks, and other places where fuel is easily dispersed, as well as above other places with significant fire hazards in machine spaces.

For the fixed pressure water mist system in the ro-ro space, the water mist nozzle should be of a full hole type, and the distance from the nozzle to the roof should not be less than 0.5 metres. However, the distance from the nozzle to the roof of a ro-ro cargo ship carrying commercial vehicles should not be less than 0.5 metres or the distance required by the pressure water mist system. The arrangement of nozzles should ensure effective and uniform distribution of water mist in the roll on/roll off area.

For places with deck height of less than 2.5 metres, the system shall provide amount of water for at least 3.5 L/min·m². For deck height of 2.5 metres or above, the system shall provide amount of water for at least five L/min·m². The water pressure shall be sufficient to ensure the uniform distribution of the water mist. Each sub-zone shall cover the entire width of the roll-on deck, with the length direction not less than 20 metres. Except that the width of the partition should be reduced due to the longitudinal separation of the stairwell by "A" level.

The water supply pump should be able to continuously supply water to the nozzles of at least two zones at the required pressure and sufficient water volume simultaneously. The water supply pump shall be able to start remotely from the control position of the distribution valve.

3) Carbon dioxide fire-extinguishing system

Carbon dioxide fire-extinguishing system, including fire station, carbon dioxide gas cylinder, carbon dioxide piping and control system and other auxiliary systems.

The amount of carbon dioxide filled in the carbon dioxide fire-extinguishing system shall not be less than the maximum value of the fire-extinguishing requirements of each protected cabin.

When using carbon dioxide fire-extinguishing agents to extinguish fires in machinery spaces, cargo oil pump compartments, and closed ro-ro spaces where people often work or enter, auditory and visual automatic alarm devices should be installed. The auditory alarm should be located in a position that can be heard anywhere within the protected area while all machines are in operation, and should be distinguished from other auditory alarms by adjusting the sound pressure or tone. The early-warning should be automatically activated, such as by opening the door of the fire-extinguishing agent storage area. The length of warning time should be the time required to evacuate the spaces. But in any case, it should not be less than 20 seconds before the fire-extinguishing agent is applied. Ordinary cargo spaces and small spaces only equipped with partial release devices (compressor rooms, paint rooms, etcetera) do not need to be equipped with such alarm devices. Appropriate facilities should be provided to stop the fans in the protected area and close the fire dampers in the ventilation system of the protected area before applying fire-extinguishing agents.

The volume of free carbon dioxide gas required for extinguishing the fire in each protected chamber shall be determined according to the following requirements, of which the volume of free carbon dioxide gas shall be calculated at 0.56m³/kg.

① Important machine places take 35% of the total volume of the place (including the cabin);

② Cargo oil pump compartment takes 45% of the total volume of the cargo oil pump compartment (including the cabin);

③ Cargo hold takes 30% of the maximum cargo hold volume under the freeboard deck;

④ Closed roll on/roll off spaces take 45% of the volume of the space.

If the compressed air contained in the air bottle in the machine room is released due to a fire and its quantity seriously affects the fire-extinguishing effect, the amount of carbon dioxide should be appropriately increased.

The layout of the carbon dioxide pipeline and the setting of the nozzle should obtain the uniform distribution of carbon dioxide. The carbon dioxide pipe leading to the machine places,

the cargo pump chamber and the closed roll-off places shall have enough size and nozzle quantity, so that 85% of the carbon dioxide required by the machine places and the cargo pump chamber can be sprayed in within two minutes, and 70% of the carbon dioxide required by the closed roll-off places can be sprayed in within 10 minutes. The carbon dioxide distribution valve box to each protected cabin shall have an independent branch pipe, and each branch pipe shall be equipped with a control valve on the distribution valve box. Each control valve shall indicate the name of the protected cabin.

The valve used to control the discharge of carbon dioxide, regardless of its power mode, regardless of whether it is remote control, shall be able to be operated manually locally beside the valve. The control device of the CO₂ system shall be provided with two separate controls to release the CO₂ to the protected space and to ensure the activation of the alarm device. First, one set of control devices is applied to open the valve installed on the pipe to deliver the gas to the protected spaces. And then another control device is applied to release the gas from the stored container. The control devices shall be designed to ensure operation in this order. Two sets of control devices shall be arranged in a release box, and prominently marked in specific parts of the box. If locked on the release box with a control is attached, the key for opening the box shall be placed in a box with a glass panel, which shall be placed in a prominent position near the release box.

A check valve should be installed on the connecting pipe between each carbon dioxide bottle head valve and the manifold. A pressure gauge with a range of 0-24.5 MPa should be installed on the main pipe from the manifold to the distribution valve box. On the main pipe or distribution valve box, the compressed air blowing pipe joint should be installed. Carbon dioxide pipe should be seamless steel pipe. The carbon dioxide fire-extinguishing pipeline shall not pass through the accommodation and shall be avoided through the service spaces. If unavoidable, the pipes through the service spaces shall not have removable joints.

4. Other fire-fighting equipment

In addition to the necessary fire detection, alarm, water extinguishing systems, and fixed fire-extinguishing systems, the number and location of fire extinguishers, fire-fighter equipment, and emergency escape breathing devices and other fire-fighting supplies should also meet the requirements described below.

The type, quantity and arrangement of fire-fighting supplies for inland passenger ships shall comply with the provisions in Table 3-6.

Table 3-6 Quantity layout table of basic fire-fighting supplies for passenger ferries

	Portable fire extinguisher	Large foam extinguisher	Hand-held foam gun	Gas fire extinguisher	extinguishing and protection water breaker	Sand box	Emergency axe	Iron rod and hook	Firemen's outfits
The length \geq 50 metres	Each deck 6 Kitchen 2 Important machine spaces 4 Roll place 1/50m ²	At the passage of the roll on/roll off location 2 Important machine spaces 1	Important machine spaces 1	Power distribution room (board) 1 Substation 1 Centralized control room 1 Propulsion of the motor chamber 2 Other electrical spaces are configured as required	6	each deck 2	4	2	2
The length < 50 metres	Each deck 4 Kitchen 2 Important machine spaces 4 Roll place 1/50m ²	-	-		4		2	1	

Note: Ro-Ro spaces equipped with pressure water mist fire-extinguishing systems, the number and layout of the portable fire extinguishers shall ensure that the distance between the fire extinguishers shall not exceed 20 metres.

The type, quantity and arrangement of fire-fighting supplies for river passenger ferry shall comply with the provisions in Table 3-7.

Table 3-7 Layout of fire supplies for vehicles and passenger ferries

Fire supplies name	Handheld fire extinguisher	Gas fire extinguisher	fire bucket	Emergency axe	Iron rod and hook
Configuration	Each deck 6 Engine-room 4 Roll places 1 / 50 meters ²	Radio Room 1 Power distribution room (board) 1 Substation 1 Other electrical spaces are configured as required	4	2	1

In addition to meeting the requirements in Table 3-6, a large foam fire extinguisher shall be added in the ro-ro space for a vehicle and passenger ferry when the length of the boat is more than or equal to 50 metres and a voyage time is more than 0.5 hours.

For push (towing) vessels with total power of main engine greater than 370kW push (towing), at least four portable foam fire extinguishers shall be added in addition to the requirements of 3-6 in this section.

1) Fire extinguishers

Fire extinguishers shall be of an approved type. The extinguishing agent used in the fire extinguisher should be suitable for extinguishing fires in the cabin used, and the gas emitted should be harmless to human health either in itself or under the expected conditions of use. Carbon dioxide fire extinguishers should not be installed in accommodation. In control stations and other places equipped with electrical equipment necessary for ship safety, the extinguishing agent of the fire extinguisher should be neither conductive nor harmful to this equipment.

The capacity of the portable liquid fire extinguisher shall not be more than 13.5 litres and no less than nine litres. The quality of the fire-extinguishing agent of a portable gas fire extinguisher shall not be less than five kilograms, and the portability of the fire extinguisher shall be at least equal to that of a 13.5-litre liquid fire extinguisher. The capacity or quality of portable fire extinguishers in a passenger ship's accommodation and service spaces can be appropriately reduced. If so, the corresponding quantity should be increased. The carbon dioxide gas extinguisher in the radio room and distribution board shall be at least two kilograms. Each gas fire extinguisher can also be replaced with an appropriate capacity of a dry powder fire extinguisher.

The portable fire extinguisher shall be placed in an easily accessible place of the protected place, and one shall be stored near the entrance of the place. Fire extinguishers should be evenly and reasonably arranged on each deck or main vertical area.

Large foam fire extinguisher refers to the cart foam fire extinguisher with a capacity of not less than 45 litres. This type of fire extinguisher shall be provided with a hose around the drum to access any part of the protected spaces. Other equivalent large fire extinguishers can also be used.

The portable foam gun shall include a suction type air foam gun that can be connected to the fire main pipe with a fire hose, attached with an inhaler or connected to a separate inhaler, together with a portable container that can hold at least 20 litres of foam liquid and a standby container.

2) Fire-fighters' equipment

Fire-fighter equipment on river passenger vessels shall include personal equipment, approved type breathing apparatus and fire-resistant life line. Personal equipment includes protective clothing, fire boots, gloves, fire helmets, approved safety lights and fireman's hand axes. Each respirator should be equipped with at least one spare cylinder of the same capacity.

Fire-fighter's equipment or personal equipment should be stored in a place that is easily accessible and immediately available. If more than one fire-fighter's equipment or personal equipment is available, it should be stored as far away as possible.

3) Emergency escape breathing device

The emergency escape breathing device is a device that provides air or oxygen, only for the purpose of escaping from a cabin with dangerous gas, and shall be an approved device. Emergency escape breathing devices shall not be used for fire-fighting, entering oxygen-deprived empty or liquid cargo cabins, nor shall they be used by fire-fighters. In these situations, self-contained breathing apparatus that is particularly suitable for this purpose should be used.

The emergency escape breathing device should be provided for at least 10 minutes of continuous use time. Emergency escape breathing devices shall include a suitable hood or mask to provide protection for the eyes, nose and mouth during the escape. The hood and mask shall be made of fireproof materials and shall include a clean and bright viewing window. The emergency escape breathing device not used temporarily should be able to be worn on the body and keep the hands free.

When storing an emergency escape breathing device, it should be properly protected from environmental impact. Brief use instructions and schematic diagram shall be clearly printed on the emergency escape breathing device. The wearing procedure should be both fast and simple, so as to obtain safety protection from the dangerous gas environment in the shortest possible time.

Maintenance, manufacturer's trademark and flow number, term of use and production date, and the name of the approved institution shall be printed on each emergency escape breathing device. And all emergency escape breathing devices used for training shall be clearly marked.

4) Other fire-extinguishing equipment

Other fire-fighting equipment includes a sand box with a capacity of not less than 0.03 meters³, and an iron or wooden fire bucket with a suitable length of lashing line.

5. The escape route

In order to ensure the safe and rapid evacuation of personnel on board to the boarding position and safe location of life-saving equipment, a safe escape route should be provided. The escape route should be kept unobstructed, and obstacles should not be stacked. The setting of its floor should consider preventing personnel from slipping during the escape process. Other necessary auxiliary escape facilities should be provided to ensure that they are easily accessible, clearly marked, and designed to meet emergency needs.

Accommodation of passengers and crew of river passenger ship and places normally inhabited by crew, there shall be readily available escape route composed of corridors and staircases. The escape route shall be accessible to the open deck for the evacuation of the ship. If the ship is equipped with collective life-saving equipment, the corridor and stairway shall enable the crew to reach the deck where the assembly station and rescue equipment are boarding.

All stairs used in escape route shall be of steel structure. The elevator shall not be used as one of the escape routes required.

The escape passage of the control station, accommodation and service space of inland passenger ships shall meet the following requirements.

(1) Each watertight cabin and each main vertical area of the accommodation, service spaces and control station shall be equipped with two escape routes;

(2) For ships equipped with collective life-saving equipment, if the boarding deck does not extend to the main vertical area under consideration, the stairway enclosure of the main vertical area should first connect to the top weather deck, and then use the direct access of external outdoor stairways and walkways to reach the boarding deck. The limit interface facing the external open-air stairs and gangways that are part of the escape route, as well as the limit interface located at the point where the evacuation to the boarding deck will be obstructed in

the event of fire damage. They should have the corresponding fire resistance integrity and insulation level in accordance with control stations and corridors;

(3) The doors leading from the escape route and the residential cabin to the entrance and exit of the open deck shall be opened outward. When there are no more than four people living in the cabin, if the door that is open outward may hinder the operation or cause harm to the personnel, the door may be allowed to open inward. The door leading from the residential cabin to its exclusive balcony does not have to be opened outward;

(4) All the enclosed public places shall be equipped with two entrances and exits far away from each other. The area shall not exceed 20m². And a public place with no more than ten people can have one entrance and exit;

(5) Unless otherwise specified, it is prohibited to set up corridors, foyers, or local corridors with only one escape route. A section of local corridor with depth not exceeding width, which can be considered as recessed or local extension can be set;

(6) The net width of the stairway in the living place shall not be less than 900 millimetres. Except for passenger ships with a sailing time of no more than two hours or a one-way upstream voyage of no more than 20 kilometres, the stairway should be located within the ring formed by fire-resistant separation. And reliable closing devices should be installed at all openings. The stairway enclosure should have entrances and exits that directly lead to the corridor;

(7) For the stairway connecting only two decks, it can be protected by using closed doors on only one deck without enclosure. If the stairway is located entirely in the common spaces running through the deck, the stairway may be provided in the open part of the spaces, but shall not be considered one of the escape routes required by this section;

(8) The public place running through the deck shall be equipped with two distant entrances and exits at each deck, which shall be able to enter the escape route;

(9) A stairway serving only one space and its balcony shall not be regarded as one of the escape routes required by this section;

(10) The fire resistance integrity and insulation level of the escape route should meet the relevant requirements for control stations and corridors;

(11) Tourist ships, ro-ro passenger ships and ordinary passenger ships with berth cabins shall meet the following requirements:

① At least one ladder shall be set up at each end of the escape route. If the main vertical area is provided on the ship, at least one ladder shall be set up in each main vertical area;

② The dimension of the stairs, corridor and door of the escape route shall comply with the requirements of Appendix I of this chapter;

③ The exit of the escape route on the freeboard deck shall be accessible to the two sides of the ship;

④ Escape direction shall be marked in the escape route, corridor and exit points, and shall comply with the relevant technical specifications.

Section 3 Coastal Ferry Fire-Fighting Facilities and Equipment

1. Fire detection and alarm system

The fixed fire detection system shall be able to detect the occurrence of the fire quickly. The type of the detector and its spacing and position should consider the influence of ventilation and other related factors to achieve satisfactory results. After installation, the system shall be tested under normal ventilation conditions, and the overall response time obtained shall achieve the intended purpose. In addition to special category space, coastal ferries shall be equipped with fixed fire detection and fire alarm systems in accordance with the technical specifications in accordance with the class of ro-ro passenger ships.

The fixed fire detection and fire alarm system equipped with Class II ro-ro passenger ships shall meet the following requirements.

(1) Approved automatic sprinklers, fire detection and fire alarm systems shall be installed in all accommodation, service spaces and control stations, including corridors and staircases.

At a control station, if water spraying may damage the important equipment in it, other types of fire-extinguishing systems may be installed as an alternative.

(2) Approved fixed fire detection and fire alarm systems shall be installed in all accommodation, service spaces and control stations, including corridors, staircases and escape routes in the accommodation to detect smoke in these spaces. No smoke detectors are required in the room's lavatory and kitchen.

(3) In places with very little fire danger or no fire danger, such as empty cabin, public toilet, carbon dioxide room and similar places, there is no need to install automatic sprinkler system and fixed fire detection and alarm system.

(4) An approved fixed fire detection system and misfire alarm system or an approved smoking fire detection system shall be set up in the roll-on cargo place. This requirement does not apply for class III ro-ro passenger ships carrying less than 100 passengers.

(5) The ship shall be equipped with a sufficient number of equipment to ensure that the crew on duty can immediately receive any initial fire alarm.

(6) There shall be a special alarm for convening the crew operating in the cab or control station. The alarm may be a part of the universal emergency alarm system, but it shall be used separately from the alarm system of the passenger spaces.

(7) Public broadcasting systems or other effective communication facilities shall be generally provided in the accommodation, service spaces, control stations and open deck.

(8) An effective patrol system should be maintained in order to quickly detect the occurrence of a fire.

(9) Each fire patrol Officer shall be trained to familiarize himself with the layout of the ship and the location and handling of any equipment they may use. Each fire patrol Officer shall be equipped with a two-way portable wireless telephone machine.

(10) When arranging furniture and furnishings on the cabin balcony, the necessary fire-extinguishing system and fire detection system should be installed.

Class III ro-ro passenger ships shall be equipped with a system in accommodation, service premises and control stations that meets the requirements in (1) above. However, for Class III ro-ro passenger ships carrying less than 100 passengers, manual alarm buttons may be installed in the accommodation, service spaces, control stations. Each channel outlet should be equipped with one manual alarm button. The manual alarm button in the corridor of each deck should be located at a location that is easy for personnel to reach, and the distance between any part of the corridor and the manual alarm button should not exceed 20 metres.

the approved smoke fire detection system may be used in the closed ro-ro space to replace the fixed fire detection and fire alarm system required above.

An effective patrol arrangement shall be maintained in special category spaces. Fixed fire detection and fire alarm systems may not be required if effective fire patrols can be ensured by continuous fire patrol throughout the voyage.

The arrangement interval of manual alarm buttons should be such that the distance from any point in the spaces to the manual alarm button does not exceed 20 metres, and a manual alarm button should be arranged at each exit near such spaces.

2. water fire-extinguishing system

1) Fire protection pump

The coastal ferry equipped with fire pumps shall at least meet the equivalent requirements of the same level of passenger ships. The total displacement of the pump should not be less than 2/3 of the required displacement when the bilge pump is used for bilge pumping.

Except for emergency fire pumps, the required displacement of each fire pump shall not be less than 80% of the required total displacement divided by the required minimum number of fire pumps. But in any case, it shall not be less than 25 meters³ per hour (m³/h), and each fire pump shall be capable of maintaining at least two required jets of water. These fire pumps shall be able to supply water to the fire main pipe system according to the required pressure and displacement. For ships of less than 500 gross tonnage, the displacement of each fire pump shall be at least 15m³/h.

For ferries, at least three independent power-driven fire pumps should be set for ships of 4,000 gross tonnage or upwards. At least two independent power-driven fire pumps should be set for ships of more than 500 gross tonnage but less than 4,000 gross tonnage, and at least one independent power-driven fire pump should be provided for ships of less than 500 gross tonnage.

In order to ensure that water is available at any time, the water extinguishing system should be arranged for ferries of 1,000 gross tonnage and upwards such that at least one effective jet of water is immediately available from any hydrant in an interior location and so as to ensure the continuation of the output of water by the automatic starting of one required fire pump. For ferries of less than 1,000 gross tonnage by, automatic start of at least one fire pump or by remote starting from the navigation bridge of at least one fire pump. If the pump starts automatically or if the bottom valve cannot be opened from where the pump is remotely started, the bottom valve shall always be kept open.

On ferries, if there are machinery spaces that are periodically unmanned, it should be ensured that the water fire-extinguishing system in these spaces meets the same requirements of machinery spaces that are usually manned.

If the pressure of the fire pump may exceed the design pressure of the fire water supply pipe, fire hydrant and fire hose, the safety valve should be installed on the fire pump. Installation and adjustment of these valves shall prevent over pressure in any part of the fire main system.

2) Drainage system

Passenger ferries shall be equipped with an effective underfloor drainage system to remove and drain water from any watertight compartment. The bilge drainage system should be able to operate under all possible circumstances after average damage, regardless of whether the ship is upright or tilted. The arrangement of the cabin should enable the water to flow to the suction pipe, the cabin for the special shape can require additional suction pipe.

Sanitary pumps, ballast pumps, and general pumps can be used as independent power bilge pumps when they have sufficient displacement and necessary connections to the bilge drainage system. Bilge pumps should be self-priming or pumps with self-priming devices. At least three power pumps should be connected with the main bilge pipe, one of which can be driven by the main engine.

For the passenger ship that is less than 100 tons and carrying no more than 100 people, if the sailing time is no more than four hours, two independent power-driven bilge pumps may be equipped.

For the following vessels, an independent power pump shall be added when the bilge pump number is ≥ 30 .

- ① Passenger ferries sailing near offshore water area and beyond;
- ② Passenger ferries sailing in coastal water areas with 500 passengers or more.

For passenger ships with less than 100 tons and no more than 100 passengers, if the sailing time is not more than four hours, two independent power cabin pumps can be set.

The bilge pump number C shall be calculated by the following formula:

When $P_1 > P$:

$$C = \frac{72(M + 2P_1)}{V + P_1 - P} \quad (3-2)$$

In other cases:

$$C = \frac{72(M + 2P)}{V} \quad (3-3)$$

Where: M — volume of machine space, meters³, which is located below the bulkhead deck, plus the volume of any fixed fuel compartment above the inner bottom at or behind the machine.

V — Total ship volume below the bulkhead deck, meters³.

P — Total volume of passenger and crew spaces below the bulkhead deck, m^3 , providing spaces for residence and use for passengers and crew, but not luggage, materials, food and mail rooms.

$$P_1 = KN; \quad (3-4)$$

Where: N — approved the number of passengers carrying the ship.

$$K = 0.056L \quad (3-5)$$

Where: L — the length of the boat, metres;

However, if the value of KN is greater than the sum of P and the total volume of the actual passenger space above the bulkhead deck, then P_1 should be taken as the sum of the above or $2/3$ of the KN value, whichever is greater.

If practical, the power bilge pump should be placed in separate watertight compartments, and its arrangement or location should ensure that these compartments are not flooded due to the same damage. If the main engine, auxiliary engine, and boiler are placed in two or more watertight compartments, the pumps used for bilge drainage should be arranged as dispersed as possible in these compartments.

For passenger ships with the length of the boat with 91.5 metres or more or a bilge pump number of 30 or more, the arrangement should ensure that at least one power pump is available for use under all flooding conditions that the ship is required to withstand.

Except for additional pumps exclusively used for peak tanks, each required bilge pump should be arranged to be able to draw water from any required location as mentioned above. The connection between the bilge pump and the bilge water pipe system should ensure that at least one pump can continue to operate when other bilge pumps are disassembled for maintenance.

Each power bilge pump should be able to ensure that the water flow velocity through the required bilge main is not less than two metres per second. The independent bottom pump located in the machine places shall have direct suction tubes from these places with no more than two such suction pipes in any place. If there are two or more such suction pipes, at least one for each port. Each direct suction pipe shall be properly arranged, and the diameter of the direct suction pipe in the machine places shall not be less than the diameter required by the bottom drainage main pipe.

For passenger ferries of more than 100 gross tonnage and those navigating in shaded navigation areas of less than 500 gross tonnage, an autonomous circulating water pump should be added in the main machinery space to lead to the emergency bilge water suction pipe at the drainage level of the machinery, which should be equipped with a check valve. The valve stems of the seawater inlet valve and emergency suction pipe valve should extend to a considerable height above the engine-room floor iron plate.

All tank floor suction lines, until connected to the pump, shall be independent from other lines.

Facilities shall be provided to prevent the compartment containing bilge suction pipes from flooding due to pipe breakage or damage to pipes in other compartments due to collision or grounding. For this purpose, when any part of the pipe is less than a vessel width from the broadside or within the box keel, a check valve shall be installed on the tube in the chamber where the opening is located.

The arrangement of distribution boxes, cocks, and valves connected to the bilge drainage system should enable one of the bilge pumps to be used for any compartment drainage during flooding. In addition, when the bilge pump located outside the $1/5$ ship width line or the pipe connected to the bilge water main is damaged, the bilge drainage system should not lose its function. If only one piping system is used for each pump, the valves necessary for controlling the bilge suction pipe should be able to be operated from above the bulkhead deck. If there is an emergency bilge drainage system in addition to the main bilge drainage system, this emergency drainage system should be independent of the main system and arranged so that one pump can be used for any compartment drainage in case of flooding. In this case, only the

valves required for emergency drainage system operation are required to be able to operate above the bulkhead deck.

For all the plugs and valves that can operate above the bulkhead deck, there shall be a clearly marked controller at the operating place, and an indicator device showing its opening and closing status.

Bilge pump (excluding dedicated bilge pumps in front of collision resistant bulkheads) should not be installed in front of the collision resistant bulkheads.

All distribution boxes and manual valves related to bilge drainage equipment shall be normally accessible.

The bottom drainage system of roll-on passenger ships shall also meet the relevant requirements for vehicle loading and fixing.

If a fixed pressure water mist system is installed, considering that a large amount of water accumulates on one or several decks during the operation of the fixed pressure water mist system, which can seriously weaken stability, a drainage hole should be installed above the bulkhead deck to ensure that this water can be quickly and directly discharged overboard. Below the bulkhead deck, drainage and pumping devices should be able to prevent the formation of free liquid surfaces. In this case, the scale of the drainage system should be able to discharge no less than 125% of the combined capacity of the water mist system pump and the required number of fire nozzles. The valves of the drainage system should be able to operate from the outside of the protected position close to the position controlled by the fire-extinguishing system. The sewage well should have sufficient capacity and be arranged on the ship's side, and its distance between each watertight compartment should not exceed 40 metres. If a fixed pressure water mist fire-extinguishing system is installed in closed vehicle spaces or roll on/roll off spaces, measures should be taken to prevent blockage of the drainage outlet.

3) Fire hydrant

For domestic ferries sailing along the coast, the number and location of fire hydrants should be able to have at least two jets of water that are not fired from the same fire hydrant, of which one jet of water is only fired from a single length fire hose to any part of the ship that passengers or crew frequently reach during navigation, as well as any cargo space, any ro-ro space, or any special category space when empty. In the latter case, each of the two effective jets of water should be able to reach any part of the location using only one single length of fire hose. In addition, these fire hydrants should be located near the entrance of the protected area.

For passenger ship, when all watertight doors and doors on the main vertical bulkheads of accommodation, service spaces, and machinery spaces are closed, the number and position of fire hydrants should comply with the above requirements. If there is an entrance and exit from the shaft tunnel adjacent to the class A machine to the lower position of the Class A machine, two fire hydrants shall be set outside the entrance and exit of the machine but near it. If other places have the above-mentioned entrances and exits, two fire hydrants should be installed near the entrance and exit of class A machine spaces in any of these places. If the shaft tunnel or adjacent area is not part of the escape route, the above measures do not need to be considered.

4) Fire pipe

Materials that are prone to failure under thermal action should not be used as fire mains and hydrants unless adequately protected. The position of the fire pipe and the fire hydrant should be easy to connect to the fire hose. The layout of fire pipes and hydrants shall prevent possible freezing. The fire main shall be provided with suitable drainage facilities and all open deck fire main pipes for fire-fighting purposes shall be provided with isolation valves. On ships where deck cargo may be shipped, the position of fire hydrants should be easily accessible at any time, and the layout of fire pipes should be used to avoid damage by deck cargo as far as possible.

Each fire hose coupling and each fire nozzle should be completely interchangeable use, otherwise each fire hydrant on the ship should be equipped with one fire hose and one fire nozzle.

Each fire hydrant shall be equipped with one valve, so that any fire hose can be removed when the fire pump is working.

When one or several fire pumps are provided in the place of the machine, isolation valves should be installed in a safe position easy to reach and outside of the machine, so that the fire main inside the machines can be separated from the fire main outside the machine. The fire main shall be arranged so that when the isolation valve is closed, all fire hydrants on board (except those in the machinery space mentioned above) can be supplied with fire water by one fire pump or one emergency fire pump located outside the machinery space through pipes that do not enter the space.

The emergency fire pump and its seawater inlet, suction and discharge pipes and isolation valves shall be located outside the machine space. However, if the actual arrangement of the ship is not feasible, a sea valve box can be installed in the machinery space. The remote-control position of the seawater inlet valve should be in the same compartment as the emergency fire pump, and the suction pipe should be as short as possible. A small portion of the suction and discharge pipes can penetrate the machine space, but should be wrapped in a sturdy steel jacket or insulated to A-60 standard. The pipe should have sufficient wall thickness, which should not be less than 11mm in any case, and all joints should be welded except for the connection with the seawater inlet valve using flanges.

5) Fire hose

Fire hoses should be made of approved non-corrosive materials. It is long enough to spray the water steam to any place where it may be needed. Each fire hose shall be equipped with a nozzle and necessary coupling. The fire hose shall be stored with its necessary accessories and tools in a visible place near its water supply hydrant or coupling for ready access. The fire hose shall be connected to the hydrant at all times in all internal Spaces of passenger ships of 500 gross tonnage and above, and the length of the fire hose shall be at least 10 metres, the machinery space shall not exceed 15 metres, other Spaces and open decks shall not exceed 20 metres.

On passenger ships, each fire hydrant shall be equipped with at least one fire hose, which is only used for fire-fighting or testing fire-extinguishing equipment during fire-fighting training and inspection.

The number of fire hose provided by the ship should be able to meet the above requirements, and the diameter of the fire hose should be able to be used with the fire nozzle equipped with the ship.

6) Fire nozzle

The size of the standard fire nozzle shall be 12 mm, 16 millimetres and 19 millimetres, or as close as possible. The use of larger diameter fire nozzle may be permitted with the consent of the competent authority.

In the accommodation and service spaces, it is not necessary to use a fire nozzle with diameter greater than 12 millimetres.

In the machine space and each external space, the size of the nozzle shall be sufficient to obtain the maximum amount of water from the smallest pump (other than the emergency fire pump) at the specified pressure from the two water streams, but it is not necessary to use a fire nozzle with a nozzle diameter greater than 19 millimetres.

All fire nozzles should be of the approved dual use type with shut-off devices (i.e., jet/spray type)

3. Fixed fire-extinguishing system

Except for special category spaces, vehicle places and rolling places that can be sealed from the outside of cargo place shall have one of the following fixed fire-extinguishing systems: fixed gas fire-extinguishing system; fixed high power foam fire-extinguishing system; fixed pressure water mist fire-extinguishing system.

1) General requirements of fixed gas fire-extinguishing system

The fixed gas fire-extinguishing system equipped on board should not use fire-extinguishing media that can produce toxic substances that pose a threat to personal safety, either by themselves or under expected environmental conditions. The pipes conveying the fire-extinguishing agent to the protected spaces shall be equipped with control valves, and the places to which the pipes lead shall be clearly indicated. Appropriate measures shall be taken to prevent negligent injection of extinguishing agents into any spaces.

If the cargo compartment with a gas fire-extinguishing system is used as a passenger place, the gas pipe shall be secured with a blank during the passenger transport. The pipes can pass through the accommodation on the condition that these tubes have sufficient thickness and their tightness is installed and verified by a pressure test of no less than 5MPa. In addition, the pipes passing through the accommodation shall only be welded together, and drainage outlets or other openings shall not be installed in these spaces. The pipeline shall not pass through the refrigerated spaces.

The layout of the fire-extinguishing agent distribution pipeline and the setting of the nozzle should ensure the uniform distribution of the fire-extinguishing agent. There should be facilities to close all openings that may allow air to enter or gas to escape from the protected area. In any spaces, if the amount of free air contained in the air bottle released in the spaces due to a fire will seriously affect the effectiveness of the fixed fire-extinguishing system, an additional amount of fire-extinguishing agent may be required.

For any ro-ro spaces, spaces that enter or exit through doors or hatches, and other spaces where personnel usually work or enter, there should be an auditory and visual automatic alarm device for releasing fire-extinguishing agents. Audible alarms should be located in a position that can be heard throughout the protected area while all machines are in operation, and should be distinguished from other audible alarms by adjusting the sound pressure or tone. The release warning should be automatically activated, such as by opening the door of the release box. The time required for alarm should be the time required to evacuate the spaces, but in any case, it should not be less than 20 seconds before the extinguishing agent is released.

The control system of the fixed gas fire-extinguishing system should be easy to access and easy to operate, and should be installed in groups in as few places as possible. The spaces shall have adequate lighting and emergency lighting in addition to the main lighting. Its location shall not be affected by the fire in the protected spaces. For the safety of personnel, there should be instructions for guiding the operation of the system in each location. The device of automatically releasing the fire-extinguishing agent should not be used, except for the narrow-closed space inaccessible to personnel and the fire-extinguishing agent is harmless to human body.

If the quantity of fire-extinguishing agent is required to protect one or several locations, the available quantity of fire-extinguishing agent should be at least the maximum required quantity of fire-extinguishing agent in any protected location. Adjacent spaces with independent ventilation systems, if not separated by A-0 level or above partitions, shall be considered the same space. The system should be equipped with normally closed control valves, through which the extinguishing agent can be directly released to the appropriate location.

When calculating the necessary dose of fire-extinguishing agent, the starting air bottle volume shall be converted to the free air volume to increase the total volume of the machine place. Instead, a discharge pipe can be installed on the relief valve leading directly to the outdoor atmosphere. Facilities should be available so that the crew can safely check the amount of extinguishing agent in the container. It should not be necessary to completely remove the container from its fixed position for this purpose. For carbon dioxide fire-extinguishing systems, a bar or other device for hanging weighing devices shall be provided on each exhaust cylinder. For other fire-extinguishing agent types, an appropriate level indicator may be used.

The design of containers and pressure components for storing fire-extinguishing agents should comply with recognized standards and take into account their location and the

maximum environmental temperature expected during operation. When the fire-extinguishing agent is stored outside the protected spaces, it shall be stored in the cabin behind the first collision bulkhead and is not used for it. Any entrance to such storage room shall be accessible from the open deck and shall be independent of the protected spaces. If it is not accessible from the open deck, the storage site below the deck shall not be below the open deck and shall be accessible directly from the open deck by stairway or ladder. For spaces located below the deck or without entrances and exits from open decks, mechanical ventilation devices should also be installed to exhaust the exhaust gas at the bottom of the location. The ventilation device should have the ability to change air at least six times per hour. The entrance and exit doors should open outward. The bulkheads and decks, including doors and other devices that close any openings, forming a boundary between such storage rooms and adjacent enclosed spaces should be airtight. Pressure containers for the storage of fire-extinguishing agents other than steam shall be placed outside the protected space in accordance with the above requirements, unless recognized standards can be met.

If the arrangement of the valve leads to the formation of closed sections in the pipeline section, a pressure release valve shall be installed on these closed sections, and the outlet of the valve shall open to the open deck. All discharge pipes, accessories and nozzles in the protected spaces shall be made of materials with a melting point temperature exceeding 925 °C. The pipeline and its related accessories shall have sufficient support. Annex for smoothness test shall be provided on the discharge pipeline. Appropriate required spare parts shall be stored on board.

2) General requirements of fixed high-expansion foam fire-extinguishing system

High-expansion foam extinguishing system refers to a fixed total flooding extinguishing system that uses internal or external air to foam mixture. High power foam extinguishing system consists of foam generator approved by fire-extinguishing test and special foam concentrate. The system shall be capable of manual release and shall be designed to initiate foam production at a specified foam supply rate within one minute. The system will not allow automatic release unless appropriate operational measures or interlock settings can be taken to prevent the effectiveness of the system from being affected by other fire-extinguishing systems in the spaces.

The system shall use approved foam concentrates. Different types of foam concentrate should not be mixed in the same high-power foam system. The fire-extinguishing capability, manufacturing and testing of the system shall meet the requirements of the guidelines formulated by IMO. The system and its components shall be properly designed to withstand the ambient temperature changes, vibration, moisture, shock, blockage and corrosion normally encountered on board. Tubing, accessories and associated components (except washers) in the protected spaces shall be designed to withstand a temperature of 925°C.

System pipelines, foam concentrate storage cabinets, components and pipe accessories in contact with foam concentrate shall be compatible with foam concentrate and made of corrosion resistant materials, such as stainless steel or equivalent materials. Other system lines and foam generators shall be fully galvanized steel or equivalent materials. The distribution pipeline shall have a self-draining capacity.

The test method for system operation test and ensuring the required pressure and flow shall be provided by configuring pressure gauges at the two inlets (water and foam concentrate) and outlets of the foam proportioner. A test valve shall be installed in the distribution pipeline at the lower end of the foam proportioner, and a test hole reflecting the calculated pressure drop of the system shall be set. All parts of the pipeline should be equipped with joints for flushing, drainage, and air purification. All nozzles should be able to be removed for inspection to prove that there is no debris in the nozzles.

Measures shall enable the crew to safely check the quantity of the foam concentrate and conduct regular sampling control of the foam quality. The system operation instructions shall be posted at each operation location. Spare parts shall be provided according to the manufacturer's instructions.

Suppose the internal combustion engine is used as the prime mover for the seawater pump in the system. In that case, there should be sufficient fuel in the fuel tank of the prime mover to enable the pump to operate at full load for at least three hours. There should be sufficient fuel reserves outside the A machine space to allow the pump to operate at full load for an additional 15 hours. If the fuel tank also serves other internal combustion engines, the capacity of the entire fuel tank should ensure sufficient supply for all engines.

The system power supply, foam concentrate supply and the control device of the system should be easy to reach and easy to operate and should be arranged in the position outside the protected place, and will not be cut-off when the protected place is on fire. All electrical elements directly connected to the foam generator shall be at least IP54. The size of the pipe system shall be determined according to the hydraulic calculation technology to ensure the flow rate and pressure required for the proper operation of the system.

The arrangement of the protected spaces shall allow for ventilation when the spaces are filled with foam. Procedures shall be provided to ensure that the upper fire barriers, doors and other suitable openings are kept open in the event of a fire. For the internal air bubble system, the place below 500 m³ is not required. The arrangement of the foam generator and piping in the protected space shall not prevent routine maintenance activities of the installed mechanical equipment.

A shipboard procedure shall be established to require the personnel who re-enter the protected space after the system is released to wear respirators to prevent oxygen deficiency in the air and combustion products in the foam coating. The ship shall be equipped with installation drawings and operation manuals and kept on board at any time. A list or drawing shall be posted indicating the location of the area covered and each partition. Test and maintenance instructions shall be available on board.

The foam generator room shall be ventilated to prevent over pressure and heated to avoid possible freezing. The quantity of foam concentrate prepared shall be sufficient to produce at least five times the volume of foam of the maximum protected space enclosed by the steel bulkhead according to the rated expansion rate, or sufficient to completely release foam for 30 minutes to the maximum protected space, whichever is the greater.

Visual and auditory alarm shall be provided in the machine spaces, cargo pump compartment, vehicle spaces, rolling-off spaces and special category spaces, so that the warning can be issued when the system is released. The alarm duration time shall meet the time required to evacuate the spaces, but in any case, shall not be less than 20 seconds.

3) General requirements of fixed pressure water mist fire-extinguishing system:

Any required automatic sprinkler, fire detection and fire alarm system shall be able to enter the work immediately at any time, without relying on the operation of the crew. The system shall be wet pipe type and may be of dry pipe type if shorter exposed sections present a risk of environmental impact. Any part of the system, which may suffer from freezing in use, should be appropriate anti-freezing measures. The system shall maintain the necessary pressure and shall have facilities with continuous water supply according to the above requirements.

Each sprinkler partition shall have the measure to automatically emit auditory and visual alarm signals on one or more indicator devices when any one of the sprinklers moves. This alarm system shall be able to show any failure of the system itself. The indicator shall be able to show the fire in the subdivision served by the system, and shall be concentrated in the cab or continuously manned central control station. The auditory and visual alarm issued by the device shall also be located in one position outside the cab or continuously manned central control station to ensure that the fire signal is immediately received by the crew.

The water sprinkler system should be connected to the fire main, and a locking cut-off check valve should be provided at the connection to prevent water from the sprinkler system to the fire main.

In addition, fixed water-based fire-extinguishing systems for ro-ro spaces and special category spaces shall be approved in accordance with the guidelines established by IMO. The fire-extinguishing system provider shall provide a document stating the size of the vehicle type allowed under the water mist system layout to ensure that the layout and type of the nozzle

will not affect the atomization effect at the maximum height limit of the vehicle. After the ship installation, the utility test shall be conducted. The document shall be kept on board and incorporated in the company's safety management system.

4. Opened vehicle places and ro-ro places and special category spaces

Ro-ro spaces and special category spaces that cannot be sealed shall be equipped with fixed water-based fire-extinguishing systems for ro-ro and special category spaces, which shall protect all parts of any deck and vehicle platform of such spaces. The water-based fire-extinguishing system shall be:

- (1) There is a pressure gauge on the valve header;
- (2) Clearly mark the location served on each manifold valve;
- (3) There are instructions for the maintenance and operation of the valve in the valve room;
- (4) There is a sufficient number of drainage valves to ensure the complete drainage of the system;
- (5) The height of the nozzle from the roof is not less than 0.5m;
- (6) There is a sufficient number of nozzle spare parts.

5. Other fire-fighting equipment

Fire extinguishers, fire-fighter equipment, and emergency escape breathing devices and other fire-fighting supplies equipped on coastal ferries should meet the following requirements.

1) Fire extinguishers and other fire-fighting equipment

All fire extinguishers on board and their spare fire-extinguishing agent shall be approved. Each powder or carbon dioxide extinguisher shall have a capacity of at least five kilograms and each foam extinguisher shall have a capacity of at least nine litres. The mass of all portable fire extinguishers shall not exceed 23 kilograms and they shall have a fire-extinguishing capability at least equivalent to that of a nine-litre fluid extinguisher.

Do not use the extinguishers that produce a certain amount of toxic gas under their own or expected conditions of use are sufficient to harm personal safety.

Accommodation, service spaces and control station should be equipped with appropriate type and sufficient number of portable fire extinguishers. Vessels of 1,000 gross tonnage and upwards shall be equipped with at least five portable fire extinguishers. One of the portable fire extinguishers used in any place shall be stored near the entrance of the place. Accommodation should not be equipped with carbon dioxide fire extinguishers. Fire extinguishers equipped in control stations and places equipped with electrical or electronic equipment or devices necessary for ship safety shall have non-conductive extinguishing agents that do not pose a hazard to the equipment and devices.

The layout of fire extinguishers should be easy to see and can quickly and easily reach in case of fire. Fire extinguishers shall be always available and protected from weather, vibration or other external factors. Handheld fire extinguishers shall be equipped with indication devices to indicate whether they have been used.

The ship shall be checked regularly to ensure that all portable fire extinguishers used are valid.

For fire extinguishers that can be recharged on the ship, spare fire-extinguishing agent should be provided on the ship. And the quantity should be calculated by 100% of the 10 fire extinguishers and 50% of the remaining fire extinguishers. The number of the above spare fire-extinguishing agents should be calculated separately according to the different types of fire extinguishers, but the total number should not exceed 60 copies. The ship shall be provided with the filling instructions of various types of fire extinguishers.

For fire extinguishers that cannot be recharged on the ship, portable fire extinguishers of the same dosage, type, capacity and quantity as determined by the above-mentioned shall be provided additionally instead of spare fire-extinguishing agent.

The portable foam gun device shall be composed of the following components: one self-priming foam gun/branch pipe, which can be connected with the fire main through the fire hose or combined with a separate proportional mixer; one portable container with at least 20 litres of foam liquid inside; and at least one additional barrel of foam liquid with the same capacity shall be provided.

2) Fire-fighters' equipment

Fire-fighter equipment includes personal equipment, breathing apparatus and fire-resistant life line. Personal equipment shall include: a protective suit of material which shall protect the skin from the thermal radiation of the flame, and from steam burns and scalds, the exterior of which is waterproof; one pair of fire boots and one pair of gloves, made of rubber or other non-conductive material; a fire helmet that provides effective protection against impact; an approved fireman's hand axe, the handle of which shall have high voltage insulation; and an approved type of electric safety lamp (hand lamp) with a lighting time of at least three hours.

A type-approved breathing apparatus may be a smoke helmet or smoke mask fitted with an appropriate air pump and an air hose of sufficient length to reach any part of the cargo hold or machine space from an open deck, unimpeded by hatches or doorways. In order to meet this requirement, if the required length of the air hose exceeds 36m, a self-contained breathing apparatus should be used instead of a smoke helmet or smoke mask or a self-contained breathing apparatus should be added. It can also be a self-contained compressed air breathing apparatus with at least 1200L of air storage in the air cylinder or a self-contained breathing apparatus with a usable time of at least 30 minutes. The ship shall also be equipped with two spare cylinders for each respirator required. Only one spare cylinder is required for each respirator requested, if the equipment to fill all cylinders without pollution is available in the appropriate location. Air bottles for all respirators should be interchangeable. Passenger ships carrying 100 or more passengers should still be equipped with at least two spare cylinders for each respirator.

For the compressed air respirator type, the compressed air respirator shall be equipped with auditory alarm and visual or other devices to alarm the user before the bottle storage is reduced to no less than 200 litres. A pressure indicator that allows the user to read the remaining volume in the air bottle can be regarded as a visual device.

Each respirator shall be equipped with one fire-resistant rescue rope with a length of at least 30 metres, which shall pass the approved test with a static load of 3.5 kN and time of five minutes. The rope shall be able to be attached to the strap of the respirator or to a separate belt to prevent the respirator from being disengaged when pulling the life line.

Fire-fighters' equipment or personal equipment shall be stored in readily accessible and readily available locations with permanent clear markings. When there is more than one set of fire-fighter equipment or personal equipment available, the storage location should be as far away as possible. For passenger ships carrying more than 100 passengers, each respirator shall be equipped with a water mist gun and stored near the respirator.

The ship shall be equipped with at least two two-way portable wireless telephones for each fire brigade for communication between fire-fighters. These two-way portable wireless phones shall be explosion-proof or intrinsically safe.

According to the different class of passenger ship, the number of fire-fighter equipment requirements are different. Class II passenger ships should be equipped with 2 sets of fire-fighter equipment; Class III passenger ships carrying 100 or more passengers but less than 500 passengers shall be equipped with 1 set of fire-fighter equipment and 1 set of personal equipment; Class III passenger ships carrying less than 100 passengers shall be equipped with one set of fire-fighter equipment.

In addition, for Class II passenger ships, for decks with passenger cabins and service spaces, according to the total length of their passenger cabins and service spaces, or if such decks have more than one layer, according to the maximum length of the combined passenger cabins and service spaces on the deck. When it exceeds 80 metres, two sets of fire-fighter equipment and two sets of personal equipment should be added. At the same time, two sets of fire-fighter equipment should be added to each main vertical area. However, for the stairway enclosures which constitute individual main vertical zones and for the main vertical zones in the fore or aft end of a ship without accommodation, class A machinery spaces, and kitchens, there is no need to add fire-fighter equipment.

3) Emergency escape breathing device

Passenger ferries, ro-ro passenger ships and ordinary passenger ships with sleeping seat cabins shall be equipped with a corresponding number of emergency escape breathing devices. Emergency escape breathing devices should be located in easily visible locations and readily available.

Table 3-8 lists the requirements for the number and location of emergency escape breathing devices for different classes of passenger ships.

Table 3-8 Requirements for the number and location of emergency escape breathing devices

Passenger ship level	Class A machine spaces (manned)		Other machine spaces (manned)	Living place	Total number of spare parts	Training
	With an internal combustion engine for main propulsion	With an internal combustion engine used for non-main propulsion				
Class II	(1) Machine control room located in the machine spaces: one; workshop: one (but without direct access to escape routes); each deck or platform near the escape corridor (this escape corridor constitutes another escape access beside the enclosed escape route or watertight door at the bottom of the cabin): one. or (2) The number and location of EEBD can also be determined according to the cabin's layout and the personnel situation, but there should be at least two cases.	Each deck or platform near the escape way (this escapes way constitutes another escape way besides the enclosed exit way or watertight door at the bottom of the cabin): one.	At least one	At least two for each area; at least two for each main vertical area	two	one
Class III				At least two		

6. Escape route

Unless otherwise provided, at least two widely separated and ready means of escape shall be provided from all spaces or group of spaces, which shall be free from obstructions. The exit doors of the control station, accommodation spaces and service spaces shall, in general, open in way of the direction of escape, except that individual cabin doors may open into the cabins in order to avoid injury to persons in the corridor when the door is opened and doors in vertical emergency escape trunks may open out of the trunk in order to permit the trunk to be used both for escape and for access.

1) Escape routes for accommodation and service spaces

Stairways and ladders shall be so arranged as to provide ready means of escape to the lifeboat and liferaft embarkation deck from passenger and crew accommodation spaces and from spaces in which the crew is normally employed, other than machinery spaces.

(1) Below the bulkhead deck two means of escape, at least one of which shall be independent of watertight doors, shall be provided from each watertight compartment or similarly restricted space or group of spaces. Exceptionally, the Administration may dispense with one of the means of escape for crew spaces that are entered only occasionally, if the required escape route is independent of watertight doors. This sole means of escape shall provide safe escape. However, stairways shall not be less than 800 millimetres in clear width with handrails on both sides;

(2) Above the bulkhead deck there shall be at least two means of escape from each main vertical zone or similarly restricted space or group of spaces at least one of which shall give access to a stairway forming a vertical escape;

(3) If a radiotelegraph station has no direct access to the open deck, two means of escape from or access to, the station shall be provided, one of which may be a porthole or window of sufficient size or other equivalent facilities;

(4) A corridor, lobby, or part of a corridor from which there is only one route of escape shall be prohibited. Dead-end corridors used in-service areas which are necessary for the practical utility of the ship, such as fuel oil stations and athwartship supply corridors, shall be permitted, provided such dead-end corridors are separated from crew accommodation areas and are inaccessible from passenger accommodation areas. Also, a part of a corridor that has a depth not exceeding its width is considered a recess or local extension and is permitted;

(5) Of the escape route required of (1) and (2) above, at least one of the means of escape shall consist of a readily accessible enclosed stairway, which shall provide continuous fire shelter from the level of its origin to the appropriate lifeboat and liferaft embarkation decks, or to the uppermost weather deck if the embarkation deck does not extend to the main vertical zone being considered. If the boarding deck is confirmed not to extend to the main vertical area or similar clearance space group, in the latter case, direct access to the embarkation deck by way of external open stairways and passageways shall be provided and shall have emergency lighting and slip-free surfaces underfoot.

The width, quantity of the passage and the continuity of each escape route shall meet the following requirements:

① Stairways shall not be less than 800 millimetres in clear width with handrails on both sides. If the number of evacuations from the stairway exceeds 90, the minimum net width of the stairway shall be increased by 10 millimetres for each additional evacuation. When the ladder width is greater than 800 millimetres, the maximum net width between railings or handrails shall not exceed 1,800 millimetres. The number of crew and passengers of two thirds of the stairway service area shall be set as the total number of evacuees passing through the stairway;

② The ladder with more than 90 people should be aligned at the beginning and end;

③ The size of the doorway, corridor and the middle platform of the stairs as part of the escape route should be determined by the same method as determining the size of the stairway;

④ The vertical height of the stairway without the landing shall not exceed 3.5 metres, and its inclination angle shall not be greater than 45°;

⑤ In addition to the stairway platform serving the public spaces directly leading to the stairway ring, the area of the stairway platform on each deck shall not be less than two meters². If the number of personnel using this platform exceeds 20, an additional one meters² of area will be added for every additional 10 people, but it does not need to exceed 16 meters²;

⑥ Protection of access from the stairway enclosures to the lifeboat and liferaft embarkation areas shall be provided either directly or through protected internal routes which have fire integrity and insulation values for stairway enclosures;

⑦ Stairways serving only a space and a balcony in that space shall not be considered as forming one of the required means of escape;

⑧ Each level within an atrium shall have two means of escape, one of which shall give direct access to an enclosed vertical means of escape meeting the above requirements of ⑤. The size shall consider the total number of personnel at each level within an atrium;

⑨ The doors of the cabin and the hall shall not require keys to unlock them from inside the room. Neither shall there be any doors along any designated escape route which require keys to unlock them when moving in the direction of escape;

⑩ For class III passenger ships carrying less than 100 passengers, under the condition of ensuring two escape routes, the circular stairway in the above ⑤ may not require continuous fire shielding, but at least it should be protected by appropriate shielding or manners of shielding.

2) Escape routes for the machine space

Each machinery space should be equipped with two escape routes, and their relevant arrangements should comply with the relevant interpretations of IMO (refer to the unified interpretation of articles II-2/9 and II-2/13 of the *SOLAS Convention*), especially in accordance with the following provisions:

(1) Where the space is below the bulkhead deck the two means of escape shall consist of either:

① Two sets of steel ladders as widely separated as possible, leading to doors in the upper part of the space similarly separated and from which access is provided to the appropriate lifeboat and liferaft embarkation decks. One of these ladders shall be located within a protected enclosure from the lower part of the space it serves to a safe position outside the space. Self-closing fire doors of the same fire integrity standards shall be fitted in the enclosure. The ladder shall be fixed in such a way that heat is not transferred into the enclosure through non-insulated fixing points. The protected enclosure shall have minimum internal dimensions of at least 800 millimetres x 800 millimetres, and shall have emergency lighting provisions; or

② one steel ladder leading to a door in the upper part of the space from which access is provided to the embarkation deck and additionally, in the lower part of the space and in a position well separated from the ladder referred to, a steel door capable of being operated from each side and which provides access to a safe escape route from the lower part of the space to the embarkation deck.

(2) Where the space is above the bulkhead deck, the two means of escape shall be as widely separated as possible and the doors leading from such means of escape shall be in a position from which access is provided to the appropriate lifeboat and liferaft embarkation decks. Where such means of escape require the use of ladders, these shall be of steel;

(3) For passenger ships of less than 1,000 gross tonnage, after full consideration of the width and layout of the upper part of the spaces, only one escape route can be required with the consent of the ship inspection authority. For passenger ships of 1,000 gross tonnage and upwards, if there is a safe passage to the boarding deck through a door or a steel ladder, considering the nature, location, and whether the space is frequently used, with the consent of the ship inspection agency, only one escape route can be required;

(4) One mean of escape shall be provided from a machinery control room located within a machinery space, which will provide continuous fire shelter to a safe position outside the machinery space;

(5) In the steering gear space, a second means of escape shall be provided when the emergency steering position is located in that space unless there is direct access to the open deck.

3) Other provisions on the setting up of escape routes

The clear width of the stairway used as an escape route in the machine space should be at least 600 millimetres, and its inclination angle should not exceed 60°. If a ladder is used as an escape route, its type and size shall meet the national or industrial standards. All open pedals that are part of the escape route or lead to the escape route but are not located within

the protected enclosure, as well as inclined ladders/stairs, shall be made of steel material. The bottom surface of such ramp / stairway shall be provided with steel guards for escape personnel to protect against the heat and flames from below. Lifts shall not be considered as forming one of the means of escape.

The means of escape, including stairways and exits, shall be marked by lighting or fluorescent strip display signs placed not more than 300 mm above the deck at all points of the escape route including angles and intersections. The marking must enable passengers to identify the routes of escape and readily identify the escape exits. If electric illumination is used, it shall be supplied by the emergency source of power and it shall be so arranged that the failure of any single light or cut in a lighting strip will not result in the marking being ineffective. Additionally, escape route signs and fire equipment location markings shall be of fluorescent materials.

As specialized vessels frequently crossing main waterways and transporting vehicles and passengers on short routes, ferries are prone to accidents such as collisions, hazardous material leaks, fuel spills, grounding, and hull damage. These accidents can lead to fires in vehicle compartments and passenger cabins, posing a serious threat to the safety of passengers and the vessel itself. With regard to the prevention of fire on ships, IMO has given detailed regulations and requirements on structural fire prevention, fire detection and fire-extinguishing of international ships in Section 2 of Chapter II of the *SOLAS Convention*. In view of the particularity of the domestic ferry in the navigation area and its ship type, the "Statutory Inspection Rules for Ships and Offshore Facilities" from China Maritime Safety Administration have made corresponding provisions for the structural fire prevention and fire safety equipment of domestic navigation vessels, in order to ensure compliance with international standards as far as possible, whilst meeting the needs of domestic vessel operation. Fire safety is a key focus in ferry safety management. In addition to necessary fire-resistant structures and sufficient fire-fighting safety equipment, strengthening fire safety management, raising awareness of fire prevention among personnel, and enhancing the emergency response capabilities of relevant personnel are crucial for effective fire prevention, control, and extinguishment.

This chapter provides an overview of the characteristics of ferry fires, based on the *Regulation on Coastal Navigation 2020* and the *Regulation on Inland Navigation 2019*, which are parts of *Statutory Inspection Rules for Ships and Offshore Facilities*. It describes the requirements for fire-resistant structures and fire-fighting equipment for coastal passenger vessels and inland passenger vessels, respectively. Considering the varying applicability of statutory inspection technical rules for vessels of different ages, this material does not provide specific details. Existing ships should refer to the provisions of the statutory inspection technical regulations for sea or river ships and their amendments which are in force when the ship is laid with a keel or in a similar construction stage.

Chapter 4 Ferry Life-Saving

Safety is the primary concern in ferry transportation, just like any other type of maritime activity. To ensure the safety of the large number of passengers and crew members associated with ferry transportation, adequate and suitable life-saving equipment is essential. Large passenger/vehicle ferries face the same challenges as cruise ships, which means that in case of an emergency, personnel may need to be evacuated from a vessel with relatively high freeboard. Ferries also encounter common issues such as crowd control, avoiding panic, and effectively transferring a large number of people under controlled conditions. Therefore, understanding the life-saving equipment applicable to ferries is essential to ensure timely and effective response to emergencies.

With regard to the safety equipment of ship, IMO has given detailed regulations and requirements on life-saving appliances and arrangements of international ships in Chapter III of the *SOLAS Convention*. In view of the particularity of the domestic ferry in the navigation area and ship type, the *Statutory Inspection Rules for Ships and Offshore Facilities* from China Maritime Safety Administration have made corresponding provisions for the life-saving appliances and arrangements of domestic navigation vessels, in order to ensure compliance with international standards as far as possible while meeting the needs of domestic sailing vessels. This chapter provides a general overview of the life-saving equipment currently used on vessels, with a specific focus on the requirements for the provision and arrangement of life-saving equipment on coastal and inland ferries.

Section 1 Lifeboat and Liferaft

1. Brief introduction of lifeboat and liferaft

The lifeboat is one of the most important life-saving equipment on the ship, which is used when abandoning the ship in extreme emergency situations. At present, there are three main types of lifeboats equipped on ships, namely, open, fully enclosed, and free fall. Due to strict safety regulations, open lifeboats have been replaced by fully enclosed lifeboats, but they are still used on some small vessels, especially inland water vessels.

Lifeboats must carry all types of equipment specified in the *SOLAS Convention* and the *Life-Saving Appliance Code (LSA Code)*. This includes food rations, fresh water, first aid kits, compass, smoke, fire and rocket distress signal equipment. In addition to lifeboats, each ship must carry a rescue boat for rescue. If there are two or more lifeboats on board a boat, one of them may be designated as a rescue boat if the lifeboats meet the performance standards for rescue boats.

A liferaft is a non-self-propelled vessel used for life-saving on a ship. The liferaft is equipped with a certain amount of food and fresh water for the occupants to use while drifting at sea.

Inflatable liferaft without tent is also known as inflatable floating raft, its manufacturing materials, main structure, performance requirements, forming process, storage requirements, equipment, are the same as inflatable liferaft, but the release method is only throwing type.

2. Requirements for the allocation of lifeboats and rafts for inland passenger ships

Tourist ships shall be equipped with lifeboats and liferafts equal to 100% of the total number of people on board. At least one life boat shall be equipped, and the remaining capacity can be equipped with inflatable liferafts, and the number of liferafts shall not be less than two.

Tourist ships with the length of greater than or equal to 60m shall be equipped with collective life-saving equipment according to 100% of the total number of people. Among them, one lifeboat and at least two inflatable liferafts shall be equipped, and the total capacity of the liferaft shall be not less than 60% of the total number of people on board. The remaining capacity may be equipped with any form of collective life-saving equipment specified in this chapter.

Ro-ro passenger ships and inland passenger ships with the length greater than or equal to 60m should be equipped with one lifeboat and at least two inflatable liferafts, and the total capacity of the liferafts should not be less than 60% of the total number of people on board.

Passenger and vehicle passenger ferries with the length greater than or equal to 60m shall be equipped with any form of collective life-saving equipment specified in this chapter at a rate of 30% of the total number of passengers on board.

3. Storage and embarkation arrangements of liferafts for inland water passenger boats

1) Storage requirements for collective life-saving equipment

Lifeboats should be stored far enough in front of the ship's propeller. The distance between the tail end of a lifeboat and the ship's propeller shall be greater than the length of the lifeboat. Lifeboats shall, where practicable, be located in a safe place and protected from damage caused by fire and explosion. The protruding part of the ship's side shall not hinder the launching of the boat, and the lifeboat body shall not protrude overboard. The lifeboat should be placed on the boat seat, the shape of the boat seat should be consistent with the lifeboat line, and the operation of the boat is convenient.

Inflatable liferafts should be evenly distributed along the port-starboard of the length of the boat as much as possible. The landing position of the bloated liferaft should keep a certain distance from the propeller, and it is convenient for personnel to board. Its landing and storage position should not interfere with the operation of other liferafts. Inflatable liferafts should be stored on a dedicated raft rack, with the bow cable securely fastened to the ship and equipped with a free-floating device to allow the liferaft to detach from the ship and float freely and automatically inflate when sinking. In addition, the liferafts on the fastening device should also be able to be manually released.

Multi-person floating device shall be uniformly stored on both sides of the ship and in a place easily accessible to personnel. It shall be stored in such a way as to ensure that the floating device can float freely and be easy to disengage when the ship sinks.

2) Design requirements for landing and boarding of passenger ship rescue equipment

When the height of the embarkation position of the collective life-saving equipment from the lightest waterline does not exceed 4.5m, an embarkation ladder or emergency evacuation system should be equipped for personnel on board to embark on the collective life-saving equipment on the water surface.

When the embarkation position of the collective life-saving equipment exceeds 4.5m from the lightest waterline, launching and embarkation equipment should be equipped for personnel on board to directly board and land at the storage location of the collective life-saving equipment. Emergency evacuation systems can also be equipped.

3) Design requirements for launching and embarkation of life-saving equipment

In order to ensure the safe and orderly boarding of passengers on board lifeboats, the length of the embarkation ladder, emergency evacuation system exit channel shall extend from the deck to the waterline when the ship is in its lightest seagoing condition under adverse conditions of ship trim to 5° and any one side roll to 10°.

Emergency lighting shall be provided at all passages, stairways, and exits leading to the storage areas of lifeboats, rafts, and other collective life-saving equipment, as well as at assembly stations, boarding stations, and collective life-saving equipment storage areas, as well as the water areas where they launch. The "Inland Water Ship Life-saving Equipment" that meets the current national standards to indicate the location and direction of the storage location (or embarkation location) of the life-saving equipment should be posted. The embarkation place of the collective life-saving equipment of passenger ships shall set up signs with the words "priority for the elderly, the sick, the disabled and pregnant".

Each lifeboat should be equipped with a davit that can launch and recover the lifeboat. The arrangement of the lifeboat launching equipment should be able to be operated by one person on the deck. During the lifeboat launching and recover process, the movement of the lifeboat should be observed at any time from the operating position on the ship.

4. Requirements for the equipment of lifeboats, rafts and rescue boats for coastal passenger ships

The percentage of the crew quota of lifeboats, rescue boats and liferafts for each ferry and the total number of people on board shall not be less than the provisions stipulated in Table 4-1.

For class I passenger ships and class II passenger ships with the length of 85m or above, except conforming to the provisions of Table 4-1, the ratio of the total number of lifeboats and rescue boats (if available) to liferafts shall not be less than 1:9. For Class II passenger ships carrying 500 passengers or more, the life-saving equipment shall comply with the provisions of class I passenger ships. For Class III passenger ships carrying 500 passengers or more, the life-saving equipment shall comply with the provisions of Class II passenger ships. For Class III passenger ships carrying 1,000 passengers or more, the life-saving equipment shall comply with the provisions of Class I passenger ships.

Equipped with one or more offshore evacuation systems and their accompanying inflatable liferafts can replace the equivalent capacity in Table 4-1 and the requirements for liferafts equipped with hangers for landing.

All lifeboats and rafts required for all personnel on the ferry to abandon the ship should be able to land on the water surface within 30 minutes after all personnel have gathered and put on their lifejackets and issued a signal to abandon the ship. For throw type liferafts, sufficient passengers should be allowed to board the liferaft that has been properly deployed to the surface within 30 minutes.

Rescue boats may not be provided for Class III passenger ferries of $L \leq 45m$, but all the following requirements shall be met.

- ① The layout of the ship should be able to rescue the helpless people on the water;
- ② In the cab, one can observe the rescue work of the helpless people on the water;
- ③ Ships should have sufficient manoeuvrability to approach and rescue drowning personnel under the worst imaginable conditions.

Table 4-1 Percentage of passenger ferry survival equipment

Ship grade / length		Lifeboat	Inflatable liferaft ^②	Total capacity of the whole ship	Rescue boat ^③
I	-	30% ^①	95%	125%	A ship
II	$L \geq 85$ metres	110% ^①		110%	A ship
III	< 85 metres	-	110%	110%	A ship

Note: ① At least one partially enclosed or fully enclosed lifeboat should be equipped on each side;

② Landing equipment should be equipped based on the height of the boarding position from the lightest sailing waterline;

③ Class III passenger ferries with $L \leq 45$ metres can be allowed not to be equipped.

5. Storage and boarding layout of liferafts for coastal passenger ships

1) Storage requirements for survival crafts

Each survival craft shall be stowed so that neither the survival craft nor its stowage arrangements will interfere with the operation of any other survival craft or rescue boat at any other launching station, and as near the water surface as is safe and practicable and, in the case of a survival craft other than an liferaft intended for throw over board launching, in such a position that the survival craft in the embarkation position is not less than two metres above the waterline with the ship in the fully loaded condition under unfavourable conditions of trim of up to 10° and listed up to 20° either way, or to the angle at which the ship's weather deck edge becomes submerged, whichever is less. For passenger ships, lifeboats and rafts that have been lowered with hangers, the height from the top of the hanger in the boarding position to the waterline of the lightest sailing condition should not exceed 15m as much as possible.

The survival craft should be in a state of continuous readiness so that two crew members can carry out preparations for embarkation and launching in less than five minutes. The

survival craft should be fully equipped as required by the *LSA Code*, and as far as practicable, in a secure and sheltered position and protected from damage by fire and explosion.

Lifeboats for lowering down the ship's side shall be stowed as far forward of the propeller as practicable. On passenger ships of 80 metres or more length, each lifeboat shall be so stowed that the after end of the lifeboat is not less than 1.5 times the length of the lifeboat forward of the propeller. Where appropriate, the ship shall be so arranged that lifeboats, in their stowed positions, are protected from damage by heavy seas.

Lifeboats shall be stowed attached to launching appliances. Every liferaft shall be stowed with its painter permanently attached to the ship. Each liferaft or group of liferaft shall be stowed with a float-free arrangement complying with the requirements of the *LSA Code* so that each raft can float freely and, if inflatable, inflates automatically when the ship sinks.

Liferafts shall be so stowed as to permit manual release of one raft or container at a time from their securing arrangements. Davit-launched liferafts shall be stowed within reach of the lifting hooks, unless some means of transfer is provided which is not rendered inoperable within the limits of trim and list or by ship motion or power failure. Liferafts intended for throw-overboard launching shall be so stowed as to be readily transferable for launching on either side of the ship unless liferafts, of the aggregate capacity required to be capable of being launched on either side, are stowed on each side of the ship.

2) Survival craft muster and embarkation arrangements

Lifeboats and liferafts for which approved launching appliances are required shall be stowed as close to accommodation and service spaces as possible. Muster stations shall be provided close to the embarkation stations. Each muster station shall have sufficient clear deck space to accommodate all persons assigned to muster at that station, but at least 0.35m²per person. The passenger spaces and the public spaces adjacent to the assembly station of the boarding lifeboat and liferaft can be included in the deck area of the assembly station. Routes to muster stations shall be indicated with the muster station symbol, and special symbols shall be posted at the assembly station. Muster and embarkation stations shall be readily accessible from accommodation and work areas.

On passenger ships, survival craft embarkation arrangements shall be designed for all lifeboats to be boarded and launched either directly from the stowed position or from an embarkation deck but not both, and davit-launched liferafts to be boarded and launched from a position immediately adjacent to the stowed position or from a position to which, in compliance.

Rescue boat arrangements shall be such that the rescue boat can be boarded and launched directly from the stowed position with the number of persons assigned to crew the rescue boat on board. If the rescue boat is also a lifeboat and the other lifeboats are boarded and launched from an embarkation deck, the arrangements shall be such that the rescue boat can also be boarded and launched from the embarkation deck.

Davit-launched and free-fall launched survival craft muster and embarkation stations shall be so arranged as to enable stretcher cases to be placed in survival craft.

An embarkation ladder complying with the requirements of the *LSA Code* extending, in a single length, from the deck to the waterline in the lightest seagoing condition under all conditions of trim of up to 10° and a list of up to 20° either way shall be provided at each embarkation station or at every two adjacent embarkation stations for survival craft launched down the side of the ship. Such ladders are allowed to be replaced by approved devices to afford access to the survival craft when waterborne, provided that there shall be at least one embarkation ladder on each side of the ship.

Alleyways, stairways and exits giving access to the muster and embarkation stations shall be lighted by the emergency source of electrical power.

If a rescue boat is concurrently used as a lifeboat, its embarkation and recovery arrangements shall comply with the relevant requirements of this section. Rescue boat embarkation and recovery arrangements shall allow for safe and efficient handling of a stretcher case. Foul weather recovery stops shall be provided for safety if heavy fall blocks constitute a danger.

6. Rescue boat

Rescue boats refer to the motor boats which is used to rescue people in distress, assemble lifeboats, rafts, and have good control. In order to rescue people in distress and assemble liferafts on sea safely and quickly, ships must be equipped with rescue boats in accordance with regulations.

The rescue boats used on seagoing ships can be roughly divided into the following three types according to the different manufacturing materials. The rigid rescue boat is commonly used on ships. The inflatable rescue boat is a rescue boat mainly composed of rubber materials and auxiliary materials. The rigid inflatable hybrid rescue boat is a rescue boat with both rigid materials and rubber materials in the materials used for making the boat body.

1) General requirements for rescue boats

According to Article 1.1, Chapter five of the *LSA Code*, the general requirements for rescue boats equipped on board a ship are as follows.

- (1) The rescue boats shall meet the general requirements for the lifeboats.
- (2) Rescue boats may be either of rigid or inflated construction or a combination of both and shall be not less than 3.8 metres and not more than 8.5 metres in length.
- (3) It should be capable of carrying at least five seated persons and a person lying on a stretcher.
- (4) Rescue boats which are a combination of rigid and inflated construction shall comply with the appropriate requirements of this section to the satisfaction of the Administration.
- (5) Unless the rescue boat has adequate sheer, it shall be provided with a bow cover extending for not less than 15% of its length.
- (6) The rescue boat shall be capable of manoeuvring at a speed of at least six knots and maintaining that speed, for a period of at least four hours, when loaded with its full complement of persons and equipment.
- (7) Rescue boats shall have sufficient mobility and manoeuvrability in a seaway to enable persons to be retrieved from the water, marshal liferafts and tow the largest liferaft carried on the ship when loaded with its full complement of persons and equipment or its equivalent at a speed of at least 2 knots.
- (8) A rescue boat shall be fitted with an inboard engine or outboard motor. If it is fitted with an outboard motor, the rudder and tiller may form part of the engine. Petrol-driven outboard engines with an approved fuel system may be fitted in rescue boats provided the fuel tanks are specially protected against fire and explosion.
- (9) The towing device should be permanently installed on the rescue boat, and its strength should be sufficient to assemble into the largest liferaft equipped with all passengers and accessories or equivalent weight.

2) Functions and application of the rescue boat

The function of the rescue boat has two aspects, one is to save the drowning people from the water, the other is to concentrate the lifeboat in a relatively safe water. In order to perform these operations effectively and to meet the competent authorities, each rescue boat must be equipped with appropriate release devices. Rescue boats may need to be used in adverse weather conditions, thus requiring two trained crew members capable of releasing and handling them in various rescue operations.

Each rescue boat must have the ability to rapidly rescue personnel from the water and transfer it to the mother ship. For this purpose, we should consider using the "recovery net" or other similar recovery equipment to lift the drowning person from the water in a horizontal position. When considering a transfer from a rescue boat to a mother ship, most vessels usually arrange recovery from fast fixtures. Although this operation is relatively safe, if there are many people falling into the water, the repeated recovery and release of rescue boats can cause unnecessary delays.

For ships with high free boards such as ferries or passenger ships, using lifeboats as elevators is a feasible option. The lifeboat was lowered, but was not detached from the sling. The drowning person is transferred from the rescue boat to the lifeboat, which can then be recovered to the boarding deck to move the survivors out. It should be noted that for ships with

higher free board, especially in heavy sea conditions, this operation is relatively difficult and dangerous.

3) Requirements for storage, launching, and recovery of rescue boats

There must be designated rescue boats on both sides of the passenger ship. Rescue boats shall be stowed in a state of continuous readiness for launching in not more than five minutes, and if the inflated type, in a fully inflated condition at all times, and in a position suitable for launching and recovery so that neither the rescue boat nor its stowage arrangements will interfere with the operation of any survival craft at any other launching station.

The rescue boat embarkation and launching arrangements shall be such that the rescue boat can be boarded and launched in the shortest possible time. Moreover, recovery time of the rescue boat shall be not more than five minutes in moderate sea conditions when loaded with its full complement of persons and equipment. If the rescue boat is also a lifeboat, this recovery time shall be possible when loaded with its lifeboat equipment and the approved rescue boat complement of at least six persons. To meet such operational requirements, the rescue ship crew should be trained to use onboard equipment and be proficient in its operation.

Section 2 The Marine Evacuation System

A Marine Evacuation System (MES) is an appliance for the rapid transfer of persons from the embarkation deck of a ship to a floating survival craft. It is usually placed on the two sides of a ship and is mostly found on passenger ships to facilitate passengers to evacuate the ship in time of distress. The system construction and performance requirements of the maritime evacuation system shall meet the following requirements.

1. Marine evacuation system construction

The passage of the marine evacuation system shall provide for safe descent of persons of various ages, sizes and physical capabilities wearing approved lifejackets from the embarkation station to the floating platform or survival craft. Strength and construction of the passage and platform shall be to the satisfaction of the Administration.

The platform if fitted shall be such that sufficient buoyancy will be provided for the working load. In the case of an inflatable platform, the main buoyancy chambers, which for this purpose shall include any thwarts or floor inflatable structural members.

Being stable in a seaway and providing a safe working area for the system operators, the MES should have sufficient area that will provide for the securing of at least two liferafts for boarding and to accommodate at least the number of persons that at any time are expected to be on the platform. This usable platform area shall be at least equal to a quarter of the total square metre of 20% of total number of persons that the MES is certified for, or 10 m², whichever is the greater. However, Administrations may approve alternate arrangements which are demonstrated to comply with all the prescribed performance requirements.

The MES should be capable of self-draining, and it should be sub-divided in such a way that the loss of gas from any one compartment will not restrict its operational use as a means of evacuation. The buoyancy tubes shall be sub-divided or protected against damage occurring from contact with the ship's side. The MES should be fitted with a stabilizing system to the satisfaction of the Administration, and be restrained by a lashing rope or other positioning systems which are designed to deploy automatically and if necessary, to be capable of being adjusted to the position required for evacuation; and provided with mooring and lashing rope patches of sufficient strength to securely attach the largest inflatable liferaft associated with the system.

2. Performance of the marine evacuation system

A marine evacuation system shall be capable of deployment by one person, and should be such as to enable the total number of persons for which it is designed to be transferred from the ship into the inflated liferafts within a period of 30 minutes from the time abandon ship signal is given.

The MES should be arranged such that liferafts may be securely attached to the platform and released from the platform by a person either in the liferaft or on the platform, and be

capable of being deployed from the ship under unfavourable conditions of trim of up to 10° and list of up to 20° either way.

In the case of being fitted with an inclined slide, the angle of the slide to the horizontal should be within a range of 30° to 35° when the ship is upright and in the lightest seagoing condition, and a maximum of 55° in the final stage of flooding for special requirements on the stability of passenger ships.

The MES should be capable of providing a satisfactory means of evacuation in a sea state associated with a wind of force 6 on the Beaufort scale, and be designed to, as far as practicable, remain effective under conditions of icing.

The MES should be so constructed that only a minimum amount of routine maintenance is necessary. Any part requiring maintenance by the ship's crews shall be readily accessible and easily maintained.

Where one or more marine evacuation systems are provided on a ship, at least 50% of such systems shall be subjected to a trial deployment after installation. Subject to these deployments being satisfactory, the untried systems are to be deployed within 12 months of installation.

3. Storage requirements for the marine evacuation system

The ship's side shall not have any openings between the embarkation station of the marine evacuation system and the waterline in the lightest seagoing condition and means shall be provided to protect the system from any projections. Marine evacuation systems shall be in such positions as to ensure safe launching having particular regard to clearance from the propeller and steeply overhanging positions of the hull and so that, as far as practicable, the system can be launched down the straight side of the ship. Each marine evacuation system shall be stowed so that neither the passage nor platform nor its stowage or operational arrangements will interfere with the operation of any other life-saving appliance at any other launching station. Where appropriate, the ship shall be so arranged that the marine evacuation systems in their stowed positions are protected from damage by heavy seas.

Section 3 Personal Floating Device

The term personal flotation device (PFD) is a general name for the various types of devices designed to keep a person afloat in water. PFDs include life preservers, vests, cushions, rings, and other throwable items, such as the lifebuoy.

1. Classification of personal floating devices

They are available in five different styles, each with its own purpose and flotation characteristics. An important life-saving appliance which is used in almost all kinds of emergencies is the lifejacket or the life vest. The details for construction and operating requirements of lifejacket are given in SOLAS chapter III under *LSA code*.

A Type I PFD, or offshore lifejacket provides the most buoyancy. Designed for use in all waters, especially open, rough, or remote waters where rescue may be delayed. It is designed to turn most unconscious wearers in the water to a face-up position. The biggest problem with the Type I shown in the picture is that you are unlikely to wear it, as they restrict your movements. These are often seen at the cruise liners safety practice.

A Type II PFD, near-shore buoyant vest is intended for calm, inland water or where there is a good chance of quick rescue. This type will turn some unconscious wearers to a face-up position. The turning action is not as pronounced nor as effective as a Type I.

A Type III PFD, or personal flotation device, is good for calm, inland water, or where there is a good chance of quick rescue. Very popular with small boat sailors, water-skiers, jet boats, fisherman etcetera. The PFD's buoyancy will aid in the case of falling in the water, but will not turn unconscious wearers to a face-up position. Type III has the same minimum buoyancy as a Type II PFD.

A TYPE IV PFD, or throwable device is designed to be thrown to a person in the water and grasped and held by the user until rescued. This device can get flotation very quickly to

the person in the water or the MOB. The most common Type IV is the ring buoy and also includes buoyant cushions and horseshoe buoys.

A TYPE V PFD, or special use device is intended for specific activities and may be carried instead of another PFD only if used according to the approval condition on the label. Some Type V devices provide hypothermia protection. Varieties include deck suits, work vests, board sailing vests, and Hybrid PFDs.

A TYPE V HYBRID INFLATABLE PFD is the least bulky. It contains a small amount of inherent buoyancy and an inflatable chamber. This type of design is automatically inflated after hydration. Inflatable lifejackets are very popular because wearing them is not as bulky as wearing inherent foam lifejackets. The wearer wears an inflatable lifejacket and pulls the strap to suit the body size. This type is designed to automatically inflate upon entering the water. They can also be inflated manually in case of failure. Type V inflatables do not count towards the 1 lifejacket per person regulation.

A usable PFD is approved, in good serviceable condition, and of appropriate size for the intended user. Each boat crewmember must wear a usable PFD appropriate for the weather conditions and operations in which he/she will be performing.

One of the first things a seafarer should check on joining a ship is the place where his or her lifejacket is kept in the cabin. Whenever there is an emergency alarm take your lifejacket along with you to the muster station. Lifejackets must be worn while working on lifeboats, gangways, over side of ships, pilot stations.

2. Requirements for the allocation of life buoys on inland water ferries

The life buoy, lifejacket, and life buoy provided by inland vessels shall meet the following requirements.

1) General requirements

The PFD may be made of plastic foam moulding as a whole, or the shell may be made of plastic moulding, the interior is filled with closed cell foam, or other approved material. The buoyancy distribution of the PFD shall be such that it shall remain effective and stable while floating on either side upward. The PFD shall be equipped around or on its surface with other grasping objects such as a floating handle rope, a pull strap or a cross-body strap to keep the person afloat after falling into the water, and shall be fastened at points equal to the number of rated climbing personnel. The surface of PFD shall be equipped with reverse reflector tape. The PFD should be put into the water from a height of 10 metres and should not be deformed or damaged. The PFD shall not burn or melt continuously after being surrounded by flames for 2 seconds and leaving the fire source. After 24 hours of immersion in fresh water, the loss of buoyancy of the PFD does not exceed 5%. The PFD shall enable the person falling into the water to be in a backward position when used correctly, with the jaw exposed above the surface of the water. The model, name of manufacturer, manufacture number, date of manufacture, main dimension, crew allowance, total quality and inspection mark shall be marked in conspicuous and durable writing on the PFD.

2) Multi-person floating device

A multi-person floating device carrying sufficient authorized crew shall maintain normal buoyance in fresh water and be able to support it for at least 24 hours. The fittings of a floating device for multiple persons shall include one self-lighting floating light for life buoy in compliance with the relevant provisions; two floating hand paddles; a head line rope with a circumference of not less than 50 millimetres and a length of not less than 14 metres.

The carrying capacity of multi-person floating device should be calculated according to the following regulations, whichever is smaller:

① The integer obtained by dividing the mass of iron blocks (kilograms) that can be supported by a life buoy in fresh water by 14.5;

② The integer obtained by dividing the outer circumference of the life buoy (millimetres) by 305;

③ The occupant quota of the lifebuoy should be equal to and greater than two people.

3) Personal life-saving buoy

The life buoy is limited to one person, and its buoyancy shall not be less than 90N.

4) Requirements for the equipment of lifejackets

Unless otherwise specified, all ships shall be equipped with at least 1 lifejacket per person on board. In addition, at least one lifejacket should be provided to each Officer on duty.

Additional requirements for passenger ships are as follows.

(1) Passenger ferries, vehicle passenger ferries, and ordinary passenger ships with a navigation time of less than or equal to four hours outside the J-class segment should be equipped with lifejackets that are not less than 60% of the total number of passengers on board. Lifejackets for other passengers can be replaced by personal life buoys, and children's lifejackets should comply with the following provision. If the sailing time is less than or equal to 0.5 hours, personal life buoys can also be used instead of passenger lifejackets;

(2) Tourist ships and sightseeing ships with open sightseeing decks should also be equipped with personal flotation device (20% for adults and 5% for children) that are not less than 25% of the total number of people on board. These personal flotation devices should be stored in a visible and accessible place on the open sightseeing deck;

(3) Each passenger ship should also be equipped with no less than 5% of the total number on board. For tourist vessels and tourist vessels with the length of greater than or equal to 60m, these lifejackets should be stored in a visible and accessible place in the assembly station. For tour vessels with the length of less than 60m, these lifejackets shall be stored on another open deck beyond the open sightseeing deck. For other passenger ships, these lifejackets shall be stored on the deck or at the assembly station in a visible and accessible place;

(4) Each passenger ship should be equipped with no less than 10% of the total number of passengers on board children's lifejackets (except for passenger ships where children are not allowed to board). Among them, when tourist boats and sightseeing boats carry more children, their operators should equip (or allocate) one lifejacket for each child based on the number of children carried;

(5) If the passenger ship is equipped with a sleeper cabin, lifejackets of not less than 5% of the total number of people on board should also be added in public spaces. These lifejackets should be stored in public places or in a visible and accessible place on the direct escape route of the public places;

(6) Passenger ships sailing in class A navigation area or in class J1 or J2 segments or at night should be equipped with at least 20% of lifejackets with lifejackets lights.

5) Life buoy equipment requirements

Passenger ships should be equipped with lifebuoys, as shown in table 4-2.

Table 4-2 Quantity requirements for life buoy equipment

Length (m)	Minimum number of buoys
45>L ≥20	4
60>L ≥45	8
120>L ≥60	12
L ≥120	18

Note: ① In addition to the regulations in the table, passengers using an open deck should also be equipped with an appropriate amount of lifebuoys on both sides, with a spacing of no more than 20 metres;

② No less than half of the life buoy specified in the table shall be equipped with a floating lifeline with a length of no less than 30 metres and a diameter of 8~11 millimetres;

③ If the ship needs to sail at night, no less than half of the number of life buoy specified in the table shall be equipped with self-lighting, and the life buoy with self-lighting shall not be equipped with floating lifeline;

④ The Lifebuoy equipped on the ship shall be evenly distributed on both sides of each deck at a position that can be taken at any time.

3. Coastal ferry life-saving buoy equipment requirements

Coastal passenger ships, including ro-ro passenger ships and ferries should be equipped with personal life-saving equipment according to the following requirements.

1) Life buoy

Class I passenger ship shall carry not less than the number of lifebuoys complying with the requirements of the *LSA Code* prescribed in the Table 4-3:

Table 4-3 Number of lifebuoys equipped for Class I passenger ship

Length (metres)	Minimum number of lifebuoys
L <60	8
120 > L ≥ 60	12
180 > L ≥ 120	18
240 > L ≥ 180	24
L ≥ 240	30

Class II and III passenger ship shall carry not less than the number of lifebuoys complying with the requirements of the *LSA Code* prescribed in the Table 4-4:

Table 4-4 Number of lifebuoys equipped for passenger ships of class II and III

The length of passenger ship (metres)	Number of lifebuoys	Buoy with self-illuminating lamp	
		Total number	Buoys with a spontaneous smoke signal
45 > L ≥ 20	4	2	-
60 > L ≥ 45	8	4	At least one on each side
120 > L ≥ 60	12	6	
180 > L ≥ 120	18	9	
240 > L ≥ 180	24	12	

At least one lifebuoy on each side of the ship shall be fitted with a buoyant lifeline equal in length to not less than twice the height at which it is stowed above the waterline in the lightest seagoing condition, or 30 m, whichever is the greater.

For class I passenger ships, not less than one half of the total number of lifebuoys shall be provided with lifebuoy self-igniting lights, not less than two of these shall also be provided with lifebuoy self-activating smoke signals and be capable of quick release from the navigation bridge. Lifebuoys with lights and those with lights and smoke signals shall be equally distributed on both sides of the ship and shall not be the lifebuoys provided with lifelines.

Class II and III passenger ships, the self-lighting and smoke signals should be equipped according to Table 4-4.

2) Lifejacket

Unless otherwise specified, a lifejacket complying with the requirements of the *LSA Code* shall be provided for every person on board the ship. A sufficient number of lifejackets shall be carried for persons on watch and for use at remotely located survival craft stations. The lifejackets carried for persons on watch should be stowed on the bridge, in the engine control room and at any other manned watch station.

Passenger ships should also be equipped with at least 5% lifejackets of the total number of crew on board, as well as at least 5% children lifejackets and 2.5% infant lifejackets of the number of passengers on board. Each lifejacket on the Ro-Ro passenger ship and cargo ship shall be equipped with one lifejacket light, and other passenger ships shall be equipped with one lifejacket light on 50% of the lifejackets.

3) Arrangement and quantity of tourist boat lifejackets

The tourist boat shall be equipped with several lifejackets suitable for children. The total number of children lifejackets on board shall be at least 20% of the total number of passengers, or equip each child with a lifejacket. In addition, the ship should be equipped with at least 3% of infant lifejackets of the total number of passengers' or each baby should be equipped with one infant lifejacket.

Lifejackets of no less than 25% of the total number of passengers (including 15% for adults, 8% for children, and 2% for infants) should be stored on the walking deck. Lifejackets should be stored in easily accessible locations, and their location should be clearly marked.

Adult lifejackets and children's lifejackets / infant lifejackets should be stored separately. Lifejacket storage box / cabinet should clearly indicate the contents stored inside, such as lifejackets for adults, children or infants, and the number of lifejackets of each category.

4) immersion suit

For passenger ships, each crew member of the rescue boat and each staff member of the maritime evacuation system shall be equipped with an immersion suit. Ships constantly engaged on voyages in tropical waters may not be equipped with immersion suit.

Chapter 5 Bridge Equipment and Navigation Instruments

Ferries may vary in size, type, and navigational waterways, which also affects the navigational instruments applicable to them. This chapter provides an overview of the basic functions and applicability of common bridge equipment and navigational instruments on ships. At the same time, the relevant requirements of ship monitoring and remote-control system for passenger ships and ro-ro passenger ship are introduced, as well as the precautions for use and maintenance of this system.

Section 1 Navigation instruments

1. Steering control system

1) Introduction of the steering gear

Steering gear control system is the equipment by which orders are transmitted from the navigating bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables. The steering gear can be generally divided into manual steering gear, electric steering gear and hydraulic steering gear. For the purposes of safety, the ship shall have two sets of independent steering gear, one for the main steering gear and the other for the emergency steering gear. If the emergency steering gear cannot be set, the main steering gear shall be provided with two sets of identical power sources. These two sets of power sources must be able to work independently and switch between each other as backup.

(1) Main steering gear is the machinery, rudder actuators, steering gear, power units, if any, and ancillary equipment and the means of applying torque to the rudder stock (e.g., tiller or quadrant) necessary for effecting movement of the rudder for the purpose of steering the ship under normal service conditions.

(2) Auxiliary steering gear is the equipment other than any part of the main steering gear necessary to steer the ship in the event of failure of the main steering gear but not including the tiller, quadrant or components serving the same purpose.

(3) Steering gear power unit is:

① In the case of electric steering gear, an electric motor and its associated electrical equipment;

② In the case of electrohydraulic steering gear, an electric motor and its associated electrical equipment and connected pump; or

③ In the case of other hydraulic steering gear, a driving engine and connected pump.

(4) Power actuating system is the hydraulic equipment provided for supplying power to turn the rudder stock, comprising a steering gear power unit or units, together with the associated pipes and fittings, and a rudder actuator. The power actuating systems may share common mechanical components (i.e., tiller, quadrant and rudder stock) or components serving the same purpose.

(5) Maximum ahead service speed is the greatest speed which the ship is designed to maintain in service at sea at the deepest seagoing draught.

(6) Maximum astern speed is the speed which it is estimated the ship can attain at the designed maximum astern power at the deepest seagoing draught.

2) Performance requirements of steering gear equipment

The performance requirements for steering equipment are as follows.

(1) Unless expressly provided otherwise, every ship shall be provided with a main steering gear and an auxiliary steering gear to the satisfaction of the Administration. The main steering gear and the auxiliary steering gear shall be so arranged that the failure of one of them will not render the other one inoperative.

(2) The main steering gear and rudder stock shall meet the following requirements:

① Be of adequate strength and capable of steering the ship at maximum ahead service speed which shall be demonstrated;

② Be capable of putting the rudder over from 35° on one side to 35° on the other side with the ship at its deepest seagoing draught and running ahead at maximum ahead service speed and, under the same conditions, from 35° on either side to 30° on the other side in not more than 28 seconds;

③ Be operated by power where necessary to meet the requirements of paragraph ② and in any case when the Administration requires a rudder stock of over 120 millimetres diameter in way of the tiller, excluding strengthening for navigation in ice; or non-traditional Marine propulsion and steering systems, the main steering device should be powered;

④ So designed that they will not be damaged at maximum astern speed; however, this design requirement need not be proved by trials at maximum astern speed and maximum rudder angle.

(3) The auxiliary steering gear device shall meet the following requirements:

① Be of adequate strength and capable of steering the ship at navigable speed and of being brought speedily into action in an emergency;

② Be capable of putting the rudder over from 15° on one side to 15° on the other side in not more than 60 seconds with the ship at its deepest seagoing draught and running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater;

③ Be operated by power where necessary to meet the requirements of paragraph ② and in any case when the Administration requires a rudder stock of over 230 millimetres diameter in way of the tiller, excluding strengthening for navigation in ice. For non-traditional ship propulsion and steering systems, when the power of a single thruster is greater than 2500kW, the auxiliary steering device should be power operated.

(4) The manpower steering device can be used only when its operating force is not exceeding 160N under normal circumstances.

(5) The arrangement of the power equipment of the main steering gear and the auxiliary steering gear shall meet the following requirements:

① Arranged to restart automatically when power is restored after a power failure; and

② Capable of being brought into operation from a position on the navigating bridge. In the event of a power failure to any one of the steering gear power units, an audible and visual alarm shall be given on the navigating bridge.

(6) Where the main steering gear comprises two or more identical power units, an auxiliary steering gear need not be fitted, provided that:

① The main steering gear is capable of operating the rudder as required by paragraph (2) while any one of the power units is out of operation;

② The main steering gear is so arranged that after a single failure in its piping system or in one of the power units the defect can be isolated so that steering capability can be maintained or speedily regained;

③ Non-hydraulic type steering gear shall meet the above equivalent requirements of this article.

3) Equipment test

(1) Within 12 hours before departure, the ship's steering gear shall be checked and tested by the ship's crew. The test procedure shall include, where applicable, the operation of the following:

① The main steering gear;

② The auxiliary steering gear;

③ The remote steering gear control systems;

④ The steering positions located on the navigation bridge;

⑤ The emergency power supply;

⑥ The rudder angle indicators in relation to the actual position of the rudder;

⑦ The remote steering gear control system power failure alarms;

⑧ The steering gear power unit failure alarms; and

- ⑨ Automatic isolating arrangements and other automatic equipment.
- (2) The following procedures must be included in the above check and testing.
- ① The full movement of the rudder according to the required capabilities of the steering gear;
- ② A visual inspection for the steering gear and its connecting linkage; and
- ③ The operation of the means of communication between the navigation bridge and steering gear compartment.
- (3) Other important requirements related to the steering gear
- ① Simple operating instructions with a block diagram showing the changeover procedures for remote steering gear control systems and steering gear power units shall be permanently displayed on the navigation bridge and in the steering compartment;
- ② All ships' Officers concerned with the operation and/or maintenance of steering gear shall be familiar with the operation of the steering systems fitted on the ship and with the procedures for changing from one system to another;
- ③ In addition to the routine checks and tests prescribed in paragraphs 1 and 2, emergency steering drills shall take place at least once every three months in order to practise emergency steering procedures. These drills shall include direct control within the steering gear compartment, the communications procedure with the navigation bridge and, where applicable the operation of alternative power supplies;
- ④ The Administration may waive the requirements to carry out the checks and tests prescribed in paragraphs ① and ② for ships which regularly engage on voyages of short duration. Such ships shall carry out these checks and tests at least once every week;
- ⑤ The date upon which the checks and tests prescribed in paragraphs ① and ② are carried out and the date and details of emergency steering drills carried out under paragraph ④, shall be recorded.

2. Position-monitoring equipment

1) Global Satellite Navigation System (GNSS)

The GNSS is a system of satellites that provide autonomous geospatial positioning with global coverage. It allows small electronic receivers to determine their location (longitude, latitude, and altitude) to within a few metres using time signals transmitted along a line-of-sight by radio from satellites. The GNSS is a generic term describing any satellite system that provides positioning, navigation, and timing services on a global or regional basis. While the US Global Positioning System (GPS) is currently the most common global navigation satellite system, other countries are also deploying or are already deploying their own satellite systems to provide complementary, independent navigation and positioning capabilities.

The world's four major navigation satellite system providers announced by the International Committee on Global Navigation Satellite Systems include China's Beidou Navigation Satellite System (BDS), GPS, Russia's Glonass Navigation Satellite System (GLONASS) and the European Union's Galileo Navigation Satellite System (hereinafter referred to as GALILEO).

2) Functional requirements of the receiving equipment of the electronic positioning device

According to IMO *Maritime Safety Commission resolution 379(93)*, the performance standards for receiving equipment of shipboard Beidou Navigation Satellite System are as follows:

- (1) be capable of receiving and processing the BDS positioning and velocity, and timing signals, and should use the ionospheric model broadcast to the receiver by the constellation to generate ionospheric corrections;
- (2) provide position information in latitude and longitude in degrees, minutes and thousandths of minutes;
- (3) provide time referenced to universal time coordinated UTC (NTSC);
- (4) be provided with at least two outputs from which position information, UTC, course over ground (COG), speed over ground (SOG) and alarms can be supplied to other equipment. The output of position information should be based on the WGS 84 datum and should be in

accordance with international standards footnote. The output of UTC, COG, SOG and alarms should be consistent with the requirements of (15) and (17);

(5) have static accuracy such that the position of the antenna is determined to be within 25 metres horizontally (95%) and 30 metres vertically (95%);

(6) have dynamic accuracy equivalent to the static accuracy specified in (5) above under the normal sea states and motion experienced in ships;

(7) have position information in latitude and longitude in degrees, minutes and thousandths of minutes with a position resolution equal to or better than 0.001 minutes of latitude and longitude;

(8) be capable of selecting automatically the appropriate satellite-transmitted signals to determine the ship's position and velocity, and time with the required accuracy and update rate;

(9) be capable of acquiring satellite signals with input signals having carrier levels in the range of -130dBm to -120dBm. Once the satellite signals have been acquired, the equipment should continue to operate satisfactorily with satellite signals having carrier levels down to -133dBm;

(10) be capable of operating satisfactorily under normal interference conditions consistent with the requirements of resolution A.694(17);

(11) be capable of acquiring position, velocity and time to the required accuracy within 12 minutes where there is no valid almanac data;

(12) be capable of acquiring position, velocity and time to the required accuracy within one minute where there is valid almanac data;

(13) be capable of reacquiring position, velocity and time to the required accuracy within one minute when there has been a service interruption of 60 seconds or less;

(14) generate and output to a display and digital interface a new position solution at least once every 1 second for conventional craft and at least once every 0.5 seconds for highspeed craft;

(15) provide the COG, SOG and UTC outputs, with a validity mark aligned with that on the position output. The accuracy requirements for COG and SOG should not be inferior to the relevant performance standards for heading and speed and distance measuring equipment (SDME) footnote and the accuracy should be obtained under the various dynamic conditions that could be experienced on board ships;

(16) provide at least one normally closed contact, which should indicate failure of the BDS receiver equipment;

(17) have a bidirectional interface to facilitate communication so that alarms can be transferred to external systems and so that audible alarms from the BDS receiver can be acknowledged from external systems; the interface should comply with the relevant international standards; and

(18) have the facilities to process differential BDS (DBDS) data fed to it in accordance with the standards of ITU-R and the appropriate RTCM standard and provide indication of the reception of DBDS signals and whether they are being applied to the ship's position. When a BDS receiver is equipped with a differential receiver, performance standards for static and dynamic accuracies should be 10 metres (95%).

3. Ship Automatic Identification System (AIS)

1) Introduction to the automatic ship identification system

Ship AIS is a new type of navigation aid equipment, which can automatically and regularly broadcast the accurate position, route, speed, turning speed and other dynamic information, as well as static information such as ship name, call sign, ship type, ship size, ship width and so on. All information can be received by ships equipped with AIS equipment. With the help of AIS, static and dynamic ship information can be communicated between AIS terminals (on board, shore or satellite). The AIS was originally a standard developed by IMO to help ships avoid collisions, while helping port authorities more effectively control maritime traffic.

2) AIS system objectives

The purpose of AIS is to strengthen life safety at sea, navigation safety and efficiency, and protect the marine environment. SOLAS Rule V / 19 requires the AIS to exchange data between ships and with facilities on shore. Therefore, the purpose of the AIS is to help identify ships, assist in target tracking, assist with search and rescue operations, simplify the exchange of information (e.g., reducing verbal mandatory ship reporting), and provide additional information to help understand the situation. AIS, as an effective supplement to the information from navigation systems (including radar), is an important tool to improve users' awareness of traffic conditions.

3) Operation of marine AIS

The AIS receiver of the ship station includes a GPS receiver that can collect the location and movement details of the ship. These dynamic information and other static information provided by the crew are automatically broadcasted on a regular basis using two specific VHF channels (161.975Mhz and 162.025Mhz -87 and 88 old VHF channels) through built-in VHF transmitters.

There are three different types of AIS information transmitted by ships. Static information, which is entered on the AIS, changes only if the ship changes its name. The Marine Mobile Service Identification (MMI), the location of the electronic Positioning System (EPFS) antenna, or a significant conversion from one ship type to another. For example, there are IMO code (if any), call sign and ship name, length and width of the ship, type of the ship, location of the positioning antenna on the ship, etcetera. Dynamic information, except the "navigation status" information, update automatically by the ship sensor connected to AIS. For example, there are ship position, UTC, ground course, ground speed, track direction, navigation state, rate of turning, transverse angle (optional), trimming and rolling (optional). There is some navigation-related information, for example, ship draft, type of dangerous goods, port of destination and estimated time arrival, navigation plan (optional), concise safety information, etcetera. This information may need to be manually entered and updated during the voyage.

The AIS shall always be in working condition while the ship is sailing or berthing. The AIS may be switched off if the Captain considers that the continued operation of the AIS may endanger the safety or security of the ship, or in the event of an impending safety event. Unless further detrimental to safety or safeguards, if the vessel operates under the mandatory ship reporting system, the Captain shall report this action and its reasons to the competent authority. Actions of this nature shall always be recorded in the log book and give reasons for this. However, once the hazard disappears, the Captain should restart the AIS.

Periodic AIS data information may be received by other vessels or base stations as long as they are within range. It is then processed and displayed with special software on a chart plotter or computer. AIS data can also be received by satellites carrying high sensitivity receivers, in which the term Sat-AIS (Satellite AIS or S-AIS) is commonly used.

4) The inherent limitations of the AIS

(1) The Captain should always be aware that other vessels, especially recreational vessels, fishing boats and warships, and some coastal stations, including VTS centres, may not have AIS installed;

(2) Personnel on duty should always be aware that other ships with AIS require mandatory transport and in some cases AIS may be switched off based on the professional judgement of the Captain;

(3) The information provided by the AIS may not be the full picture of the situation around the ship;

(4) Users must be aware that transmission of incorrect information means risks to other ships and their own. The user remains responsible for all the information entering the system and the information added by the sensors;

(5) The accuracy of the received AIS information is only as good as the accuracy of the transmitted AIS information;

(6) Officers on duty should be aware that poorly configured or poorly calibrated ship sensors (position, speed, and direction sensors) may cause incorrect information to be

transmitted. The wrong information for one ship that are displayed on the bridge of another could cause dangerous confusion;

(7) If no sensors or sensors cannot provide data, the AIS will automatically transmit "unavailable" data values. However, the built-in integrity checks cannot validate the data already processed by the AIS;

(8) It is not prudent for Officers on duty to assume that the information received from other ships is equivalent to the quality and accuracy that they may have on their own ships.

AIS is a major development in safety at sea and provides information to make better decisions. However, it must be noted that the AIS also has its limitations. The accuracy of the information received through the AIS depends entirely on the information transmitted. Therefore, when making navigation avoidance decisions basing on the information provided by AIS, in addition to fully considering the reliability and accuracy of the obtained information, it should also be aware that there are still many dangerous objects at sea that do not have AIS information.

4. Electronic chart display and information system

1) Introduction to electronic chart display and information system

The Electronic Chart Display and Information System (ECDIS) is a shipboard electronic chart information display system that meets *SOLAS* requirements. It can be used as a primary navigation method and complies with IMO standards and International Hydrographic Organization (IHO) specifications. The main purpose of ECDIS is to utilize its computerization capabilities to continuously display the relative positions of ships and lands, objects on charts, auxiliary navigation, and navigation hazards equipped with the system, while providing other useful navigation information to make navigation safer. ECDIS has been developed into a new type of ship navigation system and decision-aid system.

The ECDIS complies with articles V/19 and V/27 of the *SOLAS Convention* and can display the selected information in the System Electronic Navigation Chart (SENC). ECDIS devices that meet *SOLAS* requirements can be used to replace paper charts.

In addition to improving navigation safety, the automatic functions of ECDIS, such as route planning, route monitoring, automatic estimated time of arrival (ETA) calculation, and electronic navigation chart (ENC) update, greatly reduce the workload of mariners. In addition, ECDIS provides many other complex navigation and security features, including continuous data records for future analysis.

2) Limitations of the ECDIS

(1) The accuracy of the information received through AIS is only equivalent to the accuracy of AIS information transmission. The same applies to all other devices connected to the ECDIS;

(2) The vessel position displayed on ECDIS may not be based on WGS84;

(3) Excessive reliance on ECDIS for navigation safety should be avoided before confirming that all transmitted, received, and displayed data are accurate;

(4) Users shall be aware that any false information is unfavourable for the safety of themselves and other ships;

(5) Some sensors may lack integrity in terms of accuracy, especially those with untested sensors.

3) IMO requirements for ECDIS performance

The IMO resolution MSC.232(82) defines the basic performance range of the onboard ECDIS.

(1) The primary function of the ECDIS is to contribute to safe navigation;

(2) ECDIS with adequate back-up arrangements may be accepted as complying with the up-to-date charts required by regulations V/19 and V/27 of the *SOLAS Convention*, as amended;

(3) ECDIS should be capable of displaying all chart information necessary for safe and efficient navigation originated by, and distributed on the authority of, government authorized hydrographic offices;

(4) ECDIS should facilitate simple and reliable updating of the electronic navigational chart;

(5) ECDIS should reduce the navigational workload compared to using the paper chart. It should enable the mariner to execute in a convenient and timely manner all route planning, route monitoring and positioning currently performed on paper charts. It should be capable of continuously plotting the ship's position;

(6) ECDIS displays may also be used for the display of radar, radar tracked target information, AIS and other appropriate data layers to assist in route monitoring;

(7) ECDIS should have at least the same reliability and availability of presentation as the paper chart published by government authorized hydrographic offices;

(8) ECDIS should provide appropriate alarms or indications with respect to the information displayed or malfunction of the equipment.

Section 2 Monitoring System and Remote-Control System

1. Ship video monitoring system

For ferry transportation, especially ro-ro passenger ships involving passengers and vehicles, there is a large scale of passenger flow and the environment on-site is kind complex.

It is necessary to effectively monitor and alarm the possible emergency events in time. Therefore, enhancing the vessel's video surveillance system and utilizing internal and remote video monitoring methods can provide comprehensive monitoring of vehicle dynamics, passenger dynamics, and the safety of ship equipment during ferry transportation. By establishing an intuitive ship monitoring and management system, it becomes an effective means to ensure the safety of ferry navigation.

1) Composition of the surveillance system

The ship video surveillance system generally consists of a number of different types of surveillance cameras to collect video data, and then share it to the ship LAN monitoring system after processing by the host computer, and save the video data in the hard disk recorder. At the same time, it can also be transmitted through the ground mobile data network or satellite to achieve remote monitoring and management of the ship in the shore monitoring centre or office.

The vessel video surveillance system, in combination with the maritime regulatory authorities and shipping companies' requirements for modern ship video surveillance systems, can provide various types and functionalities of marine video surveillance. It can also develop different solutions based on the diverse monitoring and management needs of key surveillance areas on board various types of vessels.

By installing a vessel video surveillance system on each ship, different types of surveillance cameras can be selected to meet the monitoring and management needs of the particular vessel. Depending on the ship's specifications and the scope of surveillance, options such as high-speed dome cameras, bullet cameras, and PTZ cameras can be used as different types of data acquisition devices. Intelligent PTZ cameras or fatigue driving cameras can also be installed in the ship's control room, along with display and control equipment for vessel video surveillance, providing strong support and assurance for the crew in terms of standardized navigation and safe ship operation.

2) Main functions of the ship's video monitoring equipment

The vessel video surveillance system integrates high-definition surveillance cameras, switches, digital video recorders, control keyboards, display devices, and remote wireless transmission into one system. By establishing intelligent behaviour analysis alarms and 24-hour HD surveillance management, it enables comprehensive monitoring and management of critical surveillance points such as the wheelhouse, deck, cargo hold, engine-room, bow, stern, main corridors, and areas, ensuring round-the-clock, all-weather, and full coverage surveillance to safeguard water transport safety.

Modern high-definition vessel video surveillance systems can provide comprehensive coverage of large areas, assisting law enforcement and emergency service agencies in conducting maritime investigations. They can provide vital information to the authorities,

enabling them to conduct further inquiries and ultimately draw conclusions based on the gathered information.

3) Function requirements of video surveillance equipment for ro-ro passenger ships

The television monitoring equipment installed on a ro-ro passenger ship should meet the following additional safety requirements.

(1) It should be equipped with a television surveillance and water leak detection system that can provide feedback to the bridge and machinery control station about any leakage information that may result in flooding of special category space or ro-ro space through internal and external bow doors, stern doors, or any other side doors.

(2) Ro-ro passenger ships should employ effective measures such as television monitoring to continuously patrol or monitor special areas and ro-ro space during voyages. This is to detect any unauthorized movement of vehicles or passengers entering these areas, as well as potential fires, especially in adverse weather conditions. It should also monitor the normal handling of vehicles and embarkation/disembarkation of passengers in ports.

These requirements ensure the safety and security of the ship by allowing continuous monitoring and early detection of any potential hazards or unauthorized access to restricted areas.

4) Maintenance of the monitoring system

The monitoring system on board a ship typically requires regular maintenance and inspections, which should be carried out by professional technicians. The maintenance of the ship's monitoring system by onboard personnel mainly involves routine upkeep, such as keeping the equipment clean and conducting periodic checks to ensure proper functioning, complete coverage of monitoring areas, and clear display of images.

Here are the key aspects of maintaining the ship's monitoring system:

Routine maintenance: Regularly clean the external components of the monitoring equipment, including camera lenses and displays, to ensure clear and unobstructed images.

Periodic inspections: Conduct regular checks on the working condition of the monitoring system, including verifying the proper connection of cameras, ensuring the equipment operates correctly, and examining the extent of coverage in critical areas such as cabins, decks, and corridors.

Equipment repairs: Promptly address any equipment malfunctions or abnormalities by repairing or replacing damaged cameras, cables, or other relevant components.

Software updates: Perform occasional software updates to access the latest features and security patches, ensuring system stability and security.

Log recording and troubleshooting: Regularly review log records to identify and resolve any system failures or abnormalities. If issues arise, troubleshoot and ensure timely resolution.

In summary, the maintenance of a ship's monitoring system entails onboard personnel conducting routine upkeep and undergoing periodic inspections. When necessary, they should seek support from professional technicians, thereby ensuring the system operates smoothly and maintains effective surveillance capabilities.

5) Surveillance system troubleshooting

When a fault is discovered in the surveillance system, it is necessary to assess the direction, scope, and location of the fault and make adjustments considering the following situations.

(1) If the camera's monitoring angle is deviated or inappropriate, the monitoring personnel can mechanically adjust the camera to the proper position;

(2) If the camera image is blurry, clean the camera lens with a soft tissue or cotton cloth. If the image remains blurry even after cleaning, it may indicate camera deterioration. In such cases, report the fault to the company;

(3) If the monitor displays "no video signal" for all channels (not a black screen), it could be due to abnormal power supply to all cameras. Check the camera power voltage (input AC 220V, output DC 12V) to ensure it is functioning properly;

(4) If the entire monitor is black, it could be due to several reasons:

① Monitor failure: Check if the monitor has power supply and if the power indicator is lit. If the monitor has power but the indicator is not lit, it indicates a possible monitor failure. Report the fault to the company;

② Incorrect channel selection on the monitor: If the monitor has power and the power indicator is lit, check the power supply of the recording device (DVR). If the DVR has power and is operational, press the channel selection button on the monitor until an image appears;

③ Improper connection of the DVR power supply: If the above steps still do not display an image, check if the DVR power supply is properly connected. If it is not, plug in the power supply;

④ DVR failure: If the above steps still do not display an image even after confirming the DVR power supply is connected and there are no indicator lights, it indicates a DVR failure. Report the fault to the company.

In summary, when troubleshooting the surveillance system, it is important to identify the specific issue and take appropriate actions, which may involve adjusting camera angles, cleaning lenses, checking power supply, or reporting faults to the company when necessary.

2. Watertight door remote control system

1) Introduction to the ship watertight door

Watertight doors on ships are doors installed on watertight bulkheads that meet watertightness requirements. They are designed to withstand flooding in the event of hull breach. There are two common types of watertight doors: hinged watertight doors and sliding watertight doors. These doors are typically made of metal. The former is lightweight and easy to operate, while the latter is used in locations with water pressure requirements and limited space, and it requires a control system for operation.

The watertight doors in the decks of passenger ships should be installed at the highest point and as far away from the outer shell as possible. In any case, the distance between the vertical edge closest to the ship's side and the hull outer shell should not be less than 1/5 of the ship's width. This distance is measured perpendicular to the ship's centreline at the deepest compartment's load waterline. The number of openings on watertight bulkheads should be minimized, considering the ship's design and normal operation. All these openings should be equipped with reliable closing devices. Therefore, there are no specific requirements for the form of watertight door arrangements on passenger ships, and both manual hinged doors and power-operated sliding doors are acceptable.

2) Power-operated sliding watertight door equipment requirements

A power-operated sliding watertight door should be equipped with one of the following systems.

(1) A centralized hydraulic system with two independent power sources. Each power source consists of an electric motor and pump that can simultaneously close all the doors. Additionally, a hydraulic accumulator with sufficient energy for at least three operations of all doors (close-open-close) should be installed in a centralized control panel located in the control room;

(2) An independent hydraulic system for each door, with its own power source. It consists of an electric motor and pump capable of opening and closing the door. Additionally, a hydraulic accumulator with sufficient energy to operate the door at least three times (close-open-close) should be provided, even in adverse conditions with a 15° transverse inclination;

(3) An independent electrical system for each door, with its own power source and electric motor. The power source should automatically switch to a temporary emergency power supply composed of a battery bank in the event of a failure in the main power or emergency power supply. The emergency power supply should have sufficient energy to operate the door.

The power system of the power-operated sliding watertight doors described in (1), (2), and (3) should be separate from other power systems. The failure of any component in the electrical or hydraulic power control system (excluding hydraulic actuators) should not impede the manual operation of any door.

All power-operated sliding watertight doors should be equipped with indicators at their remote-control stations to indicate whether the doors are open or closed. The remote-control stations should only be located in the control room and at manual control positions above the bulkhead deck. The power supply required for the power-operated sliding watertight doors should be directly provided by an emergency distribution board or a dedicated distribution board located above the bulkhead deck.

A single electrical failure in the operation or control system of the power-operated sliding watertight doors should not result in the opening of closed doors or hinder manual operation of any watertight door. Continuous monitoring of the power supply at a point in the circuit adjacent to the watertight door operating device should be conducted. Any power failure should generate audible and visual alarms at the central control console in the control room.

3) Centralized control system of the watertight door

The centralized control console for watertight doors should be located in the control room, and it should have a "Control Mode" switch with the following two modes.

(1) "Local Control" mode for normal operation, which allows for manual opening and closing of any watertight door without the use of automatic closing devices;

(2) "Door Closure" mode for emergency situations, which automatically closes any open watertight door and allows for manual opening of any door on-site. Once the local control mechanism is disengaged, the door will automatically close.

Furthermore, the control devices for any power-operated sliding watertight doors, whether powered or manual, should be capable of closing the doors when the ship is heeled to either side up to 15°. Consideration should also be given to the force exerted on the door on either side when water rushes in from the opening, which is equivalent to a static head pressure of at least 1 metre above the door threshold at the centreline of the door.

4) Functional requirements for the watertight door

Watertight doors on ro-ro passenger ships should meet the following functional requirements.

(1) All gangway doors, cargo doors, and other closing devices that, if left open or improperly secured, could result in flooding of specific areas or ro-ro spaces should be equipped with indicators in the control room. If any of these doors are not fully closed or if any fastening devices are not in place or fully locked, the indicator should provide audible and visual alarms. The control room's indicator panel should have a mode selection function, such as "In-Port" or "Underway" to sound an alarm if any bow doors, inner doors, stern ramps, or other side doors are not closed and if any closing devices are not in the correct position when the ship departs from port;

(2) For Category III ro-ro passenger ships with only one level of vehicle deck that is an open ro-ro space or open deck, the requirements in (1) can be replaced with the following requirements:

① Installation of CCTV surveillance systems to monitor the areas where vehicles are loaded;

② Audible alarm devices in the control room to indicate when the bow and stern doors are not closed or not in the correct closed position.

(3) Except for necessary shipboard work, all passages leading from the vehicle deck and vehicle ramps to areas below the bulkhead deck should be closed and kept closed before the ship's departure and until arrival at the next berth. The master should ensure effective supervision of the closing and opening of these watertight doors and passages and record the time of each closure in the ship's logbook.

According to the above provisions, all watertight doors should be securely closed before the ship's departure and should remain closed during the voyage. If any of these doors need to be accessed during the journey, appropriate measures should be in place to prevent unauthorized opening, and any opened watertight doors should be in a state that allows for quick closure at any time.

A schematic diagram indicating the position of each watertight door should be displayed on the centralized control console in the bridge. Visual indicators showing whether the doors

are "open" or "closed" should be provided at the control console and at the manual operating positions above the bulkhead deck. The indicator circuit should be independent of the control circuit for each watertight door, and it should not be possible to remotely open any watertight door from the control console.

The operation, control, and indication of sliding watertight doors installed for maintaining the watertight integrity of internal openings at sea should meet the following requirements.

① They should be capable of remote closure from the control room and local operation from both sides of the bulkhead.

② Visual indicators indicating whether the door is open or closed should be provided at the control position.

③ Audible and visual alarm signals should be generated when the door is closed.

④ Each power-operated door should have a separate manual operating device and should be operable manually from either side of the door.

Regular drills should be conducted for the operation of watertight doors and closing devices on passenger ships. All watertight doors, whether power-operated or hinged, that are required to be used during the voyage should be operated daily. Watertight doors, as well as all mechanical devices and indicators connected to them, all valves required to be closed for watertight integrity of compartments, and all valves required to be operated for controlling damage cross flooding, should be inspected regularly during the voyage, with a minimum frequency of once per week.

Chapter 6 New Technology and Application

To enhance domestic ferry transportation safety, under the leadership and advocacy of IMO, member states have provided suggestions and proposals on comprehensive management, operational control, and the application of new technologies for ferry operations. These efforts actively promote the development of measures to improve domestic ferry safety. China is also involved, and has submitted the proposals related to improve domestic ferry safety projects to IMO. The proposals include initiatives such as shore-based monitoring of ferries and crew members, improving the informatization level of ferry companies' management, introducing new life-saving equipment suitable for small river and inland ferries to prevent large-scale casualties in ferry accidents, and adopting measures such as ferry hull colouring and marking to enhance ship identifiability. These proposals encompass various new technologies and applications aimed at improving domestic ferry transportation safety.

Section 1 Shore-based Information Autonomous Monitoring Technology

1. Background introduction

The inappropriate conduct of ferry crew members is a major cause of ferry collisions and other accidents. During ferry operations, shore-based personnel are unable to directly control the behaviour of the crew members. It is necessary to implement effective measures to strengthen the warning against improper conduct by ferry crew members.

With the development and application of modern information technology, it is now possible to utilize information technology to analyse and provide early warnings for the risks associated with ferry operations. This enables shore-based departments to enhance their monitoring and early warning capabilities for the safety of ferry navigation.

To promote the implementation of safety production responsibilities by ship operators, enhance risk management capabilities, and effectively prevent and reduce waterborne accidents, China has formulated the "The Standards for the Construction and Operation of Shore-based Monitoring System for Yangtze River Ferry Units". This document provides guidance for the construction and operation of shore-based monitoring systems for ferry operators. Through the shore-based monitoring system, modern information technologies such as positioning perception, weather monitoring, mobile internet, and intelligent analysis are integrated. This enables ferry operators to obtain real-time information about the ferries and environmental conditions, dynamically monitor and issue warnings for ferry operations, and provide command, dispatch, and comprehensive control of ferry operations.

2. Main functions of shore-based information autonomous monitoring technology

(1) Monitoring the environment and obtaining the water level information, wind speed, direction, visibility and meteorological information of the ferry waters (figure 6-1). When the hydrometeorology of the ferry waters does not meet the requirements for sailing, the shore-based monitoring personnel and ferry crew shall be given early warning by appropriate means.

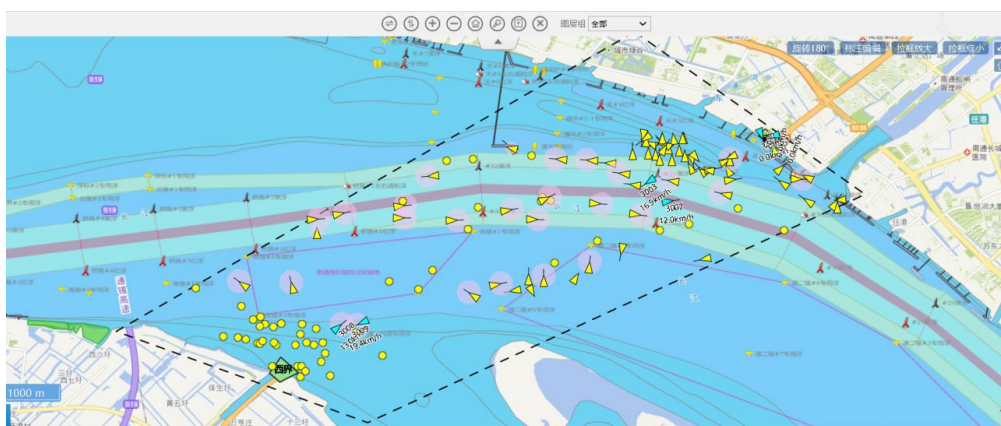


Figure 6-1 Shore-based departments monitor information of ferry waters

(2) Monitoring whether the ferry is overloaded and checking the stowage balance through monitoring the ferry loading process in real time. When the ferry is overloaded, more than the specified roll and trim angle, the warning information will be transmitted.

(3) Displaying the real-time dynamics of ships in the ferry waters, monitoring the real-time dynamics of the whole navigation process of the ferry, and analysing the situation of the ferry and other ships. Through setting the collision warning range, the shore-based monitoring personnel and ferry crew can be warned in an appropriate way before the urgent situation is actually formed (Figure 6-2).

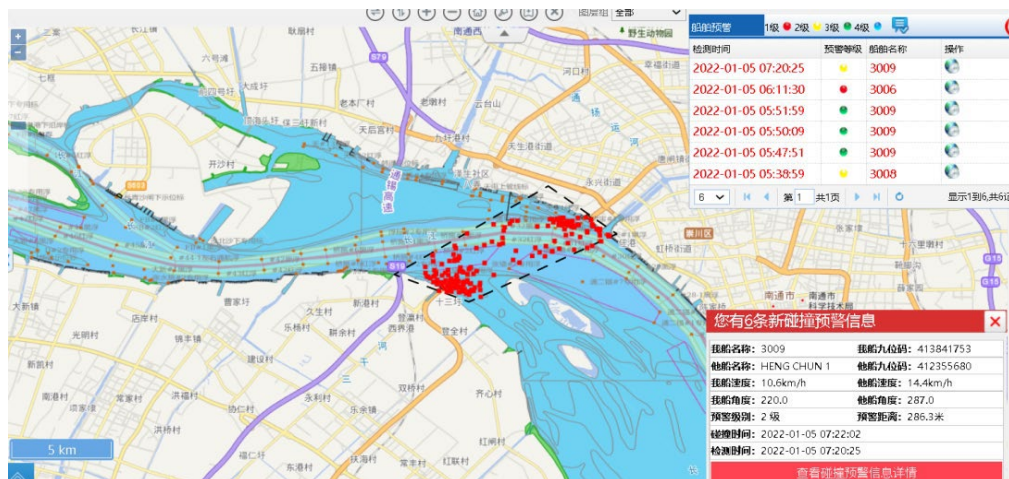


Figure 6-2 Warning system for the hazard of ferry collision

3. Application of shore-based information autonomous monitoring technology

Ferry operators establish a shore-based monitoring and command centre, with relevant qualifications of personnel. The personnel on duty are responsible for collecting hydrology, meteorology, navigation environment and safety information such as traffic flow, obtaining ship's conditions of navigation, berthing, homework, implementing the dynamic monitoring and providing security advice and warning on the factor that is likely to affect the safety of ferry.

In addition, the ferry operator has established a supporting standard system for shore-based monitoring, incorporating the duty system, monitoring system, information transfer system, system operation data and monitoring record preservation system and system equipment inspection, maintenance and maintenance system which ensure the effective implementation of shore-based monitoring.

4. Application results of shore-based information independent monitoring technology

Since the implementation of autonomous shore-based information monitoring by ferry operators, it has played an important role in preventing accidents. After the shore-based monitoring system was installed in a local ferry operator, the system has issued more than 20 effective early warning messages per day on average, which provides effective reference for the crew on safe navigation and ensures the safety of ferry sailing.

Through shore-based monitoring, the ferryboat navigation dynamics, water environment, shore-based monitoring and other processes are recorded by the ferry operator, and the relevant information is comprehensively analysed in case of various accidents and dangerous situations, which is more conducive to finding causes and preventing similar situations from happening again.

Section 2 New Life-saving Equipment for Small Ferries

1. Background information

Domestic ferries, especially inland water passenger ferries, usually operate in a busy water. Inland water passenger ferries are usually compact in structure, with large passenger capacity and frequent trips. Ferries often cross paths with other vessels on the waterway,

posing a high risk of collision accidents. In the event of a collision, the ferry may sink rapidly, resulting in significant casualties and property losses.

Currently, inland water passenger ferries are generally equipped with adult life jackets and children/infant life jackets. However, if passengers cannot be timely transferred to rescue boats in the event of an accident, fatalities may occur, especially during cold winter season. Inland water passenger ferries often carry a large number of passengers. Even if the ferry is equipped with sufficient lifeboats and liferafts, their deployment and evacuation are solely reliant on the crew, making it difficult to ensure quick passenger evacuation. Elderly people, women, and children, in particular, may find it challenging to board such lifeboats or liferafts in a timely manner.

The maritime evacuation system is an integrated maritime life-saving equipment system that includes launching devices, evacuation slides, and liferafts. It enables the rapid evacuation of a large number of passengers in emergencies. However, this type of equipment is mainly used on large vessels such as cruise ships, passenger ships, and ro-ro ferries and is not suitable for small-scale, shallow-drafted river ferries.

Given these circumstances, in order to facilitate the speedy evacuation of ferry passengers during emergencies, a local life-saving equipment manufacturer in China has developed a simplified life-saving device similar to nearshore evacuation systems specifically designed for inland water passenger ferries. This aims to meet the rapid evacuation needs of passengers of all age groups on small ferries. After the successful test on ship, it is widely used in many ferry routes in Jiangsu province.

2. Basic composition

The special life-saving equipment for the Yangtze River ferry (hereinafter referred to as the life-saving equipment) (figure 6-3), which mainly consists of slide unit, platform unit, inflatable unit and outer packaging unit. The total weight of the equipment is 87 kilograms with a soft package of 1100 mm x 1100 mm x 700 mm, which could be fastened in any position beyond the areas for passengers/cars on board the ferry and could be quickly released by two persons.



Figure 6-3 Special life-saving equipment for small ferries

1) Platform unit

The platform unit (figure 6-4) is mainly composed of upper and lower air rooms, hand rope, platform bottom cloth and towing device. It is a maritime transfer platform for personnel evacuation with a designed load capacity of 20 persons. The main material is UHMHSF high-strength coating cloth, formed through high-frequency thermal bonding processing. All performance indicators of the platform unit, including material, strength, ageing, oil resistance and hydrolysis resistance, meet the requirements of Revised Recommendation on Testing of Life-saving Appliances (*MSC.81(70)*) and its amendments. The orange main floating tyre of the platform consists of two independent upper and lower air rooms. Under the working pressure state, the pressure drops by not more than 5% on an hourly basis. If either air room leaks, the platform can still float on the surface under a rated condition. There are hand ropes inside and outside the upper air room to facilitate personnel transfer and boarding. When

passengers aboard the platform and sit down, the platform can maintain its stability in the wind and waves.



1-upper inflatable chamber; 2-lower inflatable chamber; 3-
armrest rope; 4-platform base lining; 5-traction device

Figure 6-4 Platform unit

2) Inflatable assembly

As far as the inflatable unit is concerned, the air supply unit is mainly composed of gas cylinder, manual air filling unit and air filling pipeline (Figure 3), which is connected to the check valve of the airbag through the filling pipeline at the time of packaging. A protective device is provided on the top of the manual inflation unit, the main function of which is to avoid damage or false triggering of the air filling device caused by accidental impact to the gas cylinder.

When the ferry is in distress, the crew or passengers quickly throw the life-saving equipment into the water, pull the first cable to the reserved ferry boarding place, and pull off the inflation first cable to enable automatic inflation of the platform. Then, the personnel can directly jump into or evacuate to the platform unit under the assistance of the slide unit. The first person boarding the platform unit can connect the platform to the ferry in distress through the stop rope. After all of the personnel board the platform unit, the rope can be untied, thus completely separating the platform from the ferry in distress. The platform could be towed away by rescue boats through a towing device.

3. Practical application of small ferry life-saving equipment

The application of the life-saving equipment makes up for the insufficient rapid evacuation capacity of the Yangtze River ferry. Characterized by light weight, small volume, simple operation and convenient boarding, it is capable of providing guarantee for the rapid evacuation of all passengers (including the elderly, women and children) on the ferry.

The life-saving equipment adopts advanced materials and manufacturing process, with a strong structure, satisfactory watertight performance, quick inflation, etcetera. During the comprehensive drill of "Taihai Ferry 12", the life-saving equipment was completely inflated in 20 seconds, and 20 passengers quickly evacuated to the life-saving equipment within two minutes (figure 6-5). At present, the life-saving equipment has been provided on board some of the Yangtze River ferries.



Figure 6-5 Ship drill of new life saving equipment

Section 3 Ferry Boat Hull Colouring and Marking

1. Background information

When ships navigate through congested narrow waterways, navigation aids such as AIS and radar may not be significantly effective, and ship lookout primarily relies on visual and auditory means. In such situations, the earlier the detection of approaching vessels, the better one can take measures to increase the safety distance and reduce the risk of collision. However, for ferries, due to their relatively small size, their signals, flags, shapes, and hull colours cannot be fully distinguished from a considerable distance.

To effectively enhance the visibility of ferries and reduce the risk of collisions with other vessels while crossing, the Changshu Maritime Safety Administration has conducted research on the colouring and marking specifications for ferries. They have conducted extensive on-site surveys and developed visual enhancement standards for ferry appearances. They have pioneered a colouring and marking scheme for safe ferries comparable to school buses in the country. Pilot work on exterior colouring and marking has been carried out on actual ships, and the standardized colouring and marking for ferries have been completed in the Jiangsu section of the Yangtze River, providing advanced experience for comprehensive optimization and standardization of ferry colouring and marking.

In 2022, the Changshu Maritime Safety Administration actively promoted the transformation of research results and, together with the Zhenjiang Maritime Safety Administration, carried out on-site comparative verification of ferry colouring and marking improvement. The visual effects of ferries coloured according to the scheme and those not coloured according to the scheme were compared at distances of 1,500 metres, 2500 metres, 3,500 metres, etcetera, and a comprehensive evaluation was conducted to verify the achievements in ferry colouring and marking enhancement.

2. Colour base and scheme

The visible light is an electromagnetic wave with a wavelength in the range of 380- 780nm (nanometer), and its colours are divided into red, orange, yellow, green, cyan, blue, and purple (Figure 6-6). The longer the wavelength, the stronger the penetrating power. Since red is often used as a warning sign and has been used for colouring the appearance of LNG ships, orange and yellow are preferred as the main colours for the design of the colouring scheme for the hull of the ferry.

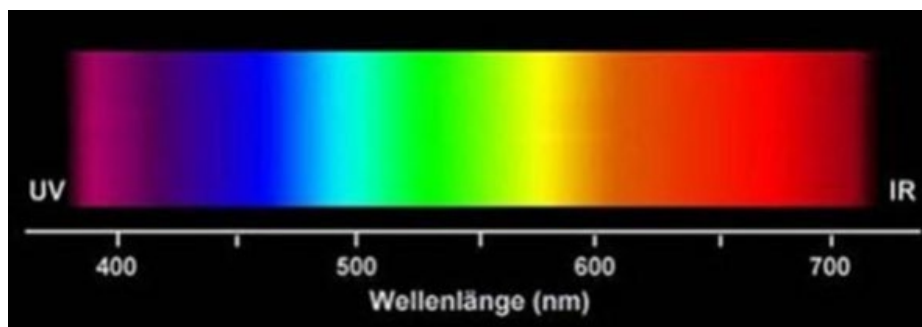


Figure 6-6 The wavelength view of the visible light

Through comparison and verification, the final colouring scheme is as follows:

(1) The main deck bulwarks and the outside of the booms at both ends are painted orange (GSB* YR04), and the main deck to the second deckhouse coamings are painted Lemon (GSBY05).

(2) The second floor and the outside above to the cornice of the compass deck and the main deck to the horizontal position of the middle of the deckhouse wall are painted orange (GSB YR04) bands, the width of which is not less than 40 centimetres (if the eave is less than 40 centimetres, the board should be fully coated with orange (GSB YR04)).

(3) The colour of the superstructure is white. The ferry number is marked with fluorescent paint on both sides of the hull.

3. Application effect of ferry hull colouring and signage

"Changtong Ferry 18" that has been coloured according to the scheme and "Tongchang Ferry 11" that has not been coloured as mentioned were chosen and taken pictures from distances of 1,500 metres, 2500 metres and 3,500 metres respectively. The findings show that the ferries coloured according to the scheme can be identified obviously from longer distance. The evaluation was conducted at 10:30 on 2nd January 2022, in a sunny weather with satisfactory visibility conditions, a temperature of eight degrees Celsius, and north wind of Beaufort force three. The sunrise time was 06:57, and the sunset time was 17:05. The shooting height was 35 metres above the river. The effects of the comparison are as follows.

Observed at the distance of 1,500 metres (Figure 6-7), the coloured "Changtong Ferry 18" was more identifiable than "Tongchang Ferry 11", while the orange double- arrow signal, the flag and shape of the ferry cannot be clearly identified.



Figure 6-7 Photos taken from 1,500 m

Observed at the distance of 2500 metres (Figure 6-8), the coloured "Changtong Ferry 18" was still clearly identifiable, while "Tongchang Ferry 11" was less visible, and the orange double-arrow signal, the flag and shape of the ferry could not be identified.



Figure 6-8 Photos taken from 2,500 m

Observed at the distance of 3500m (Figure 6-9), the coloured "Changtong Ferry 18" was still identifiable, while "Tongchang Ferry 11" was hardly visible.

A questionnaire survey and VHF interviews were conducted on 270 ferry crew members and seafarers on board more than 1,000 ships sailing nearby. The results showed that 96% of the respondents declared that the ferry colouring and marking transformation project enhanced the identifiability of ferries through increasing the visible distance, making it easier to know the ferry movement and take collision prevention measures beforehand.



Figure 6-9 Photos taken from 3,500 m

Part II Ferry Safety Management

The goal of ferry safety management is to ensure the safety of ferry personnel, ferry safety and prevent marine pollution. Improving the safety management level of ferry transport is not only the duty of government agencies, maritime authorities, ferry and shipping companies, but also the duty of relevant personnel, including ferry crew and passengers.

Chapter 7 Safety Management

Through the investigation of water traffic accidents, it is also found that more than 80% of the accidents are caused by human errors, and most of them are related to management. According to the existing safety management codes, the safety management system is established to provide safety practices and safe working environment for the ship operation, so as to minimize the occurrence of domestic ferry accidents.

Section 1 Human Error and Domestic Ferry Accident

IMO defines human error as: "A departure from acceptable or desirable practice on the part of an individual or group of individuals that can result in unacceptable or undesirable results". The major causes of domestic ferry fatalities due to human error include overloading, inadequate seaworthiness, poor lookout, negligence, and poor seamanship, for example. These factors are not singular and may be interrelated.

1. Overloading

Overloading of domestic ferries is undoubtedly the most deliberate or wilful type of human error that leads to domestic ferry accidents. Such accidents normally happen in the form of capsizing or sinking. Overloading is widely practiced in developing countries and it is the factor that consistently leads to the greatest number of fatalities per accident.

Overloading has many parents. Greed, obviously, and stupidity, ignorance, inadequate regulation and non-existent enforcement are some of the more common. Mostly, operators in poor and poorly regulated countries, seem to get away with overloading but, when something goes wrong, such as a collision or grounding, or, even, too sharp a turn, an overloaded vessel becomes a very dangerous vessel. They are less stable and, overloading will invariably exacerbate other safety deficiencies.

A major cause of accidents in many developing countries is that a high proportion of ferries, particularly in more remote areas, were never designed to carry large numbers of people. Often they are not much more than dinghies or canoes intended for purely inshore work carrying very small loads. They are unseaworthy by reason of being too small and completely unfit for purpose and are made much more so by gross overloading.

2. Inadequate seaworthiness

Almost without exception, unseaworthy vessels are older vessels that have not been properly maintained or have been badly modified to increase their carrying capacity.

The newer vessels, have invariably been poorly-read negligently-designed or constructed. Such vessels, also almost invariably, have been insufficiently carefully surveyed or examined by the appropriate government authority or a classification society if they have been surveyed at all. Older ships are more likely to become unseaworthy due to untimely or improper daily maintenance.

A ship is considered unseaworthy if it meets the following circumstances before sailing (but not limited to the following):

- (1) Insufficient ship strength or defects in the hull and machinery equipment;
- (2) The number of crew members on board is insufficient or they are not qualified or their work is not effective;
- (3) Insufficient fuel, materials, or supplies;
- (4) The ship is not suitable for loading certain goods;
- (5) Failure to obtain necessary certificates or documents for navigation.

3. Poor lookout

The *Convention on the International Regulations for Preventing Collisions at Sea, 1972* stipulates that Every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

The problem of maintaining an inadequate lookout can be the result of many behavioural deficiencies commencing with poor training and running through poor bridge discipline; fatigue; the health problems of poor eyesight and weakness due to influenza, malnutrition and similar ailments; and, the electronic distractions mentioned above. All such deficiencies can be reduced by better management, training, discipline and leadership.

4. Negligence

Negligence, obviously, is something of a "catch all" word that encompasses a number of human errors. Negligence is the synonym of careless which is lack of attention to what ought to be done; failure to take proper or necessary care of a thing or person; lack of necessary or reasonable care in doing something.

All aspects of vessel management, operation, equipment and maintenance are negatively affected by general negligence. Obviously, negligence is a cultural and behavioural problem that starts at the top with government regulation and company management and "trickles" down through all levels of a ship owning company.

5. Poor seamanship

Good seamanship is a solution to the problem that it would be impossible to make a complete description in formal regulation and laws how to handle all possible situations and choices of action that would be relevant for operating a ship. Good seamanship becomes a term of all these actions, including those trapped into rules.

Good seamanship encompasses a variety of qualities and practices that together make a safe, well-run ship. The most basic foundations for it are hard work, good judgement, humility and team.

1) Hard work

Voyaging is a lot of work, from maintaining your vessel in seaworthy shape to keeping your crew fed and rested offshore. Laziness in any form can quickly escalate into bigger problems that are harder to solve. On the other hand, keeping up your work ethic, even when it seems hardest, can turn a disaster into success. Seamanship also means constant practice of navigation skills.

2) Good judgement

This is a more complicated skill, and a harder one to define. Judgement is the making of clear, correct decisions, even under stressful circumstances. It's the ability to evaluate risk coolly without regard to ego. But to do so requires practice and experience to draw upon.

3) Humility

Besides practice and experience, good judgement comes about from a humble outlook on the world. Arrogance, like laziness, can lead to disaster. Staying careful and vigilant at all times, especially about your own actions, is just as essential to good seamanship as hard work.

4) Good team

Good seamanship requires ensuring that team members possess proficiencies. If only the captain of a ship has superb skills, it cannot guarantee the safety of the ship. Good communication, and good understanding among team members that comes with it, is crucial for a well-run, orderly, and safe vessel.

Section 2 Safety Management Codes

1. International Safety Management Code

To reduce shipwreck accidents caused by human, IMO conducted research on strengthening, improving and regulating the management of shipping companies, improving the safe operation of ships and preventing pollution management, Finally, learning from the

principle of ISO systematic management, the *International Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code)* in short) has been built.

In 1993, the eighteenth General Assembly of IMO formally adopted the *ISM Code* in the resolution *A.741(18)*. In 1994, the *SOLAS Convention* added chapter IX "Safe Operation Management of Ships".

The implementation of *ISM Code* is divided into two steps. From July 1, 1998, it is applied to passenger ships, high-speed passenger ships, oil tankers, chemical tankers, gas carriers, bulk carriers and cargo high-speed craft of 500 gross tonnage and upwards; from July 1, 2002, it is applied to other cargo ships and mobile offshore drilling units of 500 gross tonnage and upwards.

ISM Code requirements ship companies according to their own condition to develop the corresponding safety objectives, develop and implement a safety management system for the safe operation of ships and for pollution prevention, which are approved by the administration of the flag state. Ensure that the international conventions, norms, and relevant technical standards and special requirements of the flag state can be fully implemented through the effective operation between the ship and company.

The objectives of *ISM Code* are to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular to the marine environment, and to property.

The revised *ISM Code* consists of preface, Part A (implementation), Part B (certification and verification) and an appendix.

2. *NSM Code*

Based on the national conditions of each country and referring to international safety management codes, all countries can develop domestic safety management codes for ships navigating domestically and companies managing these ships. For example, China has introduced the *Safe Operation and Pollution Prevention Management Rules of the People's Republic of China (NSM Code)* in short).

NSM Code applies to ships, regardless of the date of construction, as follows:

(1) Domestic passenger ships with a passenger capacity of 50 or more for interprovincial voyages (including Ro-Ro passenger ships, tourist ships, passenger high-speed crafts), gas tankers and chemical tankers of 150 gross tonnage and upwards, not later than January 1, 2003;

(2) All passenger ships with a passenger capacity of 50 or more for interprovincial voyages (except for inland passenger ferries), oil tankers of 500 gross tonnage and upwards (except for oil tankers operation in harbour), not later than July 1, 2004;

(3) All bulk carriers and other ships of 500 gross tonnage and upwards for interprovincial voyages, not later than July 1, 2004

NSM Code adopts the principle and method of *ISM Code* equivalently, which has the same content and structure as *ISM Code*. Similar to all the contents concerning ship safety and pollution prevention, there are only some small differences in some terms and definitions, with some adjustments to the text.

3. The Construction of domestic ferry's safety management system

In order to improve the safety management level of domestic ferry, and implement the safety management system and ensure the safety of domestic ferry, the three main sections, including the competent authorities, management companies, and crew members, should work together.

1) The competent authority strengthens the supervision of the safety management system of the domestic ferry companies.

For domestic ferry companies, especially small ones, the competent authorities should strengthen the supervision of their safety management systems, and improve their safety management capabilities.

(1) Conduct special training for key shore-based and management personnel of small and medium-sized ferry transportation enterprises with low safety management levels, to enhance

the importance and management ability of management personnel to the safety management system.

(2) Establish a designated liaison mechanism for the ship safety management system, fully leverage the supervisory role of auditors, encourage ferry enterprises to establish assistance alliances, and exchange management experience with each other.

(3) Increase the intensity and frequency of safety management system audits, expand the scope of representative ships to be audited, and disqualify the enterprises and ships that have repeatedly engaged in fraud and temporarily updated safety management systems as per the rules and regulations.

(4) The competent authorities should make efforts to audit these shipping companies whose safety management systems are entrusted to manage by others, to prevent the behaviour of "acting without care", and urge the shipowners to actively fulfil the management agreement of the ship safety management system, and implement the main responsibility for ship safety.

2) Strengthen the construction of safety management system for domestic ferry management companies

The personnel of the management company should fully demonstrate their role during the running of the safety management system, strengthen the monitoring of the system's operation on board, and ensure the effective operation of the system.

(1) The top management of domestic ferry enterprises should attach importance to the construction of the safety management system, which can ensure smooth communication among various departments, thereby improving management level and efficiency.

(2) The enterprise managers should work effectively and efficiently in actual management work, promptly solve existing problems, and ensure the effectiveness of safety management measures.

(3) Enterprise managers need to update their knowledge in time, and be familiar with changes in international conventions and domestic rules.

(4) Enterprises should increase investment in ensuring safety, including personnel protection, education and training, and emergency response.

3) Strengthen the management of the crew team

The crew is a key link in ensuring the smooth running of the safety management system. The company should strengthen the management of the crew team, enhance their understanding of the importance of the system, proficiently master the core content of the system, and improve their professional skills.

(1) Enhancing the crew's awareness of the safety management system

Domestic ferry crew members, especially crew members of small ferries, have insufficient awareness of the importance and necessity of implementing mandatory safety system management. They do not realize that the purpose of the ship operation safety management system is to ensure personnel and ship safety and prevent pollution, and the most direct beneficiaries are crew members. Shipping companies should take effective measures to enhance crew members' correct understanding of the safety management system and enhance their subjective initiative in learning and implementing the system.

(2) Urge crew members to regularly study the safety management system

The company and the captain should urge crew members to regularly study the safety management system, and implement it instead of just doing paper work. The captain should conduct regular safety meetings for learning system according to the company's requirements, carry out regular assessments, and ensure clear execution of rewards and punishments accordingly.

(3) Improve the company's safety management system in practice

During the implementation of the safety management system, if the Captain and crew find any unreasonable or incorrect items in the system, they should report to the company immediately. The company should modify and improve them in the system according to the actual situation in time.

Section 3 Safety Culture

Safety is the eternal theme of ships. With the increase of shipwreck accidents, people's understanding of safety is deepening, and they increasingly feel the importance and urgency of building ship safety culture.

1. Ship safety culture

Ship safety culture is the sum of the spirit, idea, behaviour and physical state of safe production and safe life created by the crew in ship transportation production activities, and is the embodiment of the integration of safety values and safety code of conduct. Ship safety culture is an important part of shipping enterprise culture.

Ship safety culture includes elements such as crew safety concept, crew safety behaviour, ship safety system and ship safety environment. These elements complement each other. Ship safety culture is a higher-level management mode of system management. Good ship safety culture can effectively promote the improvement of ship safety management level.

Practice has proved that ship safety culture plays an irreplaceable role in ship management. Safety culture pays attention to human concept, morality, ethics, emotion, moral character and other deep humanistic factors. Through publicity, education, infection, reward and punishment, and creating a group harmonious atmosphere and other forms and means, it can promote the crew from the passive state of having to obey the system to the active state of consciously regulating safety behaviour. Therefore, only by constantly innovating the ship safety culture can we effectively enhance the safety responsibility and safety control of the crew, and improve the safety control of the ship fundamentally.

2. The approaches to building ship safety culture

Ship safety culture includes elements such as crew safety concept, crew safety behaviour, ship safety management system and ship safety environment. These elements complement each other. The construction of ship safety culture must also start from these aspects.

1) Strengthen the concept of safety among crew

The good safety concept of the crew should be the "active safety concept", which emphasizes the self-restraint mentality and conscious code of conduct, and emphasizes the safety needs "ownership" consciousness. It is the cultivation and formation of safety awareness and the cognition of safety by making change from "Keep me safe" to "I want to be safe". The formation and transformation of this security concept will take time. Ship safety work is to achieve by countless repeats of work. It is through the countless repeats of work that ferry sailors slowly cultivate their own safety concept, and with the guidance of correct safety concept that they have their own safety behaviour.

Safety education and skill training are important ways to prevent unsafe behaviours and reduce human error. Safety education can be divided into safety knowledge education, safety skills education and safety attitude education.

(1) Safety knowledge education

Safety knowledge education is to enable the crew to master the basic knowledge of accidents, to understand the potential risk factors and preventive measures in the process of ship operation.

(2) Safety skill education

Safety skill education is safety skill practising or training. The trainees can master safety skills through repeated practical operation, and achieve the degree that practice makes perfect.

(3) Safety attitude education

Safety attitude education is the most important link in safety education. After the crew has mastered the safety knowledge and techniques, whether they can achieve the safety techniques in the ship operation is completely controlled by the personal ideology. The purpose of safety attitude education is to make the crew consciously use safety knowledge as far as possible, realize safety techniques, and ensure the safe operation of the ship.

2) Standardize non-safe behaviours of crew

Crew safety behaviour includes the safety code of conduct and safe operation techniques. Safe code of conduct is the individual behaviour under the guidance of norms in daily work, while safe operation skills emphasize the safety techniques in the operation. Because there is no correct safety concept for guidance, there are often many non-safe behaviours in the daily work of ships. The non-safe behaviour of the crew directly affects the safety of the crew. If it is not correctly supervised and rectified, it will have serious consequences, and at the same time, it is difficult to cultivate the correct safety concept of the crew.

3) Strengthen the implementation of ship safety systems

Safety system is the basis of the construction of safety culture. Without a safety system, safety culture will become a tree without roots and water without a source. With the continuous improvement of the safety system documents and the establishment of the ship Safety Officer system, the ship has gradually established a sound safety system.

4) Create a safe environment for ships

The safe environment for ships is the safe atmosphere of the ship, which depends on instilling safety concepts, strengthening safety training and improving safety techniques to the crew through various supports and various theme activities. Safety environment is the fundamental guarantee of the construction of safety culture. Without this atmosphere, the construction of safety culture is an empty talk. Safety activities should be conducted to inculcate safety concepts in the crewmembers and strengthen their safety awareness.

Section 4 Risk Management

Risk management is an emerging management science, which is used to study the law of risk occurrence and risk control technology. Generally, it refers to the process in which risk management units effectively control risks and properly deal with losses through a series of ways such as risk identification, risk measurement, risk assessment and risk decision management.

1. Basic concepts of risk management

From the traditional point of view, risk refers to the uncertainty of the future results, which is generally considered as a combination of the objective embodiment of the uncertainty of the unwilling events and the severity of the frequency of consequences.

Risk assessment refers to the process of analysing and identifying the risks, indicating the causes, hazards, possibilities and consequences of the identified risks, and determining the measures to control the risks. The purpose of risk assessment is to avoid risk, reduce risk, or reduce risk to a tolerable degree.

Risk identification refers to the process of identifying and marking risks and determining their characteristics and tolerance.

One of the safety management objectives of shipping companies is to develop preventive measures against all the identified risks. Therefore, ferry companies should develop risk management procedures to prevent potential risks before they occur and ensure the safety of people and ships. The implementation of risk management can establish a comprehensive risk management framework, reduce loopholes in ship management and reduce risk losses.

2. Timing of the risk assessment

Before performing operations containing moderate risk and above, a risk assessment shall be conducted in accordance with the risk assessment procedures of the SMS. In order to be able to make the risk assessment comprehensively and systematically, different risk assessment groups are established according to the needs of safety operations. In addition to the head of the department, the members of the team should also include the commander and personnel participating in the operation, so as to comprehensively analyse and find out the risks, causes and consequences, and formulate scientific and reasonable risk control measures based on the above situation, so as to reduce the risk of ship operation to a tolerable degree.

The risk assessment shall be guided and monitored by the Captain, and the risk control measures (without shore-based support) shall be reviewed and approved by the Captain. If

the Captain and the department head think it is necessary to make a risk assessment based on experience, they shall do in accordance with the requirements of the SMS.

The evaluation shall be conducted jointly by the department head, the commander and the personnel participating in the operation. Work that is considered to have low risk under normal conditions can be varied to have high risk when working conditions change (e. g. bad weather or mechanical damage). Therefore, it is necessary to make risk assessment for the same operation under different conditions, identify the additional hazard sources, and formulate corresponding early warning and control measures for the additional hazard sources, so as to reduce the risk of the operation to a reasonable and feasible low risk and below.

3. The basic methods of risk assessment

1) Identification of hazard sources

According to the system elements of human, equipment, environment and management in all activities of a ship, hazard source identification is divided into human factors (including unsafe behaviour and human error), ship factors (including unsafe state of the ship, and ship failure) and environmental factors (including objective factors such as hydrology, meteorology, navigating environment, etcetera).

2) Assessment of the degree of risk and hazard

Any risk ultimately needs to be expressed in numbers or precise words, otherwise it cannot be correctly recognized by most people. Quantitative risk assessment method is recommended. The principle is to express the risk as the product of the possibility of danger and the consequences of danger, such as formula 7-1:

$$R = L \cdot C \quad (7-1)$$

Where: R— risk

L— possibility

C— consequences

(1) Possibility L

Possibility is the probability of a hazard occurring. Determine the possibility is the key to the risk assessment procedure. The Possibility should be a summary of the company's years of experience with accident data.

Table 7-1 is a list of possibilities of a company, with five levels of possibilities. The more detailed possible levels, the more reliable.

Table 7-1 List of the possibilities

Possibility	Level	Assignment
probable	5	An accident on this task is almost inevitable.
likely	4	It is uncertain whether an accident will occur when performing this task, but any uncertain factor can lead to an accident.
possible	3	It is uncertain whether an accident will occur when performing this task, but the combination of uncertain uncertainties may lead to the accident.
can	2	A combination of several rare factors has led to the accident.
may	1	The possibility of accidents is negligible.

(2) Consequences C

Consequences, the loss or outcome of the danger. Table 7-2 is a list of consequences of a company with 5 severity levels. The more detailed severity levels are, the more reliable the assessment will be.

Table 7-2 A list of the consequences

Degree of severity	Level	Personnel health	Ship / property loss (¥)	Degree of environmental pollution
extreme severity	5	Many people died.	Total loss / > 1 million	Major pollution

high severity	4	One person died or many were seriously injured.	be badly damaged /100,000-1 million	Large pollution
relative severity	3	Multiple injuries or more than one person was seriously injured.	Not severely damaged / 10 million-100,000	middle level pollution
partial severity	2	One person was injured or many were slightly injured.	Equipment is locally damaged / 100-1,000	Small pollution
slight severity	1	Minor injury or disease	Slightly damaged / <100	Minor pollution.

(3) Risk level

Calculate the risk R value according to the score of possibility L and the score of consequence C; and then determine the risk grade according to the risk grade standard set by the company.

The risk level is divided into five levels: small risk, tolerable risk, moderate risk, major risk and intolerable risk. The hazard grade criteria for a company are shown in Table 7-3. The relationship between possibility and consequences is shown in Table 7-4.

Table 7-3 List of hazard levels

Grade	R	Danger classes	Corresponding measures
5	≥20	Intolerable risk	Work cannot begin or continue until risk reduction, and activities must be prohibited if a reduction is not possible
4	13—19	Major risk	Work will not begin until risk reduction, and if work is ongoing, emergency measures must be taken and more resources can be requested
3	7—12	Moderate risk	Efforts are required to reduce risks and must be controlled at certain times
2	3—6	Tolerable risk	No additional control is required and must be monitored to ensure that the control is maintained
1	1—2	Small risk	No action is required

Table 7-4 A list of probabilities and consequences in relation to levels of risk

Consequence Possibility	Slight severity 1	Partial severity 2	Relative severity 3	High severity 4	Extreme severity 5
May 1	Small risk 1	Small risk 1	Tolerable risk 2	Tolerable risk 2	Tolerable risk 2
Can 2	Small risk 1	Tolerable risk 2	Tolerable risks 2	Moderate risk 3	Moderate risk 3
Possible 3	Tolerable risk 2	Tolerable risk 2	Moderate risk 3	Moderate risk 3	Major risk 4
Likely 4	Tolerable risk 2	Moderate risk 3	Moderate risk 3	Major risk 4	Intolerable risk 5
Probable 5	Tolerable risk 2	Moderate risk 3	Major risk 4	Intolerable risk 5	Intolerable risk 5

3) Implement, supervise and review the measures

During the implementation of the work, the senior Officer who has the responsibility shall monitor the measures taken, and the factors considered shall at least include the following points:

- (1) Whether the control measures can reduce the risk to the tolerable degree;
- (2) Whether the new measures will create new risks;
- (3) Whether the feedback of the person conducting the work on the control measures is effective;
- (4) Whether additional control measures can be used and carried out in practice.

4. Example of a risk assessment

Take an aloft work as an example, and Table 7-5 is the risk assessment table.

Table 7-5 The Risk Assessment Table

Ship / Department		XX ship / deck department				Date	2023.11.22				
Action or task		Working aloft									
Number	Before taking the risk mitigation measures			After taking the risk mitigation measures						Assignment whether to carry out	
	Risk	Consequence	Risk grade			Risk management measure	Additional measures	Risk grade			
			(C)	(F)	Risk			(C)	(F)	Risk	
1	Slip	Injury / death	3	4	3	Working at height	Pre-operation safety meetings and risk assessment	3	2	2	yes
2	No personal protection equipment	Injury / death	3	3	3	Working at height	Confirmation by the ferry driver in charge before the operation	3	2	2	yes
3	Improper supervision	Injury / death	2	4	3	Working at height	Responsible for the whole supervision of the ferry driver	2	3	2	yes
4	No protection in workspace	Injury	2	3	2	Working at height	Warning signs; the personnel on duty	2	2	2	yes
5	No safety net below the work area	Injury	2	3	2	Working at height	Setting up safety net	2	2	2	yes
6	The tool accidentally fell	Injury	2	3	2	Working at height	Setting up safety net	2	2	2	yes

Number	Further measures to control the residual risk	Risk assessment and approval
1	Have a safety meeting before working at height.	Fill in the evaluation form:
2	Participants performed the risk assessment and analysis.	
3	There must be guards and warning signs on-site.	Examiner:
4	Prepare personal protection.	
5	Avoid hurry operation.	

Section 5 Supervision and Administration of Passenger Ferry

Due to the wide variety and uneven condition of passenger ferries, there is a high probability of water traffic accidents. Therefore, it is imperative to strengthen the safety supervision management of inland waterway ferries, maintain the order of ferry transportation, and ensure the safety of people's lives and property.

1. Establish and improve the safety supervision management system for passenger ferry

The local governments at or above the county level should carefully study and implement relevant national laws and regulations on water traffic safety management, and establish and improve a responsibility system for water traffic safety management based on local conditions. The local and county-level people's governments at the location of the ferry should establish and improve the responsibility system and safety supervision management system on ferry safety.

2. Strictly implement the safety supervision management responsibility system for passenger ferry

Local governments at all levels, especially the governments of counties and towns, should conscientiously implement the relevant national and local rules and regulations, strictly perform their responsibilities, including safety supervision management of ferries in important agendas,

break down the tasks and responsibilities, implement them by steps, and strictly implement the goal responsibility system and accountability system.

Local governments shall designate relevant departments to be responsible for daily supervision and inspection of ferry ports and ferry safety, and strengthen the organization and coordination of maintaining traffic safety during busy water areas, heavy weather seasons, and peak traffic periods. Town governments should establish and improve the ship safety responsibility system for administrative villages and ship owners, implement specialized personnel for ship water traffic safety management, and implement safety management responsibilities for ferries, crew members, and passenger quotas. They should actively help solve the problems and difficulties in the safety management of ferries and ferry ports, clarify management funding channels, improve supervision equipment conditions, strengthen supervision and inspection, and ensure that supervision agencies, responsibilities, personnel, funds, and supervision are in place, so that they can continuously improve supervision capabilities. Besides they should strengthen professional training for the personnel who are responsible for water traffic safety management.

The accountability system must be implemented conscientiously, and those who fail to fulfil their responsibilities for safety supervision and management of ferry ports and ferries should be held accountable, as well as those who cause safety accidents due to dereliction of duty, under the law.

3. Develop joint law enforcement coordination and linkage mechanisms

To ensure the safety of passenger ferry, the maritime departments should carry out joint cruises by promoting the local government to take the lead, work with the related departments including transportation, fisheries, public security organs according to their respective responsibilities, and promote and closely cooperate with local governments to establish a joint law enforcement coordination and linkage mechanism involving relevant departments of passenger ferry.

(1) It is advised to focus on the navigable conditions of the passenger ferry routes, the zebra crossings and the water areas of ship's routings for passenger ferries, and the operation of passenger ferry stations. Joint law enforcement can be carried out to regulate the illegal and irregular behaviours that may affect the navigation safety of passenger ferries.

(2) During major holidays, summer tourism peak seasons, heavy weather, and the time when new situations arise in the safety of passenger ferry transportation within the jurisdiction, maritime departments should promote the local governments to organize relevant departments to conduct joint inspections to the passenger ferries.

(3) Any issues or safety hazards of passenger ferries found in the joint inspections should be reported in written form to the inspected passenger ferries, and the related departments should be notified as well, and follow up with checking according to the rectification requirements.

4. Strengthen publicity and education on safety of passenger ferry

It is advised to carry out regular publicity and education including popularizing rules and regulations, and safety knowledge related to water traffic safety management, so as to enhance the management's safety awareness of ferry management personnel, and make them loyal to their duties and strictly manage. The awareness of law-abiding management should be enhanced among ferry owners, operators, crew members, and ferry workers, so that they consciously comply with various safety rules and regulations, ensuring that the ship is in a seaworthy state, and crew members are competent for sailing, not to take risks to sail. At the same time the safety awareness of passengers should be enhanced so that they can consciously resist illegal behaviours such as overloading.

5. Improve emergency procedures

The county and town governments where the ferry is located should formulate emergency procedures for ferry accidents based on the actual situation of the local ferry. The relevant local governments should urge the management departments of scenic tourist areas to develop emergency plans for boat accidents and incorporate them into the local government emergency response systems, and strengthen daily training and drills. Maritime departments

should strengthen guidance for ferry enterprises to ensure quick response in case of danger and continuously improve emergency response capabilities.

Chapter 8 Minimum Safe Manning

In order to ensure the safety of navigation, berthing and operation of the ferry and prevent the pollution of the environment, the ferry must be manned with sufficient number of competent crew by owners or operators in accordance with national regulations of the minimum safe manning of the ferry.

Section 1 Requirements of Minimum Safe Manning

The minimum safe manning requirements for a ship refer to the minimum number of crew that must be manned and relevant rank requirements on the ship. These requirements aim to ensure the routine operation of the ship during navigation, respond to various emergency situations, and ensure the safety of personnel on board the ship.

According to the *SOLAS Convention*, contracting governments undertake, each for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned.

Taking China as an example, the CMSA, as the administration, has made detailed provisions on the minimum manning of seagoing and inland ships.

1. Minimum manning of seagoing vessel

The Rules of the People's Republic of China for Minimum Manning of Ships stipulate the minimum safe manning standards for seagoing vessels, as shown in Table 8-1.

Table 8-1 Minimum Safe Manning Table of Deck, Engine and Passenger Transport Department (part)

The Deck Department		
GT (gross tonnage)	General provisions	Additional provisions
GT ≥500	(1) One Captain, one Chief Mate and one Second Mate, and 3 Navigation watch ratings or deck A.B. ratings. (2) Manned with the same number of persons as lifeboats who holding the certificate of proficiency in survival craft and rescue boats (excluding Captain and Chief Mate).	If the ship is engaged on a successive voyage of more than 24 hours' duration, one Second Mate shall be added. If the ship is engaged on a successive voyage of not more than 8 hours' duration, one Second Mate and a Navigation watch rating can be reduced.
200≤GT<500	(1) One Captain and one Third Mate, and 2 Navigation watch ratings. (2) Ditto.	If the ship is engaged on a successive voyage of more than 8 hours' duration, one Second Mate shall be added.
100≤GT<200	(1) One Captain and one Third Mate, and one Navigation watch rating. (2) Ditto.	If the ship is engaged on a successive voyage of more than 16 hours' duration, one Second Mate shall be added. If the ship is engaged on a successive voyage of not more than 4 hours' duration, one Second Mate can be reduced.
GT<100	(1) One Captain (or deck Officer if there is a unit as one both engine-room and bridge) and one Navigation watch rating. (2) Ditto.	Daytime navigating permitted only. If the ship is engaged on a successive voyage of more than 4 hours' duration, one Second Mate shall be added. (deck Officer if there is a unit as one both engine-room and bridge)
The Engine Department		
MP (main engine power)	General provisions	Additional provisions
MP ≥3000 KW	One Chief Engineer, one First Engineer, one Second Engineer, one	If the ship is engaged on a successive voyage of not more than 36 hours' duration, one Third

	Third Engineer, three Engine-room A.B. ratings or watch ratings.	Engineer and one Engine-room watch rating can be reduced. AUT-0 engine-room can reduce Second Engineer, Third Engineer, and two Engine-room watch ratings. AUT-1 engine-room can reduce Third Engineer, and two Engine-room watch ratings. BRC semi-automatic engine-room can reduce 2 Engine-room watch ratings.
750 KW ≤MP < 3000 KW	One Chief Engineer, one First Engineer, two Engine-room A.B. ratings or watch ratings.	If the ship is engaged on a successive voyage of more than 16 hours' duration, one Third Engineer shall be added (except for automatic engine-room and BRC semi-automatic engine-room) .
220 KW ≤MP < 750 KW	1 Chief Engineer, 1 Third Engineer, 2 Engine-room watch ratings.	If the ship is engaged on a successive voyage of more than 24 hours' duration, one Second Engineer shall be added (except for automatic engine-room and BRC semi-automatic engine-room). If the ship is engaged on a successive voyage of not more than 8 hours' duration, one Engine-room watch rating can be reduced; If the ship is engaged on a successive voyage of not more than 4 hours' duration, one Third Engineer can be reduced sequentially;
75 KW ≤MP < 220 KW	1 Engineer, 1 Engine-room watch rating (can be reduced for automatic engine-room, BRC semi-automatic engine-room, or a unit as one both engine-room and bridge)	If the ship is engaged on a successive voyage of not more than 8 hours' duration, one Engine-room watch rating can be reduced.
MP < 75 KW	One Second Engineer or Third Engineer (or Engineer), and one Engine-room watch rating (exempt from unit as one both engine-room and bridge)	
The Passenger Transport Department		
<p>According to passenger carrying quota of the ship, every 50 passenger is assigned to 1 passenger department personnel;</p> <p>If the voyage is not more than 40 nautical miles or the voyage time is not more than 4 hours, one passenger department personnel may be assigned per 100 passengers;</p> <p>If the voyage does not exceed 10 nautical miles or the voyage time is not more than 1 hour, one passenger personnel may be assigned per 150 passengers;</p> <p>If the voyage does not exceed 5 nautical miles or the voyage time is not more than 0.5 hours, one passenger department personnel may be assigned for every 200 passengers;</p> <p>If the voyage does not exceed 5 nautical miles or the voyage time is not more than 0.5 hours, and the passenger quota is less than 50 passengers, no passenger department personnel are assigned.</p>		

2. Minimum manning of Inland ship

Table 8-2 is the list of the minimum safe manning standards for inland passenger ships.

Table 8-2 List of minimum safe manning standards for the inland passenger ships (part)

The Deck Department						
GT	GT ≥2000	1000≤GT < 2000	600≤GT < 1000	300≤GT < 600	100≤GT < 300	GT < 100
General provisions	1 Captain	1 Captain	1 Captain	1 Captain	1 Captain	1 deck Officer

	1 First Mate	1 First Mate	1 deck Officer	1 deck Officer		
	1 Second Mate					
	2 ordinary crew members	2 ordinary crew members	2 ordinary crew members	1 ordinary crew member	1 ordinary crew member	
Additional provisions	If the continuous navigation operation time does not exceed 4 hours, one Second Mate can be exempted.					
	If the continuous navigation operation time exceeds 10 hours, one Second Mate and one ordinary crew member shall be added.	If the continuous navigation operation time exceeds 10 hours, one Second Mate shall be added.	If the continuous navigation operation time exceeds 10 hours, one deck Officer shall be added.	If the continuous navigation operation time exceeds 10 hours, one deck Officer shall be added.	If the continuous navigation operation time exceeds 10 hours, one deck Officer shall be added.	If the continuous navigation operation time exceeds 10 hours, one deck Officer shall be added.
		If the continuous operation exceeds 16 hours, one Second Mate and one ordinary crew member shall be added.				
The Engine Department						
MP	MP ≥500K W	150KW ≤MP < 500KW	75KW ≤MP < 150KW	<75KW		
General provisions	1 Chief Engineer	1 Chief Engineer or 1 marine Engineer	1 crew member	null		
	1 second Engineer or 1 Third Engineer or 1 Fourth Engineer					
	1 ordinary crew member	1 ordinary crew member				

Section 2 Safe Manning During Staying in-Port

Ferry staying in-port (including berthing or anchoring) shall comply with the *Minimum Safe Manning Rules, Rules of Duty for Crew of Seagoing Ships* or *Rules of Duty for Crew of Inland ships*, and shall be manned with sufficient personnel to ensure safety.

1. Minimum Safe Manning Rules

The *Minimum Safe Manning Rules* stipulates that both Chinese and foreign ships shall be manned with enough crew members who master the corresponding safety knowledge and have the skilled ability to maintain the safe operation of the ship and equipment.

At no time shall the Captain and Chief Mate, Chief Engineer and Second Engineer of seagoing vessels of 500 gross tonnage or upwards (or 750 kw or upwards) and inland ships of 600 gross tonnage or upwards (or 441 kw or upwards) leave the vessel at the same time.

There is no specific regulation on the number of crew member required to remain on board for inland ships with gross tonnage of less than 600 while berthing.

2. *Rules of Duty for Crew of Seagoing Ships*

In addition to *Minimum Safe Manning Rules*, seagoing ships shall also comply with the *Rules of Duty for Crew of Seagoing Ships*.

1) When a ship is moored in a port, the Captain shall arrange appropriate and effective duty.

2) The Captain shall, in light of the berthing conditions, the type of ship and the characteristics of the duty, allocate sufficient skilled crew on duty and keep the necessary equipment in available.

3) When berthing, the deck crew on duty shall include at least one deck Officer and one sailor.

4) The Chief Engineer shall negotiate with the Captain to determine the duty arrangement of the engine. When determining the composition of duty personnel in engine-room, the following shall be taken into account:

(1) At least one Engineer is on duty.

(2) For ships with a power of 750 kw and upwards, at least one oiler shall be arranged to assist Engineer on duty.

3. *Rules of Duty for Crew of Inland ships*

The *Rules of Duty for Crew of Inland ships* stipulates that the ship shall have sufficient crew on duty to ensure the safety of the ship and ensure the needs of coping with emergencies may occurred. Among them, cargo ships of 1,000 gross tonnage and upwards, and passenger ships of 300 gross tonnage and upwards shall be have a deck Officer and an Engineer on board to keep on duty.

The Regulations on the Administration of Inland Traffic Safety stipulates that if a ship is berthing, enough crew member shall be kept on duty to ensure the safety of the ship.

Section 3 The Manning of Domestic Ferries

With the continuous increase in production and operation costs, domestic ferry operators, especially small ferry operators, have to reduce the labour cost by reducing the ship crewing, which seriously affects the safety of ferry transportation.

1. Problems in domestic ferry crewing

Large or medium-sized domestic ferries, including seagoing vessels and inland waterway vessels, can basically comply with national rules and regulations in terms of ship crewing, and are manned with crew members according to the minimum crewing certificate. However, the reasons why some small ferries have insufficient manning, especially inland passenger ships and passenger ferries, are as follows.

1) Lack of crew and certificates

Small inland water passenger ferries owned by households generally lack of crew and certificates. For passenger ferries with a minimum manning requirement of three crew or more, it is not possible to meet this standard if only the couple on board. If the continuous sailing time exceeds 10 hours, it is necessary to increase the crew, which is particularly serious for passenger ferries with a shortage of crew and certificates.

Small inland waterway family-owned passenger ferries generally lack crew and corresponding certificates. For passenger ferries with a minimum manning requirement of three crew or more, it is not possible to meet this standard if only the couple on board. If the continuous sailing time exceeds 10 hours, it is necessary to add more crew members, which causes the situation of a shortage of crew and certificates on ferries.

2) Crew without certificates

When the maritime department inspects the manning of the passenger ferries at port, almost every ferry can present the *Minimum Safe Manning Certificate*, the crew competency certificates and crew identity documents for the corresponding level of full crew members in accordance with regulations. But when checking if the crew are on board, sometimes a certain

number of crew member can be not actually on board. When this happens, the crew present will find various reasons and excuses to explain the crew member's whereabouts. In fact, most of these crew certificates can be borrowed or rented, and the crew members themselves do not work on the ferry.

3) There is a phenomenon of exceeding the limited time for the ships that have navigation time limit

In order to strive to arrive at the destination as soon as possible, it is a general practice to disregard the provisions of the Minimum Safe Manning Certificate on the requirements of crew augmentation for navigation overtime, and rely on a small number of crew members to navigate continuously day and night.

4) The crew identity documents did not record the crew service on board truthfully

At present, there is a common phenomenon of non-standard or inaccurate recording of crew services on board in the crew identity documents of inland passenger ships or passenger ferries. The captain failed to timely record the services on board of the signed-on and signed-off crew members.

2. Measures to solve the problems of insufficient manning of domestic ferries

1) Improve and perfect the related rules and regulations

(1) Although China's *Minimum Safe Manning Regulations* stipulate the manning during navigation, there are no clear requirements of the minimum manning during berthing. Therefore, it has become a common phenomenon for ships to have insufficient manning on duty during berthing, sometimes even without any crew on duty. It is necessary to improve and complete the minimum safe manning requirements for ships during their stay in-port.

(2) Appropriate adjustment of ship manning regulations. With the continuous improvement of ship technology, the level of informatization, mechanization, and intelligence of ships is becoming higher and higher, which has brought certain technical support to reduce the manning of ships. Therefore, it is necessary to make further modifications to the minimum manning requirements for ships.

2) Strengthen the management of domestic ferry companies

In response to some misconceptions of shipping companies and shipowners regarding the minimum safe manning of ships, the maritime departments should educate and train the shipping companies and ship owners that ships can only be safely operated with sufficient and competent crew members, combining the relevant rules and regulations with some cases of water traffic accidents. At the same time, shipping companies should actively employ and cultivate crew members to establish a reserved crew team, and allow crew members to be replaced and rotated. While ensuring that the ship's manning meets the requirements, they can also make it sure that the crew have reasonable rest time.

3) Vigorously developing vocational education for inland ship crew

The governments should attach importance to and support the development of education for inland ship crew members, and promote the training methods of cooperation between schools and enterprises, and expand the team of inland ship crew members. It is also necessary to strengthen the support, management, and supervision of crew training institutions to promote the healthy development of crew team for inland waterway ferries.

4) Develop service institutions of inland ship crew

Supporting the establishment of inland ship crew service institutions, as well as providing crew intermediary services for shipping companies in the jurisdiction, will effectively solve the problem of difficulty in hiring crew on ferries. At the same time, the service institutions can also provide temporary manning services for ferries, which will effectively solve the problem of insufficient manning on ferries.

5) Strengthen on-site supervision by the maritime departments

The maritime department should strengthen on-site inspection of ships. Illegal ferries should be required to man enough qualified crew members, otherwise they are prohibited from leaving the port. If the illegal circumstances are serious or if the offender persists, the maritime departments should also list the ferry or its affiliated company as a key regulatory object and conduct key tracking on it. The maritime departments should also strengthen the administrative

penalties and rigid scoring system against the illegal practices of ferry captains and crew members as well. Through education, both the captain and crew members should be aware of the importance of manning issues and recognize their own responsibilities and obligations.

Chapter 9 Crew Training

Training is a necessary way to improve the quality of the crew members. The 1978 *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW 1978)* stipulates that shipping companies should establish a perfect crew training system; ISM Codes stipulate that shipping companies must establish crew training procedures, and the Captain shall motivate and train the crew according to the convention requirements. Crew training mainly includes three ways: statutory training, training held by ship companies and onboard training.

Section 1 Statutory Training

The so-called statutory training, is the training conducted according to the national laws and regulations. According to the relevant requirements of the *STCW Convention*, China has developed the *Administrative Rules of the Crew Training of the People's Republic of China*. The statutory training of seafarers is divided into three categories according to the training contents: basic safety training, competency training and special training. According to the training participant, the crew training is divided into two categories: training of seafarer and training of inland ship.

1. Basic safety training

Basic safety training for crew refers to the training in personal survival techniques, basic fire prevention and fire fighting, elementary first aid, personal and social responsibilities received by crew before serving on board.

2. Competency training

Competency training refers to the training acquired by the crew before obtaining the certificate to provide the crew with the professional technical knowledge and professional techniques required to adapt the rank, including crew's competency training for ranks and crew' competency training for techniques.

1) Crew's competency training for ranks

(1) Seafarer's competency training for ranks

The seafarer's ranks include Captain; Chief Officer, Second Officer, Third Officer; Chief Engineer, First Engineer, Second Engineer, Third Engineer, Electronic Technical Officer; Deck A.B. Ratings, Navigation watch Ratings; Engine-room A.B. Ratings, Engine-room watch Ratings, Electro-technical Ratings; and GMDSS operator, etcetera.

(2) Inland waterway crew's competency training for ranks

The ranks include navigators (Class I, II, III) and marine Engineer (Class I, II, III).

2) Crew's competency training for techniques.

The crew's competency training for techniques includes the following training programmes:

(1) Proficiency in survival craft and rescue boats other than fast rescue boats;

(2) Proficiency in fast rescue boats;

(3) Training in advanced fire fighting;

(4) Training in medical first aid;

(5) Training in medical care;

(6) Security awareness training;

(7) Seafarers with designated security duties;

(8) Proficiency for ship Security Officer;

(9) Training for cooks and catering support staff.

3. Special training

Special training refers to the training for sailors working on dangerous goods vessels, passenger vessels, large vessels and other special vessels, which can be divided into special training of seafarers and crew on inland ships.

1) Special training of seafarers

Special training of seafarers related to domestic ferry mainly includes:

- (1) Special training for passenger ship crew;
- (2) Basic training for crew members of ships using gas or other low flash point fuel;
- (3) Advanced training for crew of gas or other low flash point fuel.

2) Special training of crew on inland ships

(1) Crew members engaged in inland passenger ships shall obtain a special training certificate for crew members of inland passenger ships;

(2) Crew members engaged in inland Ro-Ro ship (except car ferry crossing river) are required to obtain special training certificate for inland Ro-Ro ship crew.

(3) Crew members engaged in inland liquefied gas fuel power passenger ships or Ro-Ro passenger ships are required to obtain a certificate of proficiency of that kind ships.

3) Passenger ferry

China's *Regulations on the Safety Management of Inland Waterway Ferry* develops relevant provisions on the safety training of ferry operators, ferry crew and ferry workers:

(1) The departments designated by the government shall strengthen the safety education and training for the ferry operators, and shall be responsible for the training, examination and issuance of certificates of qualification for the ferry staff. The ferry operators shall regularly carry out the safety education and training for the ferry staff, the ferry crew members and the ferry workers.

(2) Ferry crewmembers shall have the qualifications in accordance with relevant regulations and hold the corresponding crew certificates.

Ferries carrying less than 12 passengers may be manned only by ferry workers. The ferry workers shall acquire the ferry navigating techniques and safety training, pass the examination and obtain the ferry workers' certificate issued by the maritime administrative authority.

The crew and workers of the ferry shall participate in safety training of at least four hours every year organized by the ferry operator, the government of the town or the relevant competent department.

Section 2 Training Held by Ship Companies

Crew is an important basic resource and important asset of the shipping company, and an important factor to ensure the safe operation of ships. Shipping companies play an important role in the construction of high-quality seafarers, and assume the main responsibility of crew training and the protection of their rights and interests.

1. Regular training

Shipping companies should establish a stable crew team, improve the proportion of its own crew, formulate crew training and development plan, strengthen the crew on-the-job education and training.

Shipping companies should regard the crew as a member of the enterprise, an important basis for the development of the enterprise, enhance the sense of belonging of the crew, enhance the sense of responsibility of the crew, and let the crew participate in the operation and development of the enterprise. Implement the retraining system for seafarers, strengthen the management of training on board. The crew training shall be incorporated into the company's safety and pollution prevention management system, and the retraining system covering internship, promotion, performance and other links shall be perfected, as well as the lifelong education system of crew members, which shall form a beneficial supplement to the on-campus training of crew members, so as to ensure that crew members can effectively maintain and continuously improve their professional techniques.

2. Pre-job training

After the crew was ordered to board the ship, the ship company shall conduct pre-job training for the crew according to the company safety management system and the actual situation of the ship. The training content mainly includes the company's safety culture and management system, various rules and regulations, responsibilities, operation process, etcetera.

Section 3 Onboard training

To achieve the goal of "safety, health, and environmental protection", onboard training is an indispensable link. Onboard training is an important means to improve the quality of crew and performance ability and improve the level of ship management. Onboard training mainly includes various regulations such as conventions, regulations, systems, standards and procedures, as well as training on basic knowledge and professional techniques necessary for the crew to perform their duties.

1. Develop onboard training management procedures

Ship company shall develop the ship training management procedures, clear the training of ranks, responsibilities, processes, records and other related requirements (including trainers and trainees), and conduct publicity for system revision. The key is to train and evaluate the company trainers, onboard trainers, and ship Captains whose ship to be trained. The training records should be maintained completely.

2. Appoint the onboard trainer

When organizing and arranging onboard training, the shipping company should fulfil their relevant responsibilities in accordance with the system documents, and appoint departments and company trainers responsible for onboard training to develop the onboard training plan, compile *The Onboard Training Record Book* according to the features of the company. The company shall submit the onboard training plan, the list of trainees and trainers to the maritime administrative authority.

The company should also develop training materials, purchase corresponding facilities and equipment, and design training courses, etcetera.

3. Make a training plan

The trainee should formulate the training plan under the guidance of onboard trainer, and complete the tasks in stages according to the training plan.

4. Fill in *Onboard training Record Book*

The trainee crew shall check whether the training time on board is enough, whether all the training is completed, and whether *Onboard Training Record Book* meet the specified requirements, etcetera, to ensure that all the requirements are in line with the provisions, otherwise it will affect the validity of the training qualifications on board or the completion of the training objectives, and then affect the issue of certificates.

As long as navigating conditions permit, the trainee shall submit *Onboard Training Record Book* to the onboard trainer for inspection every week and to the Captain for inspection every month. After completing the training on each ship, the trainee shall submit *Onboard training Record Book* to the company for inspection.

Section 4 Application of Lessons Learned from Marine Casualties in Crew Training

Learning lessons from marine casualties and applying them to seafarers' education and training is an effective way to improve the quality of seafarers and ensure seafarers can be qualified for the rank.

Based on years of accumulated experience in water traffic safety supervision, China has developed the *Guidance framework for the application of casualty cases and lessons learned to seafarers' education and training*, which helps to improve the level of crew training and education.

The procedure for applying casualties and lessons learned to the education and training of seafarers includes four steps ranging from collection and processing to application to evaluation of casualty cases:

1. Collection

(1) Competent authorities collect and summarize relevant casualty information in a timely manner, including, but not limited to, facts, cause analysis, safety recommendations. The database is established when conditions permit and is open to the public.

(2) Shipping companies promptly collect and prepare in detail data of casualties that occurred and, to the extent possible, restore the whole process of the casualty, focusing on the selection of serious casualties resulting in personnel injuries, death, property damage and environmental pollution due to human element-related causes as cases and lessons learned.

(3) Training institutions collect cases in a timely manner through different channels.

2. Processing

(1) Casualty investigation reports may not be used directly for the education and training of seafarers. It is therefore necessary to establish a model case processing framework for their application, which should take into account the following factors: seafarers' maritime qualifications, educational background, categories of casualty, typicality, changes brought from the advances of novel navigational technologies and devices, and the potential risks posed by the hazards.

(2) A processed casualty case should delete privacy information and comprise at least the following: level, history, cause, lessons learned and beneficiaries, and pictures or videos, as necessary. To enhance the effectiveness of warning, the addition of relevant information on administrative, civil, or criminal responsibilities should be considered.

3. Application

(1) Instructors are encouraged to identify potential risks according to the casualty process, analyse the causal factors such as improper operations and management, and state any preventive measures to be taken for each risk point. They can also describe the common improper practices to the seafarers and strengthen the risk identification effect.

(2) Instructors should conduct goal-oriented case teaching according to the classification of seafarers, which is based on seafarers' maritime qualifications and experience during the training. For students, case teaching should focus on safety and warning education, and training can be used with more pictures, videos and other intuitive means to build cases so that students can better understand them.

(3) Shipping companies are encouraged to inform the ship and seafarers under their management of casualties in a timely manner. Shipping companies can transform casualties and lessons learned into seafarer training through regular training, pre-service training, risk manuals and circulars.

(4) Training institutions should encourage everyone involved, so that seafarers can analyse the causes of casualties in light of their own work experience, and stimulate thinking and discussion in the course of the organization of training. Meanwhile, training should focus on the human element, organizational management, situational awareness, etcetera, in order to develop the ability of seafarers with good seamanship and ascertain the most beneficial mitigation measures based on the circumstances.

(5) Simulators, virtual reality technology, group discussions and other means can be considered at the stage of application to give full play to the subjective initiative of seafarers and deepen their understanding according to the training needs.

4. Evaluation

(1) Periodic assessments should be conducted of the effect of applying cases and lessons learned to seafarers' education and training through statistics, questionnaires, self-evaluation, etcetera, and the training procedures should be adjusted as appropriate.

(2) Competent authorities should conduct statistical analysis of the cases collected in a timely manner, summarize the casualty patterns and predict the trend.

Chapter 10 Contingency Plan

Shipping companies shall identify various potential shipboard emergencies, accidents and incidents which may have adverse impacts on health, safety, quality and the environment, and develop and implement contingency plans which required to be closely followed on board and ashore in order to ensure in appropriate and immediate response to particular shipboard emergencies.

Section 1 Muster List and Emergency Card

According to the emergencies the ship faced, the contingency plans mainly include abandon, fire fighting, man overboard, pollution, flooding, etcetera.

The ship should compile an *Emergency Must List* for various situations, so that each crew member understands his responsibilities when the ship is in crisis, which facilitate regular drills and training for the crew. In the event of marine accidents or distress, the crew can be quickly organized to carry out rescue works to reduce the loss and ensure the safety of personnel.

1. *Muster List*

The Captain should compile the *Emergency Must List* based on the characteristics of the ship and the natural conditions of the navigation area.

1) Numbering

To compile the *Muster List*, all crew should be numbered with clear action instructions, work and tasks to be completed, as well as the equipment and items to be carried.

2) Reasonably assign personnel according to the task

The ranks and tasks of each crew member in emergencies shall be set in the *Muster List* according to particular duties and responsibilities, specialties, working abilities, and whether they have certificates of proficiency. According to circumstances of the ship, multiple people are needed for singular task, or one person can have multiple tasks; the personnel arrangement should be most conducive to the completion of contingency tasks.

The *Muster List* shall indicate the replacement of key personnel after injuries, considering different response circumstances requiring different actions.

3) The assigned personnel shall have clear responsibilities

The assigned personnel should be fully aware of their shared tasks in the *Muster List*, and should specify the location they must arrive and what equipment and articles to be carried. The specific responsibilities should be recorded in the corresponding column of *Muster List* in a concise and clear manner. Once the assigned personnel hear the emergency alarm signal, they should be able to immediately carry their own equipment, tools and articles according to the requirements, quickly reach the designated position, and complete the tasks specified in the *Muster List*.

4) Emergency alarm signals

International conventions or rules have no specific provisions for emergency alarm signals, only in the *SOLAS convention* mentioned the general emergency alarm and public addressed system and *LSA Code* mentioned the general emergency alarm shall be composed of seven or more short sounds followed by one prolonged sound.

Emergency alarm signals as listed in Table 10-1 shall be issued by whistle or alarm, as ordered by the Captain, if possible, by radio broadcast. When the crew hears the alarm signal, they should dress and be in position immediately.

Table 10-1 Common vessel emergency alarm signals

Alarm type	Signal	Duration	Remarks
abandon ship	Seven short and one prolonged sound (.....—)	for one minute	

Fire fighting	urgent short sounds (.....)	for one minute	
leaking stoppage	two long and one short sound (— —·)	for one minute	
oil spilling	one short, two long and one short sound (·— —·)	for one minute	
man overboard	three long sounds (— — —)	for one minute	
all clear	A prolonged sound (—)	for six seconds or oral discharge	

In addition to the emergency signals listed in Table 10-1, in case of other emergencies, the general alarm signal issued by the emergency alarm (seven or more short sounds after a long sound) can be manually broadcast the emergency types by the public address system.

5) Update of the *Muster List*

After the formulation of *Muster List*, if the crew changes or the situation changes, it shall be updated or revised in time.

The *Muster List* shall be formulated before the ship starts, and shall come into force after being signed by the Captain.

6) Post requirements of *Muster List*

For passenger ships, a copy of the *Muster List* shall be posted in the bridge, engine-room, messrooms, corridors and public places frequently reached by passengers.

2. Emergency card

Each crew on board should be equipped emergency card or emergency task card, also known as "bedside card", which mainly includes emergency alarm signals and emergency tasks for the crew. Table 10-2 is an emergency task card of crew; Table 10-3 is an emergency task card of passengers.

Table 10-2 Emergency Card of Crew

Emergency Card		
number:	position:	name:
lifeboat number:	liferaft number:	Fire-fighting muster station:
abandon ship	signal (seven short, one prolonged for one minute)
	tasks	
Fire fighting	signal(rapid short sounds for one minute)
	tasks	
man overboard	signal	— — — (three prolonged sounds for one minute)
	tasks	
rescue in closed place	signal	broadcast notification
	tasks	
all clear: — (a prolonged sound for six seconds)		

Table 10-3 Emergency Card of Passengers

Emergency Card		
lifeboat number:	liferaft number:	muster station:
abandon ship signal — (seven short sounds and one prolonged sound repeated for one minute)	
	precautions:	
fire-fighting signal (quick short sounds for one minute)	

man overboard signal	— — — (three prolonged sounds repeated for one minute) precautions:
rescue signal in enclosed place	broadcast notification precautions:
all clear: — (a prolonged sound lasted for six seconds)	

Section 2 Emergency Response Procedures

Frequently emergencies in domestic ferry mainly include abandon ship, fire/explosion, collision, stranding on rocks/grounding, man overboard, machine damage/failure, damage control, and oil spill, etcetera.

1. Abandon ship

When the ship is seriously damaged after an accident and in serious dangerous situations such as sinking, overturning or explosion, and the rescue is indeed invalid, the Captain shall decide to abandon the ship and order the crew to take emergency actions according to the emergency response procedures to ensure the safety of human life and reduce property losses.

1) Before abandoning the ship

Before abandoning the ship, we should fully estimate and judge the development trend of the accident, as well as the degree of threat to the ship's self-rescue ability and personal safety. The decision to abandon ship can only be made when all efforts to save the ship have failed and the situation directly threatens the safety of human life. If possible, the Captain should consult the company before making a decision to abandon the ship. Various measures should be taken to send distress signals.

2) Abandoning ships

(1) The Captain shall issue an order and a signal to abandon the ship.

(2) After receiving the order, all the crew members and passengers should immediately wear warm clothes and life jackets, bring the equipment and articles, and quickly arrive at the muster station.

(3) All the personnel must obey the command, be in place according to the *Emergency Muster List*, launch and board all the lifeboats and rafts orderly.

(4) The Captain shall confirm that all crew and passengers have boarded the lifeboats and liferafts (the Captain leaves the ship last), and order to depart the ship.

(5) Before the lifeboats and liferafts leave the ship, the Captain and the coxswains should check whether the equipment and items have been carried again, especially the logs, national flag, cash, two-way walkie-talkie, etcetera.

3) After abandoning the ship

(1) If conditions permit, keep the lifeboats and liferafts lie to windward as far as possible within a safe distance of the mothership, so that other ships and aircraft can search for easily.

(2) The lifeboats and liferafts should keep contact each other, and follow the command of the command lifeboat.

(3) It is important to be certain that they may be detected by other ships before using rockets, red flares or smoke signals. Using daylight mirrors to ask the ship or aircraft in the vicinity for help is preferable.

(4) Check and adjust the use of equipment and drugs, and control the consumption of fresh water and food. Do not drink seawater.

(5) When the rescue ship comes to rescue, all crew and passengers embark the ship in order.

2. Fire/explosion

1) Action to be taken by the discoverer

The following (but not limited to) measures shall be taken when fire is found:

(1) If the fire is small, shout loudly and get a nearby portable fire extinguisher to put out the fire.

(2) If the fire is too large to be put out immediately, you should shout "fire in xx" loudly and activate the nearby alarm signal, so that the duty Officer of the bridge can send an alarm signal to the whole ship in time.

(3) Close the doors and windows nearby, and take isolation measures to prevent the spread of the fire.

2) Fire-extinguishing

(1) When the fire alarm signal is sounded or the oral alarm is received, the Captain shall instruct the deck Officer or Engineer to detect the fire, and send an alarm signal to the whole ship after confirmation.

(2) After getting the alarm signal, all crew shall immediately reach the respective muster station with tools according to *Emergency Muster List*.

(3) The notification should be broadcast by the public address system immediately. If there are foreign passengers on board, English shall be available.

(4) Maintain the order of the passengers and guide the passengers to evacuate from the fire scene.

(5) The Captain orders the commander on-site to send fire detector to quickly identify the fire source and fire situation. If any crew or passenger are trapped, search and rescue should be carried out actively.

(6) If a fire occurs when navigating and the ship still is under control, the Captain shall manoeuvre the ship to make a lee for the fire part to avoid the spread of the fire; if the fire occurs when the ship is berthing in a port, call 119 to strive for the rescue of the port public fire-fighting department.

(7) If the self-rescue is invalid, the Captain shall have the right to apply for rescue from the third-party, including requesting rescue from the nearest search and rescue centre.

(8) When the rescue is indeed invalid, the Captain has the right to abandon the ship. When abandoning ship, all means should be used to send out a distress signal, and the life safety of passengers must be kept.

(9) The injured persons should be treated and cured. Comfort and transfer passengers if necessary.

3. Ship collision

Ship collision will lead to the damage of the ship structure, and may lead to flooding, leakage, pollution, fire, explosion, sinking and casualties, etcetera.

In the event of a collision, the following measures shall be taken:

(1) Raise an alarm and muster all crew members and passengers to take emergency actions in accordance with emergency procedures;

(2) Count the number of crew members and passengers, check if there are any injured people, and provide first aid if need;

(3) When one ship is embedded into another ship, she shall provide an increased permeability factor. For the ship to withdraw, this would effectively remove the plug to the impact area and allow a major flooding issue to affect the impacted ship. It may even be prudent for the striking ship to retain a few engine revolutions, to ensure that the ships do not separate of their own accord and too soon.

(4) The Captain shall urge the Chief Officer and Chief Engineer to quickly find out the collision site, damage and flooding, and close the corresponding watertight doors;

(5) Determine the specific emergency plan according to the consequences of the collision such as hull damage, oil pollution, etcetera;

(6) Timely report to the shipping company;

(7) If the hull is seriously damaged due to the collision, and a large amount of water cannot be pumped out in time, the ship may seek out a shoal area to deliberately beach as far as possible to avoid the ship sinking in the deep-sea;

(8) Make a comprehensive assessment according to the situation and possible developments of the situation at that time, to determine the safety of the ship (including stability, strength, etcetera), whether it is necessary to adjust the emergency measures taken; whether to request external assistance; whether to abandon ship, etcetera;

(9) Fix the latest position of the ship at any time, and inform the company of the current situation as far as possible, and follow the further instructions of the company;

(10) The Captains of ships in collision are obliged, by law, to remain on scene and render assistance to each other;

(11) Exchange information such as ship's name, port of registry, details of collision, etcetera;

(12) Record the collision accident occurrence process and emergency action in detail;

(13) Passengers should be comforted and transferred if necessary.

4. Stranding on rock/grounding

Stranding on rock is that the ship enters into unsafe waters due to the negligence of the operator or force majeure, and the bottom plate (hull plate) has hard contact with the material other than aqueous medium, affecting the operability of the ship, accompanied by ship deformation or damage, heeling, flooding, and/or leakage, for example. When the ship runs aground or strand on rock, blind use of propeller and rudder aiming to get off the shallow eagerly is prohibited.

1) Emergency measures to be taken after grounding

(1) Immediately raise alarm signal for plugging, and muster all crewmembers to act according to the emergency procedures;

(2) Immediately exhibit the grounding signal (daytime: three balls in a vertical line; night: display the anchor light and two all-round red lights in a vertical line);

(3) Urge the Chief Officer to quickly identify the stranding parts, the draught on six sides, the feature of seabed surrounding, water depth, hull damage and flooding. The Chief Engineer shall know whether the engine-room is damaged, or flooded, the rudder and propeller and other equipment is damaged;

(4) According to the consequences caused by the accident (such as hull damage, oil pollution, etcetera), make a feasible emergency plan, and report to the ship company;

(5) After evaluating comprehensively, a refloating plan shall be developed according to the specific situation of the damage, combined with the weather, sea conditions, tide and other factors.

2) Measures to be taken if the ship cannot refloat in a short time

If the ship is stranded and cannot refloat in a short time, in order to avoid the deterioration of the hull caused by wind, current and waves which may lead to damage to the hull, measures should be taken to fix the hull as follows:

(1) Drop port and starboard anchors and tighten up;

(2) Pump seawater into ballast tanks to make the ship sit on steadily. However, it should be considered not to damage the hull due to increased pressure load;

(3) Apply for external assistance.

5. Man overboard

The accident is a common accident of the ferry, which refers to the accident of the crew or passenger falling from the ship by accident or other reasons. Rescue operations are similar whether a person falls into the water from the boat or a person is found on the surface of water.

The accident of man overboard occurs on ferries frequently, referring to the accident where crew or passengers fall into the water unexpectedly or due to other reasons. Whether a person falls into the water from their own ship or discovers a person on the water surface, the rescue actions are basically the same.

1) Action of the discoverer

When discovering a person fall into the water, the discoverer should immediately throw a life-ring nearby over the side as close to the person as possible, and shout "man overboard", report to the Officer on watch, and keep the man overboard in sight.

2) Operations of the Officer on watch on bridge

(1) The Officer on watch on bridge raises three prolonged blast and manoeuvre the ship for avoidance the man overboard. The Captain shall come to the bridge to take command;

(2) Post lookouts to keep the person in sight;

(3) Write down the time and location of the person falling into the water;

- (4) Broadcast the information of man overboard by public address system;
- (5) Standby the main engines as quick as possible and manoeuvre the ship back to the position where the person falling into the water according to the current situation;
- (6) Adjust the course and speed according to the position of the person falling into the water;
- (7) Send the message of man overboard to ships in the vicinity and to search and rescue centres through VHF;
- (8) Rig the pilot ladder to assist in recovery;
- (9) Report to the company and the nearest maritime authority.

3) Rescue operations

- (1) Make preparation to launch the lifeboat according to the emergency procedures;
- (2) The crew ready to take part in rescue should wear enough warm clothes and life jackets in cold area;
- (3) Carry warm clothes, life jackets, blankets, etcetera, on the rescue boats for the man overboard;
- (4) When the ship gets close to the man overboard, launch the rescue boats on the lee side for rescue;
- (5) All the personnel of the passenger department shall be responsible for maintaining the order of passengers according to the requirements of emergency procedures and prevent passengers from obstructing the rescue operation due to crowding;
- (6) The personnel of engine department should be on duty in the engine-room, standby engine, and operate according to the requirements of the bridge.

If the rescue is not successful or to be unsuccessful, the Captain should report to the company and the maritime authorities. After that, the Captain shall decide to stop the rescue operation. Pay attention to collect evidence and make detailed records.

6. Ship machine breakdown/malfunction

In case of failure/damage of the main engine, steering gear and power station of the ship, if the people on watch in engine-room find it, they shall immediately report it to the bridge and the Chief Engineer; If it is discovered by personnel on the bridge, they should immediately report it to the Captain. The emergency response should be conducted according to the emergency response procedures immediately.

- (1) The ship shall exhibit lights or shapes of vessel not under command according to the regulations;
- (2) The personnel of the engine department should immediately get to the engine-room and, under the leadership of the Chief Engineer, quickly carry out repair, and restore the main engine and power;
- (3) If the ship is navigating along the coastal islands or in narrow channels, the Captain shall try to drop anchor to avoid stranding due to not under command;
- (4) The ship shall be maneuverer as per the procedures of not under command when it is in heavy seas;
- (5) If the machinery cannot be recovered by ship's hands, the Captain shall report it to the company, and ask the maritime search and rescue centre or relevant authorities for rescue;
- (6) Passengers should be comforted and transferred if necessary.

7. Damage control

If the ship is flooding due to collision or stranding, emergency measures can be taken according to the emergency procedures of ship collision or stranding.

(1) Upon discovering flooding, crew members should immediately report to the Captain. Upon receiving the report, the Captain should immediately raise a flooding control alarm, and organize all crew members to check flooding parts, amount of flooding, and cause of flooding, and extent of damage to the ship, and issue instructions to all crew members and passengers by the public address system;

(2) While organizing the crew to control flooding, the Captain shall report the flooding situation, the measures are taking, the dangers faced by the ship and other situations to the nearby maritime authority and the company;

(3) After ascertaining the situation, the Captain shall immediately instruct all the crew members to take measures according to the emergency procedures. The personnel in engine-room shall pump out the water and control the flooding. The Chief Officer and Chief Engineer order the relevant personnel to sound the ballast tanks, fresh water tanks and fuel oil tanks, and constantly monitor the flooding situation;

(4) If the engine-room is flooded, the Chief Engineer is the on-site commander who should organize all the engine-room personnel to control flooding, so as to prevent the main engine, auxiliary engine and steering gear from being soaked by seawater and losing power;

(5) If other parts outside of engine-room are flooded, the Chief Officer is the on-site commander who should check if there are any dangerous goods that may explode in the water tank, and if so, try to move them away as much as possible;

(6) If there are little effect of flooding control, or the water amount of flooding is greater than the amount of pumping out, or the ship is sinking which endangers the safety of the ship and personnel, the Captain should choose the appropriate sea area to beach;

(7) During navigating, it becomes impossible to control the sinking of the ship even if making every effort to drain by pumps, the Captain shall request assistance by shore or the third party;

(8) The Second Officer shall keep the communication between the ship and the company;

(9) Passengers should be comforted and transferred if necessary.

8. Oil spill

The occurrence of fuel oil leakage on a ferry may be due to reasons such as ruptured fuel pipes during bunkering, overflowing of fuel tanks, and improper operation during fuel transfer on board. Once oil leakage is discovered, measures should be taken according to emergency procedures to prevent oil pollution accidents.

(1) General emergency alarm must be sounded and the Master immediately notified of the occurrence. All crewmembers shall be mustered and take actions as per the ship's muster list and the Master's instruction.

(2) Notify terminal or bunker barge to stop bunkering. Any other shipboard operations must be terminated including ballasting/de-ballasting, or bunkering and similar.

(3) To find the leakage parts or the tank overflowed.

(4) If the oil spill is caused by the tank overflowing, some part of the fuel of the spilled fuel tank should be transferred to the empty tank to reduce the liquid level in that tank.

(5) Immediately readiness of fire-fighting equipment such as fire main and foam system must be confirmed.

(6) The emergency team shall proceed to the location of the release and attempt to control and clean-up the spilled oil by using all available onboard spill clean-up equipment, materials and tools.

(7) Notify management company/owner/authorities and concerned party.

(8) If any bunker spillage into water, report to the port authority and cooperate with the shore oil spillage removing team to remove the oil spilled.

(9) Passengers should be comforted and transferred if necessary

(10) After the cleaning operation is completed, a thorough investigation should be conducted, and a written report should be submitted to the management company as soon as possible. The Master should state in this report the lessons that be learned to prevent similar accidents from recurrence.

Chapter 11 Crew Health

Section 1 Medical Examination of Crewmember

Crew medical examination is an important procedure for conducting a comprehensive examination and evaluation of the physical condition of crewmembers at sea. The medical examination requirements for crewmembers are strict, aiming to ensure that crew members have good physical fitness and health status during navigation work, to ensure the safety of ships and personnel.

1. Regular medical examination of crewmembers

Both the *STCW Convention* and the *2006 Maritime Labour Convention* (hereinafter referred to as the *MLC 2006*) provide detailed provisions for regular medical examination of crewmembers. Countries can refer to the international conventions and formulate rules related to crew health based on their own national conditions.

Crewmembers shall undergo medical examination before boarding a ship in accordance with the rules and regulations. Crewmembers shall hold prescribed medical examination certificates or documents to prove their fitness for work on board. The items of medical examination for crewmembers generally include ultrasound, electrocardiogram, fluoroscopy, eyesight, liver function, blood pressure, urine test, and more, mainly to check whether they are fit to work on board and whether they have contagious diseases.

2. Medical Certificate for crewmembers

Taking China as an example, the *Measures for the Administration of Medical Certificates for Seafarers of the People's Republic of China* and *Measures for the Administration of Medical Certificates for River Waterway Crewmembers of the People's Republic of China* have been formulated regarding the issuance and management of medical certificates for crewmembers. It is required that crewmembers should hold valid medical certificates when applying for crew registration, crew certificates, and services on board ships. The following is the relevant content of the *Medical Certificate of Seafarers of the People's Republic of China*.

1) Main content

- (1) Full name of the holder, gender, date of birth, nationality, department on board, signature and photo of the holder;
- (2) Certificate No.;
- (3) Applicable provisions of international conventions;
- (4) Declaration of the recognized practitioner;
- (5) Date of issue of certificate and date of expiry;
- (6) Authorizing authority;
- (7) Name of issuing authority and signature of recognized medical practitioner;
- (8) Other information that need to be specified in the regulations

2) Validity period

The validity period of the medical certificate shall not exceed 2 years. If the seafarer applying for the health certificate is under the age of 18, the validity period of the medical certificate shall not exceed 1 year.

3) Medical examination authority

Seafarers should apply for a medical certificate from a medical examination authority recognized by the authorizing authority.

4) Application conditions

Applicants for a medical certificate should meet the following conditions:

- (1) At least 16 years old but not exceeding 65 years old;
- (2) Holding valid identity documents;
- (3) Standards that meet the medical examination requirements of seafarers.

Section 2 Alcohol and Drug Control

Drug and alcohol abuse not only seriously harm the user's health, make people lose or weaken the response ability and judgement ability, but also will enable the people to lose their ability of response and movement, especially in an emergency, leading to work error, which may threaten the safety of ship, and may even cause serious marine disaster.

National laws and regulations have developed strict regulations on the control of alcohol and drugs among crew members, and shipping companies should establish relevant requirements for the issue of alcohol and drugs among crew members in the safety management system in accordance with national regulations.

1. Alcohol control

(1) Insobriety of crew is prohibited. The crew shall not drink alcohol within the four hours before duty and the blood alcohol concentration (BAC) should not be higher than 0.05% or the respiratory alcohol concentration should not be higher than 0.25 mg/L on duty;

(2) Anyone on duty or operating equipment on board drinks alcohol before duty shall immediately be reported to the Captain or department head to change work to ensure the safety of the ship;

(3) Any crew member who has experienced alcohol abuse must be transferred from position immediately;

(4) The crew shall give cooperation when required to take alcohol tests. If any person has any abuse of alcohol, the Captain and/or relevant witnesses shall report to the crew deployment supervisor.

2. Drug control

(1) Any crew member who has experienced drug abuse must be transferred from position immediately;

(2) The crew shall give cooperation when required to take drug tests. If any person has any abuse of drugs, the Captain and/or relevant witnesses shall report to the crew deployment supervisor;

(3) No one on board is allowed to buy, carry, use and transmit drugs;

(4) The crew shall not take drugs whether on ship or on land;

(5) A small number of narcotic drugs shall be used under the control of the Captain for the purpose of first aid.

Section 3 Work and Rest

Crew fatigue has become a common problem and has attracted more and more attention by the shipping industry. Human error due to fatigue is considered to be one of the main causes of most marine accidents.

The *MLC 2006* and *STCW 1978*, made specific provisions on the crew's work and rest time on the ship, so as to ensure that the crew has enough rest time, and to prevent the crew from losing concentration due to fatigue, which may cause accidents.

China's laws, regulations and rules also make specific provisions on the working hours of seafarers on ships.

1. Limitation of working hours

The shipping company and the Captain are required to take effective measures to prevent the fatigue of the crew members. Except for emergency or abnormal work, the rest of crew on duty responsible for safety, pollution prevention and security duties shall meet the following requirements:

(1) Minimum hours of rest not be less than 10 hours in any 24-hour period;

(2) Minimum hours of rest shall not be less than 77 hours in any 7-day period;

(3) Hours of rest may be divided into no more than two periods, one of which shall be at least six hours in length, and the interval between consecutive periods of rest shall not exceed 14 hours.

An exception may be made when the Captain arranges rest periods based on sub-paragraph (2) and (3), but the minimum hours of rest in any seven-day period shall not be less than 70 hours.

The exception in sub-paragraph (2) shall not exceed consecutive fortnight. The interval between consecutive periods of exception shall be not less than the twice duration time of the exception.

The exception in sub-paragraph (3) of hours of rest may be divided into no more than three periods, one of which shall be at least six hours, and the other two periods shall be at least one hour. The interval between consecutive periods of rest shall not exceed 14 hours. An exception shall be no more than two 24-hour periods in any seven days.

2. Special circumstances

(1) Where there are need of musters, fire-fighting and lifeboat drills, and drills prescribed by national laws and regulations and by international instruments, the Master may suspend the schedule of hours of work or hours of rest without the limit of "maximum hours of work shall not exceed 14 hours in any 24-hour period". However, such musters, drills should be as far as practicable conducted in a manner so as to minimize the disturbance of rest periods and not to induce fatigue.

If the crew is on standby and breaks the normal rest time due to being sent to work, compensatory rest shall be given.

(2) The Master may suspend the schedule of hours of work or hours of rest and require a seafarer to perform any hours of work necessary for the immediate safety of the ship, persons on board, cargo or environment, or for the purpose of giving assistance to other ships or persons in distress at sea, until the normal situation has been restored. As soon as the normal situation has been restored.

(3) As soon as the normal situation has been restored, the Master will arrange compensatory rest period for the seafarers concerned and make entries in the record of hours of rest.

(4) The Master will arrange compensatory rest period for the seafarers concerned and make entries in the record of hours of rest.

3. Post up the *Shipboard Working Arrangements*

The table of *Shipboard Working Arrangements* shall be posted in a conspicuous place on board.

4. Record

The ship shall establish the record of hours of work or rest of the crew every day. The records shall be endorsed by the Master, or a person authorized by the Master and by the crew. Crew shall receive a copy of the records every month.

5. Female crew

When arranging a crew on duty, the Captain shall give full consideration to the physiological characteristics of the female crew and the relevant provisions of the State.

Chapter 12 Ship Manoeuvring

Section 1 Vessels Entering and Leaving Port

There is a significant difference between entering or leaving port and navigating at sea, and ships face many risks when she is entering or leaving port. The routes of passenger ships and ferries are fixed, and both the Captain and deck Officer are familiar with the channels of the port. However, it is precisely because of this that they relax their vigilance from a psychology, leading to risks or accident.

1. Navigating while entering and leaving port

When entering or leaving the port, the Captain shall take command at the bridge. In case of complicated circumstances when entering and leaving the port, the Captain shall appoint additional navigating Officers / crew to the bridge as lookouts.

1) Safe speed

When navigating in the port area, the safe speed stipulated by the port shall not be exceeded, and keep the ship in the prescribed channel at all times.

2) Lookout

Every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision. The additional person as lookout on the bow shall be appointed according to the Captain's instruction if necessary.

When navigating at night, the small boats that are not lit, and some boats that do not obey the rules shall be paid attention to.

3) Communication and contact

When entering and leaving the port, the designated channel of Very High Frequency (VHF) shall be kept on listening watch and keep contact with the port control, VTS and other relevant parties. The Officer on watch shall also contact with the relevant ships to avoid collision.

4) Reasonable avoidance

When the situation of the coming channel is complex, navigating with caution to avoid unreasonable overtaking is the navigator's responsibility. Overtaking in curved and complex waters should be avoided. The control of the ship position should fully consider the influence of the wind and current. The measures to avoid collision should be timely, clear and kept in sufficient room.

2. Manoeuvring of berthing and unberthing

1) Berthing

The passenger ferry should slow down and pay attention to the influence of air flow, especially the adverse factors such as strong offshore wind, onshore wind and current, if necessary, apply for tug assistance for berthing; getting on and off the ship is prohibited during berthing manoeuvring; get off the ship by the order of people firstly and vehicle secondly after safely berthing.

When a passenger ferry is berthing, it is necessary to slow down and pay attention to the influence of wind and current, especially unfavourable factors such as strong winds and torrents, or combined forces of wind and current. If necessary, tugboats should be applied to assist the operation of berthing. Personnel are prohibited from embarking and disembarking during berthing operations. After berthing, the order of disembarking is that passengers are more preferential than the vehicles.

2) Unberthing

When a passenger ferry is unberthing, the navigators also shall take the influence of wind and current into consideration, especially the onshore wind and current. If necessary, tugboats should be applied to assist the operation of unberthing. Personnel are prohibited from embarking and disembarking during unberthing operations. Before sailing, the order of embarking is that the vehicles are more preferential than the passengers.

Section 2 Anchoring Operation

Anchoring refers to the mooring method to tie the ship at a certain point of the anchorage, which is suitable for temporary mooring, such as waiting for quarantine, berthing, tidal window, lightering or sheltering from heavy weather, for example.

1. Anchoring methods

According to the number of anchors used, the anchor methods can be divided into riding to a single anchor and riding to two anchors. According to the angle of the intersection of the two chain cables, riding to two anchors is divided into three ways: open mooring by two anchors, mooring to two anchors and riding one point by two anchors.

1) Riding to a single anchor

Riding to a single anchor refers to that a ship uses a single anchor to ride in the anchorage, as shown in Figure 12-1 (a). The advantages of riding to a single anchor include simple operation, dropping and heaving up anchor conveniently, which is fit for large and medium. Its disadvantages are that the anchoring power is slightly insufficient under the strong wind and torrent, and the yawing is serious, which leads to dragging easily.

2) Open mooring

The anchoring method in which the ship pays out the two anchors and the chain cable maintains a certain horizontal angle is called open mooring, as shown in Figure 12-1 (b). The open mooring has large anchoring power and small swing areas. The yawing can be inhibited under strong wind and torrent if the ship dropped by this anchoring method. Its disadvantages are that the operation is more complex, and the two chain cables are easily twisted.

3) Flying moor (or ordinary moor)

The anchoring method with two anchors paid out one after another, and the horizontal angle of the chain cable maintained at about 180° is called flying moor or ordinary moor, as shown in Figure 12-1 (c). The anchoring method can limit the movement range of the ship, so it is often used for temporary anchoring in narrow channels or river with alternating current. The operation is more complicated, and the two chain cables are easy to be twisted, and the anchoring power is insufficient under the strong wind and torrent, so it is generally only applicable to small ships.

4) Riding to both anchors

The anchoring method with two anchors paid out at the same time is called riding to both anchors, as shown in Figure 12-1 (d). The length of the double chains is equal and the two chains remain parallel. This anchoring method can provide twice anchoring power of single anchoring, so it is often used to resist the strong wind. Especially for passenger ships which have a large wind area. The operation of dropping anchor of this method is almost same as riding to a single anchor, but it has the common disadvantages of all riding to two anchors, that is, the two-chain cable are easy to be twisted. Ferries often use the dropping method to resist the typhoon, because it can avoid dragging as much as possible.

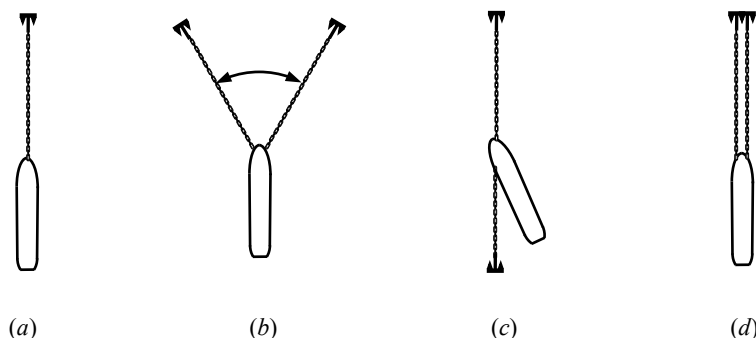


Figure 12-1 Common anchoring methods

2. Operation of dropping anchor

Traditionally, there are two methods for dropping a single anchor with a slow speed ahead and astern. Dropping anchor with speed ahead is only applicable to small ships, and dropping anchor with speed astern is more popular for cargo ships, especially for large ships.

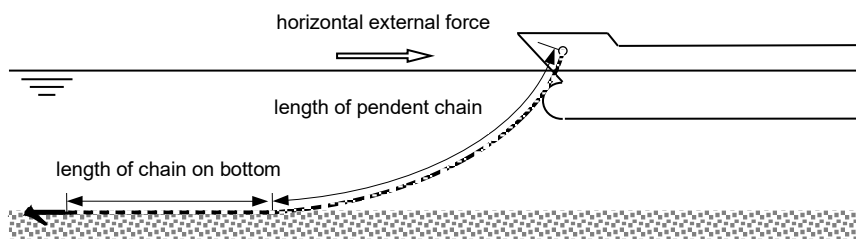
When the ferry in ballast or with light load encounters strong winds and the gentle current, it is advisable to drop anchor against the wind by bow; when the ferry with heavy load encounters torrents and not too strong wind, it is advisable to drop anchor against the current by bow. The best time to drop anchor is when the ship has a little speed astern over ground after stopping, and the speed astern should not be too high during anchoring.

The key to anchoring is to control the ship's speed over ground. When the wind and current are strong, it is necessary to use main engine to counteract the external force on the ship. Under no circumstances should the windlass be operated at a speed exceeding the manufacturer's recommended speed.

3. Length of chain to be paid out

Regardless of the anchoring method, enough shackles of anchor chain shall be paid out to ensure that the anchoring ship has sufficient mooring force. Mooring force refers to the restraining force that a ship is subjected to when she is anchoring, also known as anchoring force. The anchoring force consists of two parts: the gripping force of the anchor and the gripping force of the anchor chains.

Under the influence of gravity and horizontal tension, the length of the anchor chain is divided into two parts, as shown in Figure 12-2. The part pendent in the water is called the pendent chain, and the part lying on the seabed is called chain on bottom. The pendent chain keeps the tension at the anchor rod in a horizontal direction, ensuring the maximum grip of the anchor. The friction between the chain on bottom and the seabed is called the chain's grip,



which increases the anchoring force. When external forces increase, a portion of the length of the chain on bottom will be converted into the pendent chain, which can absorb a portion of the external force energy acting on the ship.

Figure 12-2 Status of anchor chains

Section 3 Ship Manoeuvring in Narrow Channel

The harbours, straits, rivers, rocky waters, may all be called narrow channel. Navigating in narrow channel should be taken precautions.

1. Preparation before entering the narrow channel

Before entering the narrow channel, the key equipment should be checked to ensure that the main engine and manoeuvring equipment are in good working condition and the emergency equipment is available at any time.

The shallow water channel, especially the river estuary channel, due to sediment deposition, we should consult the latest information before passing to grasp the latest changes of the channel.

2. Use the appropriate speed

When conditions permit, it is best to drive fast in front of the shoal, and to slow the car or stop in the shoal, so that the boat flows through the shoal. If the shoal is long, you should drive a slow sailing, or drive fast in the deep water and carry way with engine stopped in the shallow

water, to reduce the hull sinking and draft difference changes, to ensure sufficient excess water depth.

Driving at high-speed close to the shore, the ship wave will trigger the intense swing movement of the coastal mooring ship, sometimes leading to damage to the mooring ship or the cable break, so it must be slowed down in a narrow waterway with such concerns.

3. Avoid encountering and chasing over in shallow water whenever possible

The rudder efficiency in the shallow water area is poor, the operation is difficult, and when two ships are close to each other, there will be suction phenomenon. If it wants to pass through the shoal at the same time, you can contact through VHF in advance and coordinate with each other, so that one of the ships will pass first, and the other ship can wait slowly on the outer channel of the shoal. In case two ships collide in shallow water, they should drive on the right, using deceleration and speed change to drive through the water areas. Avoid chasing over in shallow water as much as possible. As near the starboard channel as possible if safe and feasible.

4. Predict leeway and drift angle

In the narrow waterway, the law of the change of wind and water flow should be grasped, and leeway and drift angle should be correctly predicted to ensure the safety of navigation. When passing the waterway with strong tidal flow, it should be selected in the advection with a good sight and less traffic volume, so as not to fall into a passive situation.

Master the leeway and drift and transfer with the buoy, so as not to crash the buoy and the blade by the influence of the leeway and drift.

5. Take advantage of the navigation aids

Master the narrow waterway navigation sign system, accurately identify and determine its significance, and should memorize its number and distribution, including the distance and the approximate time to each beacon, and the shore shape should also be memorized.

After the big wind and waves, the light buoy may be extinguished or displaced, cannot blindly rely on the buoy, should pay attention to the use of fixed standard or other methods to check the position before the navigation, and use the fixed standard to proofread the ship position, to prevent deviation from the course.

6. The ship must grasp the navigation time according to the draft of the ship and the height of the tide

When sailing in shallow waters, it is estimated that the surplus water depth of the ship is insufficient, it is best to pass when full tide, and if necessary, it should slow down to reduce trim by stem. Should try to avoid chasing other ships in this kind of waters, so as not to produce a serious deviation due to the uneven seabed or tilt, steering should be fully prepared as far as possible in advance. In areas where overtaking is permitted, permission must be sought from the preceding vessel. Its transfer to maintain a certain distance, to prevent the ship suction phenomenon.

Section 4 Ship Manoeuvring in Bad Conditions

The ship may encounter severe weather such as heavy sea, poor visibility and ice areas. The Captain and Officer on watch should take appropriate measures to deal with these bad weather and conditions and ensure the safety of personnel and the ship.

1. Ship manoeuvring in rough sea

1) Ship manoeuvring method in rough sea

An effective way to reduce the rolling, pitching and heaving is to change the speed and (or) course. When a ship navigates in rough sea, appropriate manoeuvring methods should be selected according to the ship type, stability, draft, loading condition, sea area and route, etcetera.

(1) "Z" navigation method

When a ship navigates against the sea, the relative speed of the sea and the ship is larger, and the impact on the hull by the sea is huge, resulting in shipping sea on the deck, the bottom

slamming and propeller idling, etcetera. So, a ship navigates against the sea, it is necessary to reduce speed and change course to relieve the swing.

The "Z" navigation method in heavy sea can be adopted, that is, navigating with the angle of 10~30° between the direction of sea and the ship's heading for a distance, and then changing course to make the sea on another side of 10~30°, as shown in Figure 12-3.

The ship navigating in heavy sea by the "Z" navigation method can not only ensure a certain speed, but also reduce the swing amplitude, which is suitable for medium and large ships with good sea-kindliness.

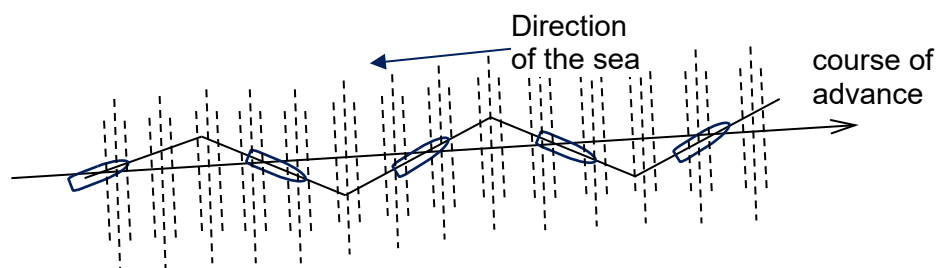


Figure 12-3 "Z" Navigation method

(2) Heaving to

If the ship cannot withstand the impact of the sea when navigating against the heavy sea, the "heaving to" method can be adopted, which is to maintain the minimum speed and make the sea at an angle of 20~30° on the port or starboard bow. At this time, the ship is actually in a state of slow ahead or stopping, or even a slight astern. It is necessary to change the course constantly as the wind direction changes.

(3) Navigating with the sea

Ships that cannot withstand the impact of heavy sea during heaving to can use the method of navigating with the sea, which is to move forward with the stern of the ship under the seas. When navigating with the sea, the relative speed between the seas and the ship is small, which can greatly reduce the impact of the seas on the ship's hull. Navigating with the sea can maintain a considerable speed, which is conducive to getting rid of the heavy sea, or the centre of the typhoon.

(4) Lying to

The main engine of the ship stops drifting with the sea, which is called lie to. Strictly speaking, lying to is not a method of manoeuvring, it is a passive drifting state of the ship. In heavy sea, as long as the main engine and steering gear are in good order, the ship generally does not take the method of lie to.

When the main engine or steering gear failure in the heavy wind and waves, and passively stop, the key is to take measures to avoid the ship in the lateral wave state, such as the chain cable out of a certain length, make the ship against the sea as far as possible, to wait for rescue.

After the main engine of a ship malfunctions and passively stops in heavy sea, the key is to take measures to avoid the ship being in a beam sea state. The anchor chain can be paid out of a certain length to make the ship against the sea as far as possible, to wait for rescue.

2) Notes on navigating in rough sea for passenger ferries

Large ferry has a large windage area, so the Captain or Officer on watch should manoeuvre the ferry carefully in rough sea, and cooperate closely with the Engineers to ensure the safety.

(1) The Officer on watch shall navigate with cautions and keep a sharp lookout, and detect the incoming ship as early as possible. Any action taken to avoid collision shall, if the circumstances of the case admit, be positive, made in ample time and room. It's best not to use large rudder angle to avoid collision;

(2) Running on beam should be avoided when the ferry navigating in rough sea. The

superstructure of the Ro-Ro passenger ship is high, and the centre of gravity of the cargo carried by the vehicle is also high. The ferry will be synchronous rolling by the action of the beam sea, so that the vehicles on board may incline to one side of the deck and turnover which may even cause the ship to capsize;

(3) Long-term rolling of the ship can cause the lashing and securing equipment to become loose and ineffective, resulting in lateral moving of the vehicles. The vehicles should be reinforced to lashing before entering the rough sea;

(4) When it is found that the vehicle's swing range is too large, or the cargo is inclined, the deck Officer should be notified in time, and the deck Officer shall change course or slow down according to the Captain's instruction to facilitate to re-lash;

(5) The number of patrol times should be increased in rough sea. There should be more than two people when entering the car's compartments, and they should keep in touch with each other. The patrol personnel should wear personnel protective equipment;

(6) In rough sea, attention should be paid to sparks generated by friction during vehicles shaking, which may cause a fire;

(7) Passengers are strictly prohibited from walking in the outer corridor during navigating in rough sea.

3) Turn around in heavy sea

Turning a ferry by large rudder angle in heavy sea will aggravate the ship's swing, and there is a huge risk in turning the ferry around. Due to the special requirements of the ferry for safety, it is best not to turn around in heavy sea unless it is absolutely necessary. The following principles should be followed when changing a large course or turning around the ferry in heavy sea:

(1) Waiting for the relative calmer sea. Under normal circumstances, after three or four big waves on the sea, there are usually seven or eight small waves. It's best to make use of this law and to turn around the ferry when the sea is calm relatively;

(2) Use a slow medium rudder angle (about 15°) at the beginning, and turn around decisively by the good performance of the rudder and main engine after turned to a certain degree;

(3) For turning around the ferry from the situation against the sea to navigate with the sea, the turning should start before the calm sea, in order to the turning operation just when the calm sea comes. After that the turning can be completed with hard rudder and speed up;

(4) The turning around is dangerous for a ferry from navigating against the sea to follow the sea. It's best to slow down first to reduce the inertia momentum, and then wait for the good opportunity to turn the second half in the calmer sea. The second half of the cycle should be completed as fast as possible.

2. Navigating in Poor visibility

The condition when the visibility is less than four kilometres called poor visibility or restricted visibility according to the provisions of the international fog level. The reasons for poor visibility include fog, rain, hail, snow, haze, sandstorms, etcetera. Due to the poor visibility, the navigators are unable to find the landmarks and the other ships in the vicinity in time with eyesight. Especially coastal navigation in fog, it seems more difficult and dangerous, because of the limitation of fixing, collision avoidance and ship's manoeuvrability. Even if the radar is equipped on the ship, the navigators shall not rely on the radar only when navigating in fog.

(1) Make full use of radar and GPS for positioning and piloting. Radar is an important navigational equipment when navigating in the fog. Open the two radars and set up different ranges according to the need;

(2) The actual visibility should be known. This can be achieved by seeing an object visually and measuring its distance with radar. But the visible distance in fog varies with the fog concentration;

(3) Proceed at a safe speed and sound the fog signals as per the regulations of collision prevention;

(4) Keep a sharp lookout, which is an important measure to ensure the safety of navigation in fog. Experienced lookouts can detect any small changes around the ship in time;

(5) When there is a risk of collision, if necessary to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or reversing her means of propulsion;

(6) The Officer on watch should make full use of the automatic identification system (AIS) to get the information and movement of the ship in the vicinity, and keep in touch with the give-way or stand-on ships;

(7) Change steering method from auto pilot to hand steering;

(8) When entering the waters of fishing boats, slow down and carefully observe the movement of fishing boats by radars. According to its trend, take the correct measures to navigate and leave away the concentration of fishing boats.

3. Navigation in ice regions

All ice is dangerous, particularly because where there is some in the area of operation of the vessel there is a possibility of more in the proximity.

In China's Bohai Bay, from November to April of the next year, due to the Siberian cold high pressure, the temperature dropped significantly, it is easy to form coastal sea ice which has a certain impact on navigation.

1) Readiness of the vessel prior to entry into ice regions

Navigational publications for ice regions should be consulted and the latest ice report should be analysed to get an appropriate ice classification, notation and to select a favourable ice route.

Take measures to prevent the deck machineries and pipe systems from freezing. The watertight doors and windows shall be closed, and prepare food, fresh water and heating equipment shall be prepared.

The main engine and steering gear should be reliable and well maintained. Operational navigation and communication equipment should be in good order. Operational radars should be capable of peak performance.

Clean bilge well to ensure that the drainage system is in good order. Increase the measurement of the fresh water tanks, ballast tanks, and bilge wells.

Good search lights should be ready forward/afterward and on bridge for detecting ice in night-time.

The ship must be adequately ballasted and trimmed to have the propeller fully immersed in water, and trim should not be excessive.

Personnel should be provided with protective and cold weather gear.

2) Notes on navigation in or near ice

A proper passage plan should be made based upon the most up-to-date reports on ice, selecting open water and leads where the concentration of ice is less and the ice is thinner. Radar should always be on for detecting the open water as soon as possible. If iceberg encountered, ships should keep a suitable distance away from it in leeward.

Where practicable, entry should be planned from leeward as the ice is likely to be less compacted and there would be less wave action. Entry should be attempted at right angles, at reduced speed, at one of the bights.

Maintain a suitable speed according to the ice concentrations, ice thickness and the strength of the hull. Proceeding very slowly for a ship is likely to become beset, whereas proceeding very fast risks damage. Usually at least three to five knots or the speed which is maintain the steerage effect only should be maintained.

When encountering large ice, a slower speed should be used to ensure the safety of engine, rudder and hull. Large rudder angle should be avoided when changing courses.

If an icebreaker leads a ship or ships through the ice, the Master of the icebreaker will order the sequence and distance between the ships, which should be carefully maintained. Usually, the minimum distance is the stopping distance and maximum is dependent upon ice condition to keep the channel open (2-3 times of the ship's length). Keep tight contact with the icebreaker.

keep a distance of 2 to 3 times the length of the icebreaker or the ship in front of it, and maintain communication with the icebreaker.

Anchoring should be avoided in heavy concentrations of ice. If you have to drop anchor in ice, choose the weakest part of the ice, and the length of cable chain shall not exceed twice the local water depth.

Chapter 13 Navigation

Navigating is the most important stage of the completion of the voyage. In order to ensure navigation safety, the Captain and crew must make preparations before sailing, navigate carefully during the voyage, and avoid collision reasonably, and make full preparations before arriving at the port, so as to successfully call at the port.

Section 1 Preparation of Pre-Departure

Before sailing, all departments of the ferry must make all preparations according to the company's safety management system to ensure that the ferry is seaworthy, all crew are in place, and self-inspection has been conducted.

1. Report of ship's entry and departure

Report of ship's entry and departure, including ship voyage, information of personnel, passenger and cargo on board, etcetera, refers to the behaviour of a ship or its operator reporting ship entry and departure information through the internet, fax, text message, telephone, etcetera.

China has formulated relevant laws to implement a port entry and departure reporting system for Chinese seagoing ships engaged on domestic voyages and inland river waterway vessels navigating within the waters under its jurisdiction. This will make it more convenient for ships to enter and leave ports, and improve the efficiency of ship turnover.

The maritime administration conducts on-site verification of ship entry and departure report information to know ship navigation conditions and information of personnel on board through various means such as AIS, VTS, port control and passenger ticketing system, and establishes information-sharing and joint inspection mechanisms with relevant departments. These ships will be listed as key tracking ships and mandatory inspections will be implemented in each port if they do not comply with the relevant regulations in ship entry and departure report.

2. Self-inspection before sailing

Article 42 of *Rules on Ship Safety Supervision of the People's Republic of China* stipulates that Chinese ships should establish a self-inspection system of pre-departure from July 1, 2017. Before departure, the ship shall conduct self-inspection to the safety and technical conditions of the ship and the cargo loaded, and fill in the *Self-Inspection Checklist of Pre-Departure* in the format prescribed by the administration which should be signed by the Captain for confirmation before the departure.

There are some additional items in the checklist for passenger ships and ferries which are listed in Annex 2; additions for Ro-Ro passenger ships are listed in Annex 3.

If a ship's route is fixed and the period of its single voyage does not exceed 2 hours, it is not need to conduct self-examination before sailing each voyage, but it shall be done at least once per day.

The Ro-Ro passenger ships loaded with dangerous goods shall comply with the provisions of Article 42 of *Regulations on the Safety Management of Dangerous Goods at Ports*: Before loading and unloading dangerous goods, the port operator of the dangerous goods shall conduct safety inspection with the ship in accordance with the relevant provisions, and confirm the safety of operations and availability of emergency measures.

3. Conditions for prohibiting sailing

The ship is prohibited from sailing under any of the following circumstances:

- (1) The predicted wind force exceeds the seaworthiness wind grades of the ship;
- (2) Poor visibility affects the ship's safety of navigation;
- (3) The main power source of the ship is faulty or there are potential accidents;
- (4) When the ship communication and navigation equipment is seriously faulty and cannot guarantee the ship's safety of navigation;
- (5) When the other key equipment of the ship fails and affects the ship's safety of navigation;

(6) The ship fails to be manned in accordance with the *Minimum Safe Manning Certificate* or the personnel fail to be in place as required;

(7) Failure to carry out a comprehensive and careful inspection and verification of cargo stowing and lashing, and failure to sign and complete various documents and port clearance;

(8) Other circumstances in which the company or the administration is not permitted to sail.

4. Prohibited passenger ferry sailing conditions

According to Article 32 of the *Regulations on the Safety Management of Inland Waterway Ferry*, the ferry shall not sail under one of the following circumstances:

(1) The wind force exceeds the wind grades that the ferry can resist; poor visibility; the water level exceeds the waterline of suspended sailing; and other circumstances that may endanger the safety of the ferry;

(2) Overload or improper stowing that may endanger the safety of ferry;

(3) The ferry has defects that may affect the safety of navigation and fails to correct them;

(4) Inflammable, explosive and other dangerous goods mixed with passengers, or vehicles carrying dangerous goods mixed with passenger vehicles are found;

(5) The occurrence of passenger fighting each other, provocations, and other affairs that may endanger the safety of ferry;

(6) The manning of ferry crew members or/and ferry workers does not meet the prescribed requirements.

Section 2 Watchkeeping of Navigation

The ship company shall develop navigation duty rules and standardize navigation duty and handover procedures. The Captain, the commander in chief of the safety navigation of the ship, shall arrange qualified crew to be on duty, and define the responsibilities of the crew. The arrangement of duty shall meet the requirements of ensuring the safety of ships and goods and protecting the marine environment, and ensure that the crew on duty have a full rest to prevent fatigue.

1. Responsibilities of Officer on watch when navigating

While keeping a watch on the bridge the Officer on watch is the representative of the ship's Master and has the total responsibility of safe and smooth navigation of the ship.

(1) The deck Officer on watch in charge of navigation is responsible for navigation safety, keeps duty at the bridge, and shall not leave the bridge, and shall operate and avoid navigation in accordance with the revised *1972 International Maritime Collision Avoidance Rules* and other safe navigation regulations;

(2) The Officer on watch shall continue to be responsible for the safety of the ship, despite the presence of the Captain on the bridge, until informed specifically that the Captain has assumed that responsibility and this is mutually understood;

(3) Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions;

(4) The Officer on watch shall fully understand the ship's manoeuvrability with different draft, and take into account other special characteristics that the ship may have;

(5) The Officer on watch shall fully grasp the operation of all safety and navigation equipment, including the performance and operational limitations of these equipment;

(6) Under special environments such as poor visibility, coastal and traffic density waters, the Officer on watch shall navigate carefully according to the safety management system and the Captain's instructions, and use good seamanship to ensure the safety of navigation;

(7) Before sailing, the radio operator shall ensure that all radio equipment and backup power for distress and safe communication are in good order, prepare all relevant documents, navigation notices and other relevant documents and logs, and correct timely.

2. Bridge watch handover procedure

The handover of bridge watch is very important, especially at night or when the visibility is poor, and many ship collision accidents occur at the time when the handover of bridge watch is doing. The relieving Officer shall go to the bridge in ample time prior to commencement of his assigned watch.

(1) Before taking over the duty, the relieving Officer shall verify the ship's position, confirm the planned route, course and speed and the working condition of all navigational equipment, the weather and current, and take any navigation danger that may be encountered during the duty into account;

(2) If there is no one to take over the duty or the two Officers have different opinions or have doubts about whether the relieving Officer can effectively perform his duties, the Officer on watch shall continue to perform his duties and shall not leave the bridge, and he shall immediately report to the Captain for handling;

(3) When a manoeuvre or other action to avoid any hazard is taking place, the relief of that Officer should be deferred until such action has been completed;

(4) When the relieving Officer is not clear about the matters or has doubts, or his vision is not fully adjusted to the light conditions, he may not take over the duty;

(5) The log book entries should be completed after relieving duty.

3. The time to call the Captain

The deck Officer on watch shall immediately report to the Captain, and the Captain shall reach the bridge as soon as possible after receiving the report, and the Captain shall command the ship if necessary:

(1) If restricted visibility is encountered or suspected;

(2) If the traffic conditions or the movements of other vessels are causing concern;

(3) If difficulty is experienced in maintaining course;

(4) On failure to sight land or navigation mark, or to obtain soundings by the expected time;

(5) If land or navigation mark is sighted or a change of soundings occurs unexpectedly;

(6) On the breakdown of the engines, steering gear or any essential navigational equipment;

(7) Failure of radio equipment;

(8) In heavy weather, or if in any doubt about the possibility of weather damage;

(9) Finding people or ship in distress;

(10) In any other emergency or situation in which he is in any doubt.

In the case of emergency, for the safety of the ship, the deck Officer on duty shall, in addition to reporting to the Captain immediately, take decisive action.

4. Responsibilities of Engineer on watch when navigating

(1) The Engineer on watch is the representative of the Chief Engineer, mainly responsible for the safe and effective operation and maintenance of the machinery and equipment related to the safety of the ship, and responsible for the inspection, operation and testing of all the mechanical equipment according to the requirements;

(2) When the Chief Engineer is in the engine-room, the Engineer on watch shall continue to be fully responsible for the work of the engine-room, unless he is clearly informed that the Chief Engineer has taken the responsibility;

(3) All crew on duty of engine-room shall be familiar with the assigned duties. The working conditions and parameters of all machinery and equipment should be verified and analysed, and kept in the normal range value;

(4) The Engineer on watch should regularly patrol the engine-room and steering gear room, promptly detect faults and damages to all machinery and equipment, and take corresponding measures accordingly;

(5) The Engineer on watch should be able to operate the propulsion systems at any time to meet the needs of changing course and speed. He should immediately reach the engine-room upon receiving an alarm or call for the Unmanned Machinery Space (UMS) operation;

(6) The Engineer on watch shall master the maintenance of the machinery and equipment, their control devices and related safety equipment;

(7) When the main engine is in standby, the Engineer on watch shall ensure that all machinery and equipment are available at any time, and shall have sufficient power reserves to meet the needs of the steering gear and other equipment;

(8) The Engineer on watch shall guide the Engine-Room watch ratings and inform them of the potentially dangerous situation that may cause adverse effects on the equipment or endanger the life and the safety of the ship;

(9) The Engineer on watch shall maintain uninterrupted monitoring of the engine-room. When the Engine-Room watch ratings loses their ability to be on duty, the substitutes shall be arranged immediately;

(10) The Engineer on watch should be aware that losing steering effect or stalling due to mechanical failure can endanger the safety of the ship and life at sea. In the event of fire in the engine-room or imminent action in the engine-room that would cause a reduction of ship speed, instant loss of steering effect, stoppage of the ship's propulsion system or failure of the power, or a similar threat to safety, the bridge shall be notified immediately. If possible, notice shall be given before action is taken so that the bridge has enough time to take all possible measures to avoid accidents at sea.

5. Engine-room watch handover procedure

The relieving Engineer shall go to the engine-room in ample time prior to commencement of his assigned watch. He shall check the records on the engine log, notebook, blackboard and other record books and compare them with own observations. If the handover is satisfying, he can take over the duty. The relieving Engineer should be convinced that his team members are clearly fully capable and effective in performing their duties. If the handing over duty Engineer has reasons to believe that the relieving Engineer is obviously unable to perform duties effectively, he shall not handover and shall report to the Chief Engineer.

The relieving Engineer shall be clear about the following matters (but not limit to):

(1) Standing orders and special instructions of the Chief Engineer on the operation of the machinery, equipment and systems;

(2) All operations and purposes of the machinery, equipment and systems, participants and potential hazards;

(3) The working conditions and level of bilge tanks, ballast tanks, sludge tanks, reserve tanks, fresh water tanks, lubricating oil tanks, etcetera, as well as the special requirements for the use or treatment of the stowed materials;

(4) The level and working condition of fuel tanks, settling tanks, service tanks and other fuel storage equipment;

(5) The operation mode and working status of the main engine and auxiliary engine system (including the electrical distribution system);

(6) The working condition of Monitoring equipment and the manually operated equipment;

(7) The working condition and operation mode of the boiler and other equipment related to the boiler;

(8) Potential threats caused by heavy weather, frozen, polluted waters or shallow water;

(9) Special operation modes and emergency measures to be taken in the case of equipment failure or endangering the safety of the ship;

(10) Assignment of tasks to Engine-Room watch ratings;

(11) The availability of fire-fighting equipment;

(12) Entry of the engine log;

(13) Others that should be briefed by the previous Engineer on watch.

6. The time to call the Chief Engineer

The Engineer on watch shall notify the Chief Engineer immediately in the following circumstances and take measures according to the circumstances:

(1) Standby engine is required by the Officer on watch or Captain when entering or leaving the port or navigating in heavy weather;

(2) When any failure or malfunction of the main engine, auxiliary engine or steering gear occurs which may endanger the safety of the ship;

(3) Immediately upon identification of any operational abnormality which may, as per Engineer on watch, cause damage or breakdown of propulsion machinery, auxiliary machinery and/or monitoring and governing (control) systems and subsequently endanger the safety of the ship;

(4) When the key equipment is being maintained or installed;

(5) In any situation when the Engineer on watch is in doubt as to what actions to take, and needs to get help from the Chief Engineer;

(6) In other cases that the Engineer or electrical Engineer on watch need the Chief Engineer;

(7) In any situation specified in the Chief Engineer's Standing Orders or Night Order Book.

7. Communication system between deck, engine and passenger department

In order to ensure the unimpeded information of the ship, and ensure the safety of personnel and the ship, the ship company shall establish a contact system between the deck, engine and passenger departments.

1) Preparation before sailing

The Captain shall notify the Chief Engineer of the estimated time of departure (ETD in short) 24 hours in advance; If the berthing duration in-port is less than 24 hours, the Chief Engineer shall be informed of the ETD immediately after berthing.

One hour before departure, the Officer on watch shall go to bridge to get the main engine ready, and make preparations according to the *Pre-Voyage Checklist*.

Before test the main engine, the Engineer on watch shall get the approval of the Officer on watch, and keep contact each other, and do it following the instruction of the bridge.

Entry of standby main engine shall be made in *deck log* and *engine log book* respectively.

2) During navigating

The Officer and the Engineer on watch shall use the various speeds of the main engine jointly agreed upon by the Captain and the Chief Engineer. In case of special circumstances, when the Captain issues the order of speed which exceeds the rated speed, the Chief Engineer shall take protective measures to actively cooperate with the implementation and explain the situation to the Captain, and record the Captain's order and execution and the protective measures to *Engine Log*.

If the navigation order cannot be obeyed due to mechanical failure, the Chief Engineer shall repair it imminently and report to the Captain. The agreement of the Captain shall be obtained before stopping the main engine, but in case the situation is emergent, the Chief Engineer may stop immediately and then notify the bridge.

The main engine should be standby when the ship enters or leaves the port, passes through the narrow channel, shoals, dangerous waters, anchorage, areas of poor visibility, intensive areas, the bridge, or other areas. The Officer on watch shall notify the engine-room to get the main engine ready. The Engineer on watch shall report to the Chief Engineer as soon as possible after receiving the notice.

When it is judged that there will be heavy weather, the Captain should inform the Chief Engineer to make preparations in advance.

At noon every day, the bridge and the engine-room shall exchange information, and make relevant records.

3) Before entering the port

Before entering the port, the Chief Engineer shall report the Captain the bunkers remaining on board.

4) After arriving the port

Upon arrival at the port, the Captain shall inform the Chief Engineer of the estimated movement of the ship. If there is any change, the movement shall be corrected in time. If it is necessary to repair the equipment affecting the main engine, the Chief Engineer shall report the repairing items and time to be taken to the Captain in advance and get the approval firstly.

If the ship heels excessively due to the vehicle getting on and off the ship or cargo operations, which affects the normal work of the engine-room, the Chief Engineer shall notify the Chief Mate or the Officer on duty to take effective measures to correct it.

The deck and engine departments shall establish an effective contact system for the adjustment of ship ballast and various operations that may involve marine pollution, including written notices and corresponding records.

Before bunkering, the Chief Engineer shall inform the Chief Officer of the bunkers remaining on board, the oil tanks to be filled and the quantity of bunkers to be filled each oil tank, so as to calculate the stability, draft and to adjust the trim conveniently.

5) Others

Before the passenger and vehicle embarking, the Chief Officer and head of passenger department should coordinate the boarding time, procedure, precautions, etcetera, and ensure the safety of them.

During embarking and disembarking, if there is any situation affecting the safe of passengers, the Chief Officer shall immediately notify the head of passenger department to stop embarking or disembarking.

After the passenger disembarking, the head of passenger department shall notify the Chief Officer or Bosun.

The head of passenger department must be notified in advance if any operation affecting passengers.

8. Navigational duty of passenger ferry crew and workers

The crew and workers of passenger ferry shall comply with the *Regulations on the Safety Management of Inland Waterway Ferry*.

(1) Abide by the ferry management system and regulations of duty, and manoeuvre, control and manage the ferries in accordance with safe operational rules of water traffic.

(2) Master the ferry's condition of seaworthiness, and get the information about the environment of the water area, as well as the necessary information related to current and weather.

(3) Do not manoeuvre the ferry after drinking, and do not keep on duty with fatigue.

(4) Make a report in time and try his best to rescue the person in distress upon discovery or occurrence of an emergency affecting the ferry safety.

Section 3 Avoiding Collision

The main reasons for ship collision accidents include lack of responsibilities and lower manoeuvring ability for navigators, chaotic navigation environment, equipment failures, and adverse weather conditions. Whether it is a sea ferry or an inland waterway ferry, the rules of collision avoidance must be followed during navigation.

1. Principles of ship collision avoidance

(1) Every vessel shall at all times maintain a proper lookout by sight and operate carefully;

(2) Any actions taken during collision avoidance should be clear, effective, and early as possible, and good manoeuvring skills should be utilized;

(3) Regardless of the reason, when the two ships are approaching or in a critical situation, either ship should decisively take all avoidance actions to save the situation.

2. Lookout

When navigating, ships shall at all times maintain a proper lookout. Lookout is the foundation of ship collision avoidance. Lookout refers to the frequent use of sight, hearing, and all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision by the navigators on duty. According to statistics, over 80% of ship collisions are caused by negligence in lookout.

3. Safe speed

Ships shall navigate at a safe speed. The safe speed of a ship should be determined based on main factors such as visibility, traffic density, ship manoeuvrability, wind, waves, current, route conditions, and the prevailing circumstances and conditions. The characteristics, efficiency, and limitations of radar should be paid attention when using radars.

Ships shall navigate at the speed specified by the maritime safety authority in areas of restricted speed and during the flood.

4. The key to avoid ship collisions

The key to avoid ship collisions is that the navigators can make correct judgements. Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist. The correct judgement of the incoming ship and situation is directly related to the measures to be taken and the effectiveness of collision avoidance.

5. Measures to be taken for ship collision avoidance

To avoid collisions between ships, directional or variable speeds can be used, or a combination of directional and variable speeds can be used.

1) Change course

When the channel conditions are good, the visibility is fine, and the intention of both ships is obvious, and there is no interference from other ships, changing course to avoid collision is the most effective way.

2) Change speed

If it is not advisable to change the course or to avoid meeting at places where ships are not easily passed through, to slow down or stop engines is usually used as the main means of collision avoidance. When the intentions of the incoming ship are unclear, it is necessary to slow down, stop engines and stabilize the ship immediately. The navigators shall carefully observe its movements, sound the related signals as per regulations, and take actions after both parties understand their respective intentions.

3) Combination of changing course and speed

In order to achieve rapid, safe, and reliable collision avoidance, changing course and speed can be used at the same time, which can avoid the shortcomings of changing course or speed only.

In an emergency situation, in addition to the above measures, dropping anchor can also be used to avoid or relieve collisions.

When taking actions to avoid collision, the effect of avoidance should be continuously observed. If the danger of collision has not been eliminated, remedial measures should be taken quickly according to the situation at that time, or the steering rudder angle should be increased to quickly keep safe distance between the two ships; or immediately slow down, stop engines, or even reverse to slow down; or take measures such as beaching to eliminate risks.

Section 4 Preparation of Pre-Arrival

"Arrival" and "departure" are the two extremely important stages of ship's navigation, and are also the most complicated during the voyage. The Captain shall inform the Chief Officer and the Chief Engineer of the estimated time of arrival (ETA). If necessary, the Captain shall hold a meeting of the heads of all departments to discuss all precautions for the safe berthing, the safety of passengers and the safe operation of the cargo.

1. Obtain the details of port

Before arriving at the port, the Captain should refer to the *Guide of Port, Sailing Direction, Navigation Warning, Temporary Notice* and other relevant publications.

Understand and strictly abide by Traffic Separation Scheme of the port, the laws of maritime traffic safety and other relevant navigational laws and regulations.

The characteristics of the anchorage shall be understood in detail, such as the navigational aids, the traffic density, current, wind force, water depth and the nature of the seabed in the vicinity of the anchorage.

2. Make the passage route correctly

The relevant nautical charts should be carefully reviewed. It is necessary to have a clear understanding of the correction of chart, dangerous obstructions, water depth of channel, light beacons, tide, current, wind direction and force, etcetera that are closely related to the safety of inbound and outbound navigation. The safety boundary of the navigable waters to the ship

should be marked on the charts. The "No-Go Area" should be highlighted on the coastal chart, the method of radar parallel index as well.

3. Ensure the equipment is in good order

Before arrival at the port, relevant personnel shall be assigned to conduct comprehensive inspection or test on mooring equipment, anchoring gear, cargo handling gear, emergency equipment, communication instrument, steering gear, etcetera, and make records accordingly.

The Officer on watch shall get the main engine/rudder ready in time according to the Captain's instruction, and comprehensively check and test all indicators, metres, ship clocks, navigational equipment and walkie-talkie.

The deck Officer responsible for communication shall timely receive the navigation warning and weather forecast from the port, and report to the Captain.

Timely hoist the national flags, signal flags and shapes, switch the specified lights.

4. Preparation of the engine department

The Chief Engineer is responsible for commanding the engine-room and shall be on duty in the engine-room during the period of standby engine or at the request of the Captain. The engine Officer and the Engine-room watch ratings should check the operation of the machine and equipment according to the working procedures to ensure that they are in good order.

Astern test of main engine shall be conducted before entering the port. Thrusters, if available, shall be tested properly.

5. Department of passenger

The head of the passenger department should get the accurate arrival time, fully understand the working conditions of the personnel of the passenger department, ensure that the personnel are in place, and all preparation have been made for the passengers' disembarkation safely.

(1) All personnel of the department shall perform their own duties, and check whether all accesses are unobstructed, and maintain the order of passengers' disembarking;

(2) The broadcaster shall strictly insist on their posts and broadcast the instructions of the Captain and the head of the passenger department. Other personnel shall remind the passengers when they are disembarking, and guide them to get off the ship in order, and help the aged and the young;

(3) Provide due service for the special passengers in time, and assist them to get off the ship safely;

(4) The personnel of the passenger department of the Ro-Ro passenger ship shall remind the passengers and drivers of using the respective access;

(5) After all passengers have left the ship, the personnel shall inspect the guest rooms and facilities comprehensively, and make a report if any question.

Part III Ferry Cargo Operation

Chapter 14 Stability, Trim, and Strength of Ferries

Section 1 Stability Concept

1. Definition of ship stability

When a vessel is floating upright (at equilibrium) in still water, the gravity and buoyancy acting on the hull are equal in magnitude and reverse in the common perpendicular line, achieving a static equilibrium for the ship. If disturbed by various external forces such as external winds and waves, the ship will deviate from its initial equilibrium position and heel. The centre of buoyancy action of the hull will also move slightly towards the heeled side of the ship, generating a restoring moment to resist the external moment. After the interference of external forces disappears, the ship gradually recovers to its initial equilibrium position under the action of its own restoring moment. Ship stability refers to the ability of a ship to heel under external forces without capsizing, and to automatically return to its original equilibrium position after the external forces disappear. Ship stability reflects the ability of a ship to resist external forces and maintain its initial equilibrium position. The key to the stability of a ship depends on whether it has a restoring moment after heeling.

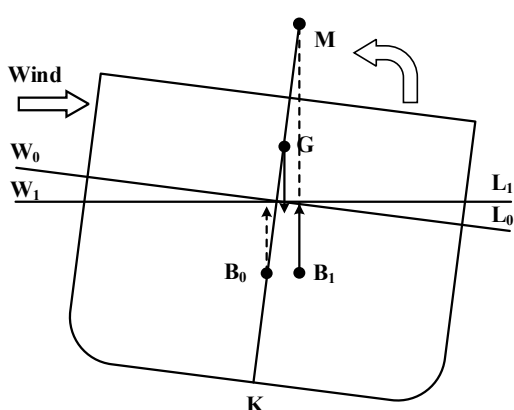


Figure 14-1 The hull tilts under external forces

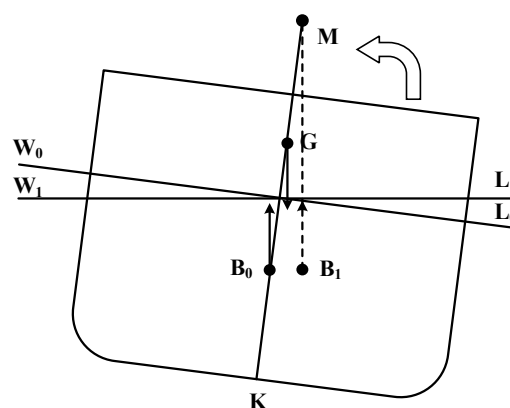


Figure 14-2 The hull returns to initial equilibrium after the external forces disappear

2. Classification of ship stability

1) Classification of ship stability based on the inclination direction

(1) Transverse stability: refers to the stability of a ship's heeling around the X-axis.

(2) Longitudinal stability: refers to the stability of a ship's heeling around the Y-axis.

2) Classification of ship stability based on the inclination angle

(1) Initial stability: refers to the stability of a ship with a small inclination angle, that is, the stability with an inclination angle of less than $10^\circ - 15^\circ$ and less than the immersion angle of the deck sideline.

(2) Stability at large angles of inclination: refers to the stability of a ship with an inclination greater than $10^\circ - 15^\circ$ or greater than the immersion angle of the deck line.

3) Classification of ship stability based on the nature of the force applied

(1) Static stability: The stability of a ship that does not take into account angular velocity and angular inertia during the process of ship's inclination.

(2) Dynamic stability: Stability that takes into account angular velocity and angular inertia during ship heeling.

4) Classification of ship stability based on whether the ship is damaged

(1) Intact stability: refers to the stability of a ship when all the compartments of the ship are intact.

(2) Damaged stability: refers to the stability of ship after it is damaged and flooded.

Generally, the longitudinal stability of ships belongs to the category of small inclination. Meanwhile, due to the fact that the ability of a ship to resist the heeling moment in the longitudinal direction is much greater than the ability to resist the heeling moment in the transverse direction, the calculation of ship stability in practice mostly focuses on transverse stability, while longitudinal stability is neglected.

3. Stability equilibrium of ships

According to the corresponding motion of the ship after the external force interference disappears, the initial equilibrium state of the ship can be divided into three categories.

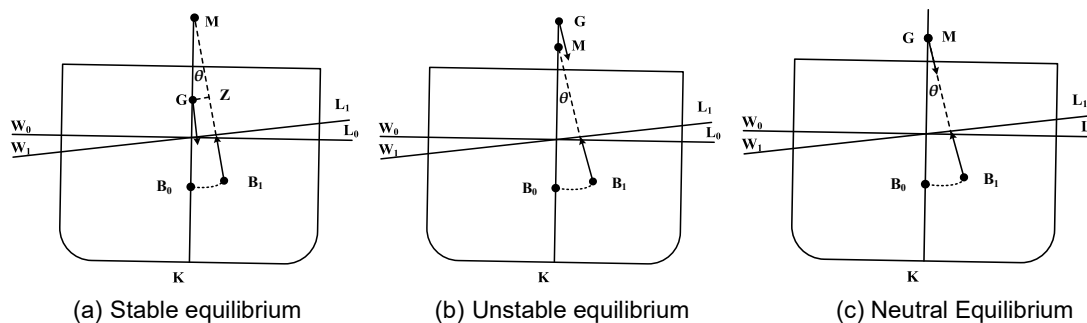


Figure 14-3 Different stability equilibrium

1) Stable equilibrium

As shown in Figure 14-3 (a), when the intersection points M of the buoyancy action lines before and after the ship's slight inclination is located above the centre of gravity G point, the restoring moment formed by the gravity W and the buoyancy Δ , and the moment developed by external forces are in opposite directions, and the ship has the ability to resist external interference. A stable equilibrium is that after the external interference force disappears, the ship can automatically return to its initial upright position. The ship is of stability if the ship can achieve a stable equilibrium.

2) Unstable equilibrium

As shown in Figure 14-3 (b), when the intersection point M of the buoyancy action lines before and after the ship's slight inclination is located below the centre of gravity G point, the restoring moment formed by the gravity W and the buoyancy Δ is in the same direction as the moment developed by external forces. The ship's restoring moment accelerates the ship's inclination, and the ship has no ability to resist external interference. An unstable equilibrium is that after the external interference force disappears, the ship cannot automatically return to its initial equilibrium state.

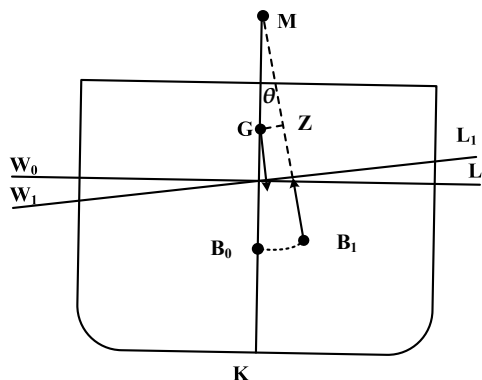


Figure 14-4 Ship Stability Accounting

3) Neutral Equilibrium

As shown in Figure 14-3 (c), the intersection point M of the buoyancy action line before and after the ship's slight inclination coincides with the centre of gravity G , and the ship's restoring moment is zero, so the ship has no ability to resist external interference. A neutral

Equilibrium is that after the external interference force disappears, the ship still maintains the heeling state.

4. Calculation of Static Stability

1) Calculation of initial stability

Before the calculation of initial stability, it is often assumed that the heel angle of the ship is small, the volume slightly decreased on one side is equal to that increased on the other, and the ship's metacentric point M is fixed. As shown in Figure 14-4, the intersection of the ship's centreline plane, midship section and the ship's base plane is referred to as the base point, denoted by K . The intersection of the two buoyant action lines before and after the ship tilts is called the metacentric point, denoted by M . The centre of gravity of the ship is indicated by G . The initial stability equation of a ship can be expressed as:

$$M_s = \Delta GM \sin \theta \quad (14-1)$$

where: M_s — restoring moment, $\text{kN} \cdot \text{m}$;

Δ — ship displacement, t;

GZ — restoring lever, m;

GM — initial stability height, m; and

θ — ship's heel angle, rad.

The initial stability height can be expressed as:

$$GM = KM - KG \quad (14-2)$$

where: KM — height of the ship's transverse metacentric centre above the baseline, m;

KG — Height of the ship's centre of gravity above the baseline, m.

During the initial stability stage of a ship, the size of the GM value is the criterion to measure the initial stability of the ship. The height of the ship's transverse metacentric centre above the baseline can be obtained from the ship's hydrostatic data. According to the requirements of IS CODE 2008, when ascertaining the value of KM in ship's hydrostatic data, linear interpolation is required based on the actual displacement, mean draft, and trim of the ship. If the ship's hydrostatic data only provide data when the trim is equal to zero, linear interpolation can be performed based on the actual displacement and mean draft of the ship.

The height of the centre of gravity of the ship above the baseline can be calculated using the following formula:

$$KG = \frac{\sum P_i Z_i}{\Delta} \quad (14-3)$$

where: GM — initial stability height, m;

KM — height of the ship's transverse metacentric centre from the baseline, m; and

KG — Height of the ship's centre of gravity from the baseline, m.

2) Calculation of the stability at large angles of inclination

$$M_s = \Delta GZ \quad (14-4)$$

When the inclination angle of a ship is large, the heeling-axis of the ship no longer passes through the geometrical centre of the water plane during positive buoyancy, and the metacentric point M is no longer considered as a point fixed on the centreline plane. The movement path of metacentric point M is actually a curve that passes through the initial metacentric centre. Therefore, in the large inclination stability stage, the stability is no longer measured by GM values, but by the restoring lever GZ or the static stability moment M_s . Normally, three methods can be used for the calculation of the stability at large angles of inclination, namely, the base point method, the assumed gravity centre method, and the assumed metacentric method.

(1) Base point method

The base point K is selected as the reference point for measuring the restoring lever, as shown in Figure 14-5(a). A line perpendicular to the buoyancy line is made from the point K and intersects the buoyancy line at point N . Then:

$$GZ = KN - KH = KN - KG \sin \theta \quad (14-5)$$

where KN — base point method shape restoring lever, which can be obtained through the ship's hydrostatic parameter table, m; and
 KH — weight restoring lever of base point method, m;

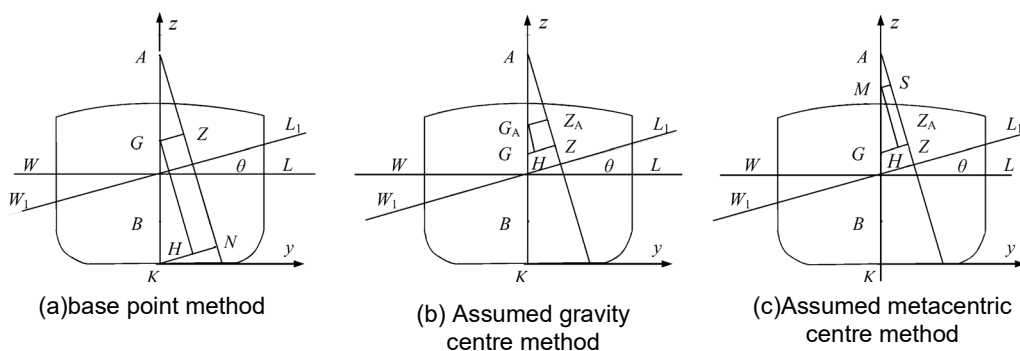


Figure 14-5 Restoring lever calculation method

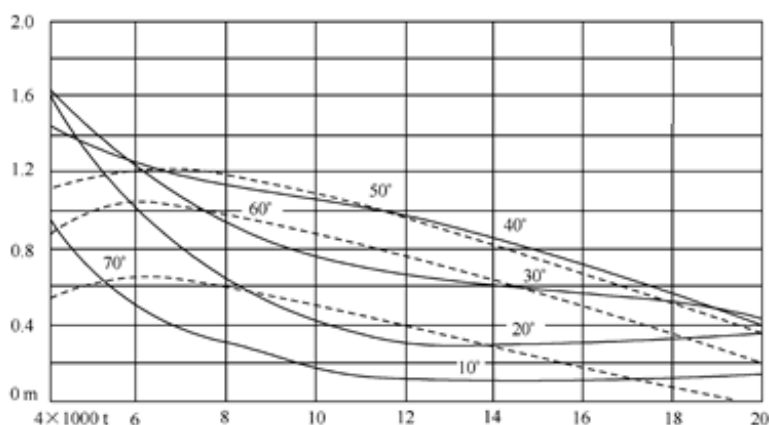


Figure 14-6 Cross Curve ($KGA=8m$)

(2) Assumed centre-of-gravity method

A centre of gravity G_A is assumed as the reference point for measuring the righting lever, as shown in Figure 14-5(b). Through the point G_A , a line perpendicular to the buoyancy force line is made, with the crossing point Z_A . Then:

$$GZ = G_A Z_A + GG_A \sin \theta \quad (14-6)$$

Where $G_A Z_A$ — Assumed centre of gravity method lever of form stability, which can be obtained from the assumed centre of gravity method stability cross cutting curve through the ship's displacement (or draft) (as shown in Figure 14-6), m;

GG_A — distance between the assumed centre of gravity and the actual centre of gravity, $GG_A = KG_A - KG$, m; and

$GG_A \sin \theta$ - Assume the weight restoring arm of the centre of gravity method, m.

(3) Assumed metacentric centre method

A metacentric centre M is assumed as the reference point for measuring the righting lever, as shown in Figure 14-5(c). Through the point M , a line perpendicular to the buoyancy force line is made, with the crossing point S . Then:

$$GZ = MS + GM \sin \theta \quad (14-7)$$

Where MS — the stability arm of the assumed metacentric method shape, which can be obtained from the assumed metacentric method stability cross cutting curve through the ship's displacement (or draft) (as shown in Figure 14-7), m; and
 $GM \sin \theta$ — Assumed the weight restoring arm of the metacentric method, m.

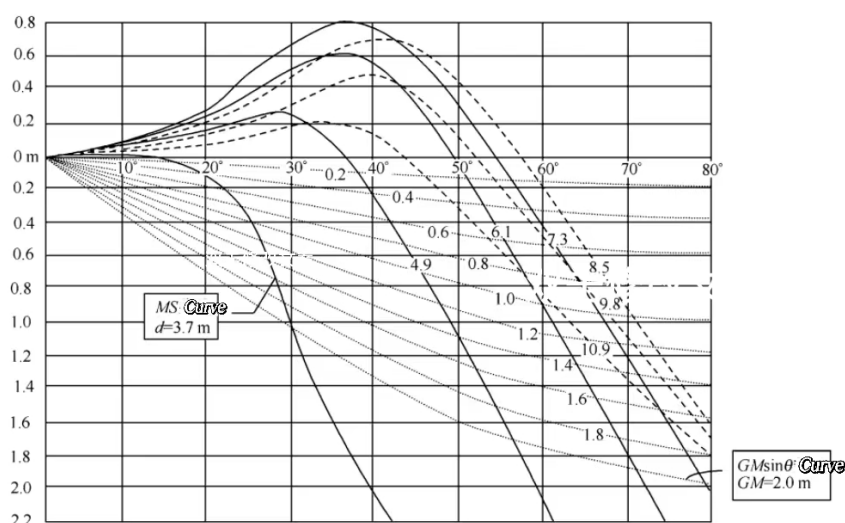


Figure 14-7 Presumptive Metacentric Method Stability Cross Cutting Curve

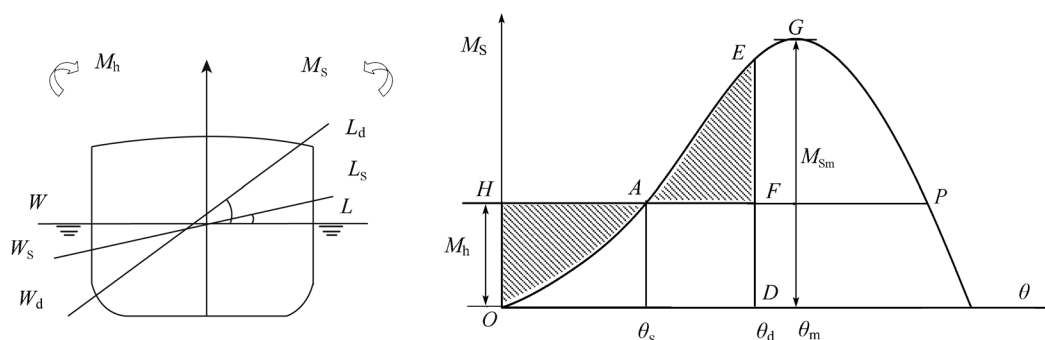


Figure 14-8 Static and Dynamic Inclination of Ships

5. Calculation of dynamic stability

1) Dynamic balance

In theory, under the action of a certain external force (or external moment), the ship will rest at the static inclination angle corresponding to the intersection point A of the external force (or external torque) and the restoring lever (or moment) curve θ_s . But in fact, the inclination of a ship has angular velocity and acceleration. When the ship inclines to θ_s , the external moment and the restoring moment reach a balance and the angular acceleration becomes zero, but the angular velocity is at its maximum value. Subsequently, the ship continues to heel to starboard side at such an angular velocity. As the restoring moment is now greater than the external one, the angular acceleration becomes reversed, and the angular velocity begins to decrease until the heeling reaches the inclination angle at θ_d of point E. The angular velocity becomes zero, and the angular acceleration reversely reaches the maximum value. θ_d is then the angle of inclination achieved by the ship under a certain external force or moment. When the ship inclines to the angle θ_d , the restoring moment of the ship reaches its maximum value, the ship begins to roll back under the angular acceleration generated by the combined moments. After the ship rolls back to the initial position, it will incline to starboard side and rolls back repeatedly. However, in practice, due to the resistance of water, the rolling of the ship can no longer be observed visually after swinging for several periods in still water.

2) Minimum capsizing moment

To achieve a dynamic balance, the work done by the external moment should be the same as that done by the restoring moment, that is, the area under the two curves is equal. In the right figure of Figure 14-8, the area enclosed by the OE section of M_s curve and θ axis is equal

to the area enclosed by the HF section of M_h curve and θ axis. If the common part of the two areas is removed, the shadow areas OHA and AEF should be equal to each other.

$$W_s = W_h \quad (14-8)$$

where W_s — the work done by restoring moment work, $W_s = \int_0^{\theta_d} M_s d\theta$; and

W_h — the work done by the external moment, $W_h = \int_0^{\theta_d} M_h d\theta$.

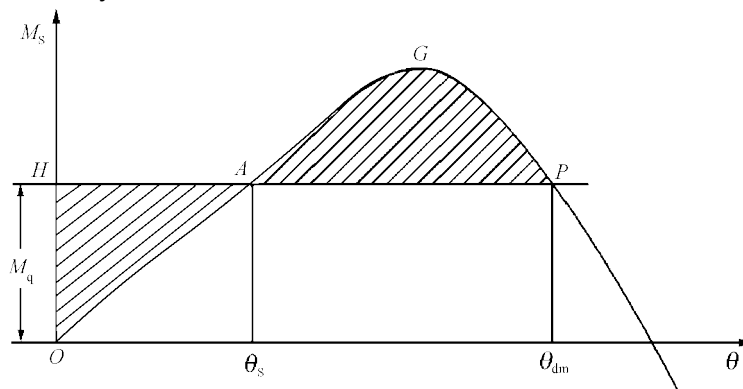


Figure 14-9 Minimum Capsizing Moment

From the perspective of ship dynamic balance, as shown in Figure 14-9, only when the area AGP enclosed by the restoring moment is greater than the area OHA , can the restoring moment curve have a corresponding dynamic balance angle, and the ship has the ability to resist external moment. However, as the external force (or external moment) increases, the area AGP covered by the restoring moment will reach the critical value which is equal to the area OHA covered by the external moment. If the external moment increases further, the area AGP covered by the restoring moment will be smaller than the area OHA covered by the external moment, the restoring moment will not be able to resist the external moment, and the ship will no longer have the ability to keep a balance. Under a dynamic balance, the minimum external moment that can cause the ship to capsize is called the minimum capsizing moment M_q (minimum capsizing moment), and the corresponding dynamical heeling angle is called the maximum dynamic heeling angle θ_{dm} . Therefore, the conditions under which the ship will not capsize under the action of a dynamic heeling moment are as follows:

$$M_h \leq M_q \quad \text{Or} \quad l_h \leq l_q \quad (14-9)$$

Where l_h — heeling lever, $l_h = M_h / \Delta$, m; and

l_q — minimum capsizing lever $l_q = M_q / \Delta$, m.

3) Dynamic stability curve

The dynamic stability curve is the curve which can show the work done by the restoring moment during the process of inclination. The work done by the restoring moment in a static stability curve can be calculated from the area enclosed by the restoring moment curve between 0° and θ° , and the θ axis. At this stage, through some integral methods and computational software, the area can be obtained more accurately. The dynamic stability curve can also be obtained by integration the restoring lever curve.

$$l_d = \int_0^\theta GZ d\theta \quad (14-10)$$

Where l_h -restoring lever, m.

Through the dynamic stability curve, the dynamical heeling angle corresponding to a given external moment can be directly obtained, and the minimum capsizing moment can be obtained. As shown in Figure 14-10, the corresponding heeling angle at the intersection point E crossed by the line connecting $(0^\circ, 0)$ and $(57.3^\circ, M_h)$, and the dynamic stability curve W_s , is the dynamical heeling angle θ_d . The tangent line of the dynamic stability curve W_s starting from

(0°, 0) is made, and intersects the vertical line $\theta = 57.3^\circ$ at the point P . Then the height of PM is the minimum capsizing moment M_q (or lever l_q), as shown in Figure 14-10.

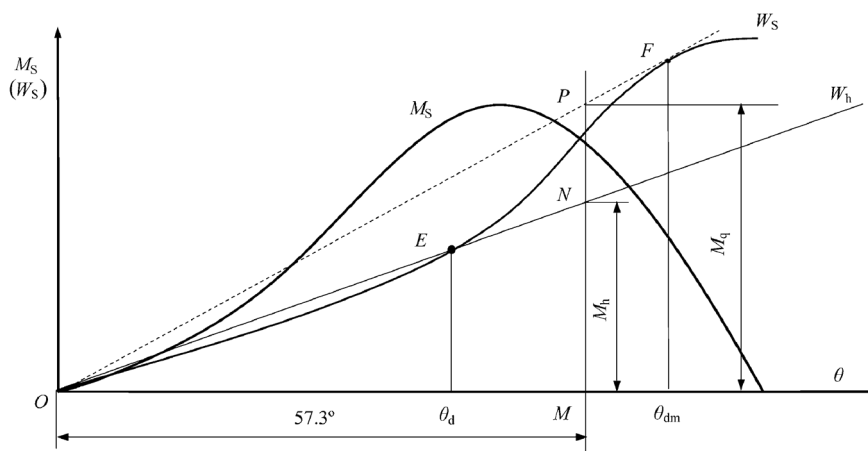


Figure 14-10 Dynamic Stability Curve

4) Combined influence of wind, waves and flooding angle

During the calculation of the dynamical stability in marine practice, a ship should consider the combined influence of wind, waves and flooding angle as per the requirements. A brief introduction on the combined influence is given below:

(1) the ship is subject to a wind pressure acting perpendicular to ship's centreline which results in a steady wind heeling lever (l_{w1}).

(2) from the resultant angle of equilibrium (θ_0), the ship is assumed to roll owing to wave action to angle of (θ_1) to windward. The angle of heel under action of steady wind (θ_0) should not exceed 16° or 80% of the angle of deck edge immersion, whichever is less.

(3) the ship is then subjected to a gust wind pressure which results in gust wind heeling lever (l_{w2});

(4) the max heeling angle owing to the gust wind is taken as (θ_2). Then, (θ_2) should be angle of down-flooding angle (θ_f) or 50° or (θ_c). (θ_f) is angle of heeling at which openings in the hull, super structures or deck-houses which cannot be closed weathertight immerse. In applying the criterion, small openings which progressive flooding cannot take place need not to be considered as open. (θ_c) is the second intercept between gust wind heeling lever (l_{w2}) and GZ curves.

(5) under this circumstance, area b should be equal to or greater than area a, as indicated in figure 14-11 below.

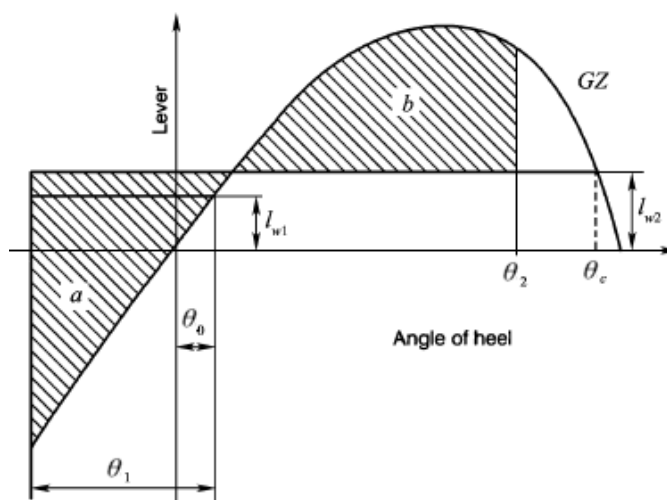


Figure 14-11 Severe wind and rolling

Section 2 Intact Stability

1. Factors affecting initial stability

1) Effect of free surface on initial stability

Generally, there are many liquid tanks in ships, such as ballast water tanks, oil water tanks, and liquid cargo tanks. If the liquid is not fully filled (the tank is normally considered full if 98% or more of the volume is occupied), the free flow of the liquid due to ship rolling will occur. As shown in Figure 14-12, after the ship inclines to starboard side, the liquid in the tank will also flow to the side, and the centre of gravity of some liquid will move from the original position g_0 to g_1 , resulting in an increase in the overall centre of gravity of the ship, and a subsequent decrease in the initial stability height of the ship. In addition, there are multiple liquid tanks in the ship at the same time, with different liquid densities. If there is a free surface in all of them, it is necessary to correct them.

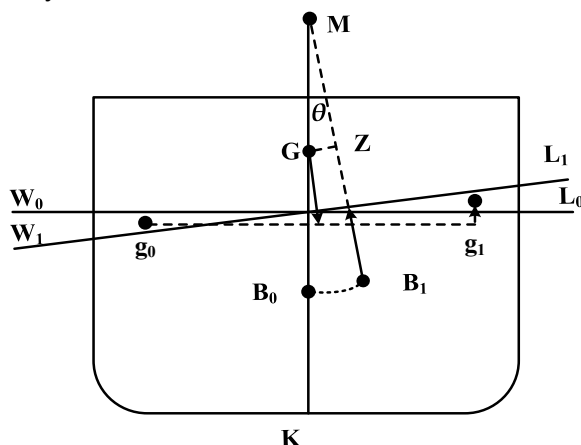


Figure 14-12 Free Surface in the Tank

$$GM_c = KM - KG - \sum \frac{\rho_i i_{xi}}{\Delta} \quad (14-11)$$

Where GM_c — initial stability height corrected by free surface, m;

ρ_i — density of the liquid in tank i , t/m^3 ;

i_{xi} — Inertia moment of liquid surface area of the liquid, m^4 ;

2) Impact of load changes on initial stability

(1) Load increase/decrease

Load changes such as cargo handling have an impact on the ship's transverse metacentric height KM from the baseline and the ship's centre of gravity height KG , and thereby affect the ship's initial stability height GM .

$$GM_1 = GM + \delta KM + \frac{\sum P_i (KG - KP_i)}{\Delta + \sum P_i} \quad (14-12)$$

Where GM_1 — initial stability height after load change, m;

δKM — $\delta KM = KM_1 - KM$, KM_1 is the new height of the transverse metacentric after the load changes. Generally, δKM can be neglected when the load change is smaller than 10% Δ , m;

P_i — the load changed, with the increased weight P being "+", otherwise it is "-", t;

KP_i — the height of the load from the baseline, m.

(2) Transverse movement of load

As shown in Figure 14-13, the ship initially floats upright, with a waterline of WL . A heavy object with a weight of P in the ship is moved transversely from point q to point q_1 . According to the principle of the parallel movement of forces, the centre of gravity G of the ship moves horizontally to point G_1 , causing the ship to incline in the direction of movement of the heavy object, and the centre of buoyancy moves accordingly. When the centre of buoyancy and the

3) Load Suspension

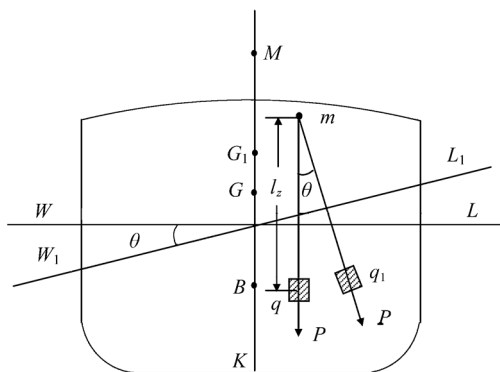


Figure 14-15 Schematic Diagram of Vertical Load Movement

As shown in Figure 14-15, an object with weight P is suspended at the point m through a rope with length l_z . when the ship heels to θ , the load P moves from the initial point q to point q_1 , which means a heeling moment that is opposite to the restoring moment is developed.

$$M_{S1} = \Delta(GM - \frac{Pl_z}{\Delta})\sin\theta \quad (14-15)$$

Where M_{S1} — corrected heeling moment, $\text{kN} \cdot \text{m}$;

M_P — the moment developed by the suspended load P , $M_P = Pl_z\sin\theta$, $\text{kN} \cdot \text{m}$.

By equation 14-15, the influence of suspending a weight is to move the weight from its original position to the suspending point of the line. At the same time, the centre of gravity of the ship will move upward to the G_1 , and the initial stability will be decreased by (Pl_z/Δ) .

2. Factors affecting stability at large angle

1) Free surface

The free surface not only reduces the initial stability of the ship. As the inclination angle of the ship increases, the free surface also reduces the stability at large angles. Generally, there are two methods which can be used as the correction of free surface for the calculation of the stability at large angles. One of them is to use the height of the centre of gravity to correct the GZ value. The other is to correct the GZ value by looking up the free surface moment table.

(1) Centre of gravity height correction method

$$GZ_1 = KN - (KG_0 + \sum \frac{\rho_i i_{xi}}{\Delta})\sin\theta \quad (14-16)$$

Where GZ_1 — corrected restoring lever, m ;

KG_0 — initial centre of gravity height of the ship, m ;

This method is relatively simple and practical, and is widely used in shipping practice. However, when the ship's inclination angle is large, the error of this method is relatively large.

(2) Looking up free surface moment table

$$GZ_1 = GZ_0 - \frac{\sum M_{fi}}{\Delta} \quad (14-17)$$

Where GZ_0 — uncorrected restoring lever, m ;

M_{fi} — the liquid level moment of a certain tank, which can be obtained from the liquid level moment table in ship hydrostatic data, $\text{kN} \cdot \text{m}$.

2) Initial heeling

Due to uneven loading of weight on both sides, the ship appears to have initial heeling angle θ_0 , and its centre of gravity moves from point G the centerline plane to point G_1 . As the inclination angle of the ship increases, the restoring lever decreases as a whole, as shown in Figure 14-16 and Figure 14-17.

applying for seagoing ships and these for river ships sailing in waters under China jurisdiction, are similar to these in the *Intact Stability Code 2008 (IS Code 2008)*.

(1) The seagoing ships in domestic waters

According to the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020*: Unless otherwise specified, the requirements for intact stability in Chapter 7 of Part 4 of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* apply to seagoing ships with a displacement, but does not apply to (1) sailboats and (2) motor sailboats. For ships in the far sea navigation area, except for passenger catamaran, tugs, crane ships, and dredgers (excluding these crane ships and dredgers with normal ship type and under a "en route" condition), if all the provisions of the *IS Code 2008* are applied, it can equivalently replace all the requirements of in Section 2, and Section 3 of the Chapter 7 of the Part 4 of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020*. But for oil tankers, the requirements of regulation 7.3.7 of the Chapter 7 of the Part 4 of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* should also be met.

(2) The inland ships

The Intact Stability regulations, as specified in Chapter 8 of Part 5 of the *Technical Rule for the Statutory Survey of Inland ships 2019*, are applicable to the calculation of intact stability for the ships sailing in inland waters, but not applicable to high-speed ships and floating docks unless otherwise specified. If existing inland civil ships cannot fully meet the requirements of the Intact Stability regulations above-mentioned, they must comply with the regulatory requirements as they previously did. When the stability of a ship is destructed due to the reconstruction or repair of some structures, or a major change of light ship, or a major change of cargo weight, the stability of the ship should be calculated and checked as the requirements of the Intact Stability regulations specified in Chapter 8 of Part 5 of the *Technical Rule for the Statutory Survey of Inland ships 2019*. Any existing inland civil ship should, if in doubt about the stability, examine the stability as the requirements of the Intact Stability regulations above-mentioned. If a ship passes through the navigational water area (navigational river section) with higher designed navigational specifications, the stability requirements suitable for the navigational water area (navigational river section) should be applied to the ship. A ship that meets the requirements for intact stability in Chapter 7 of Part 4 of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020*, can be considered to meet the requirements of the Intact Stability regulations specified in Chapter 8 of Part 5 of the *Technical Rule for the Statutory Survey of Inland ships 2019*. However, for ships sailing the river section of Class J, the stability of the ship should still be in accordance with the requirements of the Intact Stability regulations specified in Chapter 8 of Part 5 of the *Technical Rule for the Statutory Survey of Inland ships 2019*.

Section 3 Damage Stability and Criterion

1. Introduction to Damage Stability

Damage stability refers to the stability of a ship after it is damaged and flooded. At the international level, the safety issue of damage to Ro-Ro passenger ships has a long history. Since the sinking of the "Titanic" Ro-Ro passenger ship in 1912, the safety issues of Ro-Ro passenger ships have received a widespread attention. Starting in 1914, ships were required to equip a lifeboat seat for each person on board. The *SOLAS Convention* of 1929 proposed the design standards for the intact stability, and immersion length of ships. The *SOLAS Convention* of 1948 first proposed the requirements for damaged stability. The process of establishing international rules had been slow. After the implementation of the *SOLAS Convention* of 1960 and the subsequent amendments to the *SOLAS Convention* of 1974, a large number of concepts concerning ship safety had been introduced into the field of ship construction. From then on, the basic safety of ships, including the damage stability of passenger Ro-Ro ships, had been basically guaranteed. In the early days, deterministic method was used to calculate the damage stability of Ro-Ro passenger ships. Over time, the drawbacks of this method gradually emerged. Since 1992, IMO has taken the lead in adopting

probabilistic method for the calculation of the damage stability of the dry cargo ships built after 1992. Subsequently, IMO unified the probabilistic method of *SOLAS Convention 1990* and *SOLAS Convention 1992*, and enforced them in 2009. According to *SOLAS Convention 2009*, dry cargo ships of 80 metres in length and above use the probabilistic method to calculate the damage stability. In 2020, the *SOLAS Convention* made significant changes to the subdivision index, and further improved the requirements for damaged stability of passenger ships, including the requirements for Ro-Ro passenger ships.

In China, as international rules such as the *SOLAS Convention* continues to improve the requirements for the damage stability of passenger ships, the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* and the related, have also tended to improve and gradually enhance their provisions in this regard. The current version of this rule is the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020*. Due to the time limit specified in *SOLAS Convention 2009* for probabilistic method, and the existence of both international and domestic voyages of passenger ships in China (including Ro-Ro passenger ships), the deterministic method and probabilistic method will be used in the calculation of damage stability of passenger ships. For a specific ship, the detailed method of the calculation of damage stability depends on the rules which are applied on the ship.

2. Introduction of Damage Stability Calculation Method

1) Deterministic method

(1) The damage range of the ship in the longitudinal, transverse, and vertical directions, as well as the location of the damage inside the ship or along the ship's length are specifically defined;

(2) The condition of a compartment (or the condition of a group of compartments) before damage is regulated for calculation. One or more of the most dangerous damaged compartment groups are identified;

(3) The requirements for the floating state and stability of residual ships are specified;

(4) It is required to calculate the critical initial stability height (or max centre of gravity) of the ship before the damage meets the above requirements. It is not allowed that any required calculation state does not meet the requirements for damage stability.

After the ship is damaged and flooded, two deterministic methods can be used for the calculation of the buoyancy and stability of a ship, namely, weight increase method and fixed displacement method (buoyancy loss method).

(1) Weight increase method

The weight increase method regards the water flooded in the compartment after a ship damage as an added liquid weight of the ship. After the ship is damaged, the displacement is increased by the weight of flooded water, comparing its initial value, and the position of the centre of gravity of the ship also changes. At this time, the drawings and data provided by the shipyard or design unit for calculating the buoyancy, stability, and trim of the ship are all valid.

(2) Buoyancy loss method

The buoyancy loss method regards the water flooded in the compartment after a ship damage as outside water. After the damage, the weight and centre of gravity position of the damaged ship remains unchanged, and the buoyancy of the submerged volume has been lost. The ship needs to compensate for the lost buoyancy by sinking and increasing the draft. Therefore, after a ship is damaged, its displacement remains unchanged, but the shape of the displacement volume and the position of the buoyancy centre will change.

2) Probabilistic method

(1) The maximum range of longitudinal, transverse, and vertical damage to a ship is specified. The effects of longitudinal, transverse, and horizontal separation within this range can be considered, without limitation on the location of the damage.

(2) The condition of a compartment (or the condition of a group of compartments) before damage is regulated for calculation. For each condition, a series of damaged groups that may contribute to the survivability after damage are calculated.

(3) The relationship among the floating state, stability indexes, and survivability is regulated.

(4) The subdivision index calculated based on the probability of damage of various compartments or groups of compartments, as well as the and the survivability of the residual ship after damage and flooding, shall not be less than the required subdivision index required by the rules.

3. Damage stability criterion

For the details of the damage stability criteria for passenger ships, please refer to the corresponding contents in the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* and Part 4-Navigation Safety in the *Technical Rules for the Statutory Survey of International Seagoing Ships*. In addition to the requirements of the critical GM curve (table) of Intact Stability requirements, the GM corrected by the free surface under any loading condition should also meet the requirements of the critical GM curve (table) of Damaged Stability requirements. The critical GM curve (table) of Damaged Stability requirements is the minimum requirements of damage stability and covering the entire operating trim range, as shown in Figure 14-18.

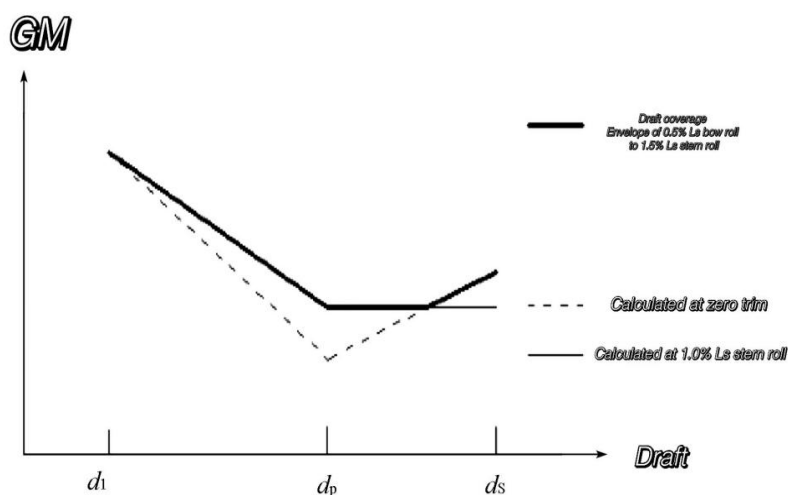


Figure 14-18 Limit GM Curve

Section 4 Trim and Strength

1. Trim

1) Calculation of trim

The main reason for the occurrence of trim is that the centre of gravity and the centre of buoyancy of the ship in longitudinal axis are not in a same vertical line, and thus a difference between the draft fore and aft is developed by the moment of gravity and buoyancy. Therefore, the key to calculate the ship's trim is to determine whether the changes in the ship's weight have caused a longitudinal moment.

$$t = \frac{\Delta(x_g - x_b)}{100MTC} \tag{14-21}$$

$$d_F = d_M + \frac{\frac{L}{2} - x_f}{L} \times t \tag{14-22}$$

$$d_A = d_M - \frac{\frac{L}{2} + x_f}{L} \times t \tag{14-23}$$

Where t — ship trim, m;
 Δ — ship displacement, in t;

x_g — ordinate of ship's centre of gravity, m;
 x_b — ordinate of centre of flotation on the water plane, m;
 d_M — mean draft of the ship, m;
 L — the ship length, m; and
 MTC — trim moment per centimetre, t·m/cm.

2) Change of trim

(1) Load movement

$$d_{F1} = d_F + \frac{L - x_f}{L} \times \frac{P(x_{p1} - x_p)}{100MTC} \quad (14-24)$$

$$d_{A1} = d_A - \frac{L + x_f}{L} \times \frac{P(x_{p1} - x_p)}{100MTC} \quad (14-25)$$

$$t_1 = d_{F1} - d_{A1} \quad (14-26)$$

Where d_{F1} — bow draft after load movement, m;

d_{A1} — stern draft after load movement, m;

P — weight of moving load, t;

x_{p1} — load ordinate after movement, m;

x_p — vertical coordinate of the original loading position of the load, m; and

t_1 — ship trim after load movement, m.

(2) Load increase or decrease

$$d_{F1} = d_F + \frac{P_1}{100TPC} + \frac{L - x_f}{L} \times \frac{P_1(x_p - x_f)}{100MTC} \quad (14-27)$$

$$d_{A1} = d_A + \frac{P_1}{100TPC} - \frac{L + x_f}{L} \times \frac{P_1(x_p - x_f)}{100MTC} \quad (14-28)$$

$$t_1 = d_{F1} - d_{A1} \quad (14-29)$$

Where TPC — tonnage of draft per centimetre, t/cm; and

P_1 — weight of load increase or decrease, with "+" for load increase or decrease, and "-" for load decrease, t.

2. Ship strength

Ship strength refers to the ability of the ship structure to withstand various external forces without causing destructive deformation. This ability mainly depends on the internal structure of the ship and the nature and distribution of loads acting on the ship. In the process of ship strength calculation, there are many uncertain factors, including the structural materials of the ship, the loads acting on the ship, and especially the wave loads. According to the characteristics of the ship structure and the nature of the loads, ship strength is classified into longitudinal strength, torsional strength, and local strength.

1) Longitudinal strength

The ship is regarded as a hollow thin-walled beam with variable cross section, simply referred to as a hull girder. The bending of the hull girder under external forces in its longitudinal vertical plane is called longitudinal bending. The study of the deformation laws and the ability to resist total longitudinal bending or damage of the entire hull structure is called the longitudinal strength. For the longitudinal strength, the maximum shear force is located at about $L/4$ from both bow and stern. The maximum bending moment is located approximately in the mid-ship and gradually decreases towards both bow and stern. Generally, hogging moment occurs on a Ro-Ro passenger ship before loading at the port. Before arriving at the port for loading, Ro-Ro passenger ships often add ballast water into the fore and stern ballast tanks to adjust the ship's trim. In addition, the weight of the equipment on both ends such as the ramp used for loading and unloading cargo at the bow and stern parts, and the buoyancy

near the mid-ship are relatively concentrated. These factors all lead to a relatively large hogging moment for Ro-Ro passenger ships.

2) Torsional strength

Torsional strength refers to the ability of the entire hull to resist torsional deformation and damage. When a ship is listed on the waves or when an asymmetric loading at the bow and stern occurs, asymmetric forces at the port side and starboard side of the bow and stern will show up, and then the torsional moment causing the hull to twist and deform will be generated. Generally, ships with large open cargo holds such as solid bulk carriers are susceptible to torsional strength, while the ships without large openings such as Ro-Ro passenger ships are generally not affected by torsional strength.

3) Local strength

Local strength is the study of the ability of a component or part of a hull structure to withstand corresponding loads. The deck, bilge, and other components of a ship may undergo deformation and damage due to too much local loads. The bottom on the bow of the ship are easily slammed due to heavy waves, resulting in a concave deformation. While the stern of the ship is more easily subjected to the excitation forces of the propeller. Under the action of external forces, components such as ship decks and bilges participate in the calculation of both the longitudinal strength and local strength of the ship. When a Ro-Ro passenger ship loads Ro-Ro cargo in the cargo hold, it should meet the local strength requirements of the cargo hold. The allowable value of local strength and the calculation method of local strength can be obtained from ship information book.

Chapter 15 Vehicle Stowage and Securing

Section 1 Vehicle stowage and securing rules

As early as 1985, IMO issued and implemented the *Guidelines for securing arrangements for the transport of road vehicles on ro-ro ships* (resolution A.581 (14)), to regulate the securing issues of Ro-Ro vehicles. Subsequently, IMO revised the guidelines in 1997, 2010, and 2020 through *MSC/Circ.812*, *MSC/Circ.1355*, and resolution *MSC.479(102)*. According to the revised the *Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro-Ro Ships* in 2020, the maximum securing point load and quantity of ropes used for securing point of Ro-Ro vehicles can be calculated in accordance with Attachment 13 of the the *Code of Safe Practice for Cargo Stowage and Securing* (referred to as the CSS Rules) issued by IMO, taking into full consideration the many risks of cargo movement.

In order to ensure the safety of domestic passenger Ro-Ro transportation, especially the safety securing of Ro-Ro vehicles, additional requirements for passenger Ro-Ro ship transportation in Part 9 of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020* are regulated. These requirements are applicable to domestic passenger Ro-Ro ships, as explicitly stated in this part. Chapter 5 of the part 9 details the requirements for the loading and securing of vehicles of the Ro-Ro in domestic waters.

1. General provisions

(1) The operator of a Ro-Ro passenger ship shall develop a vehicle and cargo securing manual, which shall be approved by the ship inspection agency;

(2) The vehicle and cargo securing manual should be provided on the Ro-Ro passenger ship for inspection purposes;

(3) The vehicle and cargo securing manual provides guidance for the captain and crew on the loading and securing of vehicles. The captain is responsible for the effective loading and securing of the vehicles according to the securing manual, but it does not exclude or replace the captain and crew's good navigation skills and experience in loading and securing;

(4) The vehicle and cargo securing manual should include the provision of securing equipment, evaluation of the effectiveness of vehicle securing, and guidance requirements for selecting the strength and quantity of securing equipment;

(5) The guidelines for the strength and quantity of securing equipment should be posted at obvious positions on the ship;

(6) The provision and arrangement of fixed securing equipment for Ro-Ro passenger ships shall meet the relevant requirements for cargo arrangement in the Part II of Chapter 5 of the part 9 in *Maritime Regulations 2020*;

(7) The number of portable securing equipment required for Ro-Ro passenger ships should be calculated based on typical design loading conditions and provided on board;

(8) The loading and securing of vehicles on the ship should be able to prevent the occurrence of any damage or danger to the ship and personnel on board during the entire process of navigation;

(9) The packaging and securing of the goods loaded on vehicles should be able to prevent the occurrence of any damage or danger to the ship and personnel on board during the entire voyage;

(10) For Ro-Ro passenger ships with keels installed or at a similar stage of construction prior to the date of entry into force of Part 9 of *Maritime Regulations 2020*, a vehicle and cargo securing manual should be re-developed and submitted for approval in accordance with the requirements of the regulation. During periodic or temporary inspections, it shall be confirmed that the configuration and functions of the vehicle securing devices comply with new vehicle and cargo securing manual.

2. Cargo arrangement

The requirements of securing arrangements for Class I, II, and III Ro-Ro passenger ships are as follows.

1) Securing points on the vehicle deck

(1) The spaces of the securing points on the vehicle deck can be arranged and determined according to the size of the typical vehicles expected to be loaded. The layout plan and information about the typical vehicles should be included in the cargo securing manual. The effectiveness of the securing should be evaluated. The arrangement of securing points shall generally meet the following requirements:

The longitudinal distance between the securing points on the vehicle deck should generally not exceed 2.5 metres, and the transverse distance should not be less than 2.8 metres but not more than 3.0 metres. The distance between the securing points on the bow and stern of the ship can be smaller than the distance between the securing points in the middle of the ship;

(2) Based on the size of the railway vehicle, a special consideration should be given to the arrangement of securing points on the deck of railway vehicles;

(3) The maximum securing load (MSL) of each securing point of a Class I Ro-Ro passenger ship shall not be less than $n \times 100\text{kN}$. The MSL of the securing point of Class II and Class III Ro-Ro passenger ships shall not be less than $n \times 90\text{kN}$. The letter "n" is the number of lashing wires applied on a same the lashing point;

(4) The securing points should be set at the positions with strong ship structures as much as possible. Otherwise, the ship structure in the securing point area should be strengthened properly.

2) Securing points on the vehicle

(1) The securing points which are sufficient in quantity and have a sufficient strength shall be equipped on each vehicle, otherwise the vehicle can be effectively lashed and secured to the vehicle deck by suitable means. The design of the securing points on the vehicle should enable the vehicle to be fastened to the ship, and should enable only one lashing wire to pass the eye of each lashing point. Securing points and eyes should allow the lashing wire to be secured to the ship's deck in different directions;

(2) According to Table 15-1, at least two but not more than six securing points shall be installed on both sides of the vehicle. In the table, n is the total number of securing points on each side of the vehicle;

(3) Each securing point on the vehicle shall be painted with a conspicuous and visible colour;

(4) The arrangement of the securing points on the vehicle should ensure that the use of lashing wires limits the movement of the vehicle effectively;

(5) Securing points should be capable of transferring the forces from the lashing wires to the vehicle chassis, and should never be installed on bumpers or axles, unless the securing points are specifically constructed and the force can be transferred directly to the chassis;

(6) The securing point on the vehicle should be located where it is easy and safe to lash a wire, especially where side protection devices are installed;

(7) The inner free passage of the eye at each securing point should be no less than 80mm, but the shape of the eye does not have to be circular.

Table 15-1 Minimum Number and Minimum Strength of Securing Points

Gross vehicle weight GVM (tonnes)			Number of minimum securing points on each side of the vehicle	Maximum securing load at the securing point MSL (kN)		
Class I Ro-Ro passenger ship	Class II Ro-Ro passenger ship	Class III Ro-Ro passenger ship		Class I Ro-Ro passenger ship	Class II Ro-Ro passenger ship	Class III Ro-Ro passenger ship
$3.5 \leq GVM \leq 20$	$GVM \leq 37.5$	$GVM \leq 70.5$	2	$GVM \times 12 / n$	$GVM \times 6.4 / n$	$GVM \times 3.2 / n$
$20 < GVM \leq 30$	$37.5 < GVM \leq 56.25$	$70.5 < GVM \leq 105.5$	3			
$30 < GVM \leq 40$	$56.25 < GVM \leq 75$	$105.5 < GVM \leq 140.5$	4			

Note: (1) For trains, this table is applicable to each vehicle in the group, such as each locomotive and each carriage;

(2) This table does not include semi-trailer towing vehicles. The securing points should be installed in front of the vehicle, and their strength should be sufficient to prevent transverse movement of the vehicle's front end. The front towing device can replace these two securing points;

(3) If a towing device other than a semi-trailer towing vehicle is used to secure the vehicle, the minimum number and strength of securing points on each side of the vehicle described above cannot be replaced.

(8) For vehicles that do not meet the requirements of Table 15-1, the captain may, based on the actual condition of the vehicle, the weather and sea conditions of the expected voyage, and other conditions that affect navigation and securing, use equivalent or better securing arrangements for the transportation of the vehicle.

3) lashing wire

(1) The lashing wire shall consist of a chain or any other appliance, and shall be made of the equivalent material having at least the same strength and elongation characteristics as the chain;

(2) The design and lashing wires should have a safe entrance. If a wire is loose, it should be able to be tightened again. If practicable and necessary, a regular inspection on the lashing condition of wires should be made during a voyage. All the loosen wires should be tightened if necessary;

(3) A hook or a similar device should be used to secure the wire to the securing point. The design of the hook or the device should ensure that the lashing wire is still lashed in the eye even if it is loosen during the voyage;

(4) One eye of a securing point on the vehicle should only be lashed by one wire;

(5) Lashing wires should only be tied to the securing point used for this purpose;

(6) The lashing at each vehicle securing point should preferably be designed in such a way that the angle between any lashing wire and both horizontal and vertical planes is between 30° and 60°;

(7) According to the characteristics of the ship and the weather conditions of the expected voyage, the captain shall determine the number of securing points and lashing wires used for each voyage.

4) Vehicle loading

(1) The free movement of the suspension devices of the locomotive and carriage of the train should be limited to keep the chassis as static as possible;

(2) When using a crane, the lifting points of the locomotive and carriage chassis of the train should be strengthened, and the location of the lifting points should be clearly marked. The lifting points should be arranged at the place with strong ship structure as much as possible, otherwise the structure in this area should be strengthened properly;

(3) Vehicles should use parking brakes and be locked. Anti-shifting blocks should be set at the wheels. The driving gears of the vehicles with a diesel engine should be disengaged during the transportation at sea.

3. Effectiveness evaluation of vehicle securing

1) The effectiveness evaluation of the securing of vehicles and cargoes on board a Ro-Ro passenger ships shall be conducted in accordance with Section 2 of this chapter or the method accepted by the CMSA;

2) The effectiveness evaluation should include the verification of the strength and quantity of the securing equipment for typical vehicles at typical loading positions under different wind scales.

4. Inspection of securing equipment

1) Maximum securing load: securing equipment both fixed and portable shall be equipped with certification documents to certify its maximum securing load;

2) Inspection: Necessary inspection shall be conducted on the fixed securing equipment of the ship in combination with the routine inspection of Ro-Ro passenger ships.

Section 2 Evaluation Method for Effectiveness of Vehicle Securing

After being loaded on board a Ro-Ro ship, vehicle may encounter a relative movement due to ship motion in a sea way. A good practice of the lashing and security of vehicles on board is thus required to prevent them from sliding and tipping. It should be noted that the use of anti-rolling devices for passenger Ro-Ro ships can decrease the rolling of the ship in wind and waves, but should not be considered when calculating the forces acting on the vehicles.

1. MSL

The MSL of the securing device can be determined according to Table 15-2 based on the breaking strength provided by the manufacturer of the securing device. The SWL used for securing purposes may replace the MSL provided it is equal to or exceeds the strength defined by the MSL. The working load of the securing equipment approved by the maritime authority should be understood as MSL. When the lashing device is connected by several parts (such as a steel wire rope connecting shackle and then connecting the deck eyebolt), the MSL should be the minimum value of all parts for the entire lashing devices.

Table 15-2 Calculation Coefficient of MSL for Different Materials

Securing Device	MSL
shackles, rings, deck eyes, turnbuckles of mild steel	50% of breaking strength
fibre rope	33% of breaking strength
web lashing	50% of breaking strength
wire rope (single use)	80% of breaking strength
wire rope (re-useable)	30% of breaking strength
steel band (single use)	70% of breaking strength
chain	50% of breaking strength

2. Calculated strength (CS)

When using balance calculation methods for assessing the strength of the securing devices, a safety factor is used to take account of the possibility of uneven distribution of forces among the devices or reduced capability due to the improper assembly of the devices or other reasons. This safety factor is used in the formula to derive the calculated strength (CS) from the MSL and shown in the relevant method used.

$$CS = \frac{MSL}{\text{Safety factor}} \quad (15-1)$$

Where *MSL* — maximum securing load, kN;

CS — calculated strength, kN;

Safety factor — depending on the calculation method. It is 1.5 for advanced calculation method, and 1.35 for alternative calculation method. In addition, when checking the strength of the securing equipment of the vehicles lashed on an amphibious hovercraft, the safety factor of the securing equipment is taken as 1.

3. Calculation method

1) External force acting on a vehicle

The longitudinal force F_x , lateral force F_y , and vertical force F_z acting on the vehicle can be calculated using the following formula:

$$\begin{aligned} F_x &= ma_x k_1 k_2 k_3 + A_x q \\ F_y &= ma_y k_1 k_2 k_3 + A_y q \\ F_z &= ma_z k_1 k_3 \end{aligned} \quad (15-2)$$

Where *m* — vehicle mass, t;

a_x — longitudinal basic acceleration, m/s^2 , as shown in Table 15-3;

a_y — transverse basic acceleration, m/s^2 , as shown in Table 15-3;

a_z — vertical basic acceleration, m/s^2 , as shown in Table 15-3;
 k_1 — basic acceleration correction coefficient for ship length L not equal to 100m and service speed not equal to 15kn, as shown in Table 15-4;
 L — length between perpendiculars, m;
 k_2 — correction coefficient of transverse acceleration value when $B/GM_0 < 13$, as shown in Table 15-5;
 K_3 — correction coefficient of basic acceleration value, as shown in Table 15-6;
 B — ship breadth, m;
 GM_0 — initial stability height, m;
 A_x — longitudinal wind exposure projected area, m^2 ;
 A_y — transverse wind exposure projected area, m^2 ; and
 q — wind pressure, kN/m^2 , as shown in Table 15-6.

Table 15-3 Basic Accelerations a_x , a_y , a_z

Transverse acceleration a_y (m/s^2)										Longitudinal acceleration a_x (m/s^2)
On deck, high	7.1	6.9	6.8	6.7	6.7	6.8	6.9	7.1	7.4	3.8
On deck, low	6.5	6.3	6.1	6.1	6.1	6.1	6.3	6.5	6.7	2.9
Tween deck	5.9	5.6	5.5	5.4	5.4	5.4	5.6	5.9	6.2	2
Lower hold	5.5	5.3	5.1	5	5	5.1	5.3	5.5	5.9	1.5
X/L	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
Vertical acceleration a_z (m/s^2)										
	7.6	6.2	5	4.3	4.3	5	6.2	7.6	9.2	

Note: Transverse acceleration values include the component forces parallel to the deck caused by gravity, pitch, and heave. The vertical acceleration value does not include the gravitational component. X is the distance from the centre of gravity of the vehicle to aft perpendicular, m.

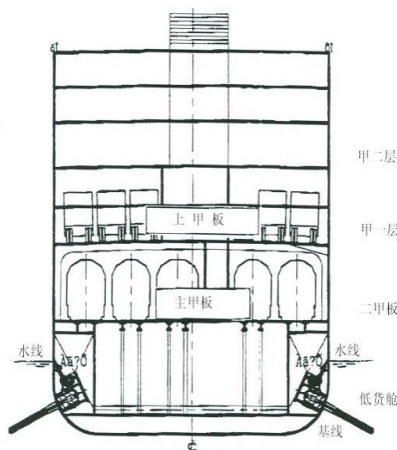


Figure 15-1 Typical Arrangement of Vehicle Loading

2) Ship length and speed correction coefficient k_1

For basic acceleration corrections where the ship length L is not equal to 100 metres and the operating speed v is not equal to 15kn, see Table 15-4 - Coefficient k_1 Correction Table.

Table 15-4 Correction Positive Coefficient k_1 for Ship Length and Speed Correction Coefficient

$L(m)$ $v(kn)$	50	60	70	80	90	100	120	140	160	180	200
9	1.20	1.09	1.00	0.92	0.85	0.79	0.70	0.63	0.57	0.53	0.49

12	1.34	1.22	1.12	1.03	0.96	0.90	0.79	0.72	0.65	0.60	0.56
15	1.49	1.36	1.24	1.15	1.07	1.00	0.89	0.80	0.73	0.68	0.63
18	1.64	1.49	1.37	1.27	1.18	1.10	0.98	0.89	0.82	0.76	0.71
21	1.78	1.62	1.49	1.38	1.29	1.21	1.08	0.98	0.90	0.83	0.78
24	1.93	1.76	1.62	1.50	1.40	1.31	1.17	1.07	0.98	0.91	0.85

Note: The correction coefficient k_1 for length/speed combinations not directly listed in the table is calculated using the following formula:

$$k_1 = \frac{0.345v}{\sqrt{L}} + \frac{58.62L - 1034.5}{L^2} \quad (15-3)$$

Where: v — speed, kn ;

L — Length between perpendiculars, m, this formula is not applicable to ships with a length of less than 50m or more than 300m.

3) Correction coefficient k_2 for ship breadth and initial stability height

When the ratio of ship breadth to initial stability height without free surface correction (B/GM_0) is less than 13, correction is required, as shown in Table 15-5.

Table 15-5 Modification Factor k_2 for Ship Width and Initial Stability Height

B/GM_0	7	8	9	10	11	12	13
On deck, high	1.56	1.40	1.27	1.19	1.11	1.05	1.00
On deck, low	1.42	1.30	1.21	1.14	1.09	1.04	1.00
Tween deck	1.26	1.19	1.14	1.09	1.06	1.03	1.00
Lower hold	1.15	1.12	1.09	1.06	1.04	1.02	1.00

4) Wind class and passenger ship class correction coefficient k_3

The correction coefficient k_3 for basic acceleration based on wind pressure, route, ship class, and design conditions is shown in Table 15-6.

Table 15-6 Correction Factor k_3 for Wind Level and Passenger Ship Level

Wind scale	Class I Ro-Ro Passenger Ship	Class II Ro-Ro Passenger Ship	Class III Ro-Ro Passenger Ship	Wind pressure q (kN/m ²)
Above scale 8	1	-	Determined by wave height (Note)	1
7-8	0.9	0.7		0.4
5-6	0.75	0.6		0.2
Below scale 5	0.75	Determined by wave height (Note)		0.1

Note: $k_3=0.3+0.1H$, and not greater than 0.5. In the formula, H is the maximum significant wave height for sea state prediction during the expected voyage.

5) Friction coefficient μ

The friction coefficient between material and deck is shown in Table 15-7.

Table 15-7 Friction Coefficient (μ)

Materials in Contact	Friction Coefficient (μ)
Wet or Dry Wood	0.4
Steel Wood or Steel Rubber	0.3
Dry Steel	0.1
Wet Steel	0

6) Advanced calculation method

Under normal conditions, the purpose of the design of the securing system is to prevent transverse and longitudinal movement of the vehicle, and to prevent the vehicle from transverse tipping. Due to the extremely small possibility of vehicle longitudinal tipping, the prevention of longitudinal tipping is not considered in the design planning. There are usually

two methods for checking and preventing transverse and longitudinal movement of vehicles, and transverse tipping of vehicles, namely, advanced calculation method and alternative calculation method. For advanced calculation method, the equations for preventing transverse movement, longitudinal movement and transverse tipping of the vehicle, are specifically listed below.

$$\left\{ \begin{array}{l} \text{Calculation of transverse sliding: } F_y \leq \mu mg + \sum_{i=1}^n CS_i f_i \\ \text{Calculation of transverse tipping: } F_y a \leq bmg + \sum_{i=1}^n CS_i c_i \\ \text{Calculation of longitudinal sliding: } F_x \leq \mu(mg - F_z) + \sum_{i=1}^n CS_i f_i \end{array} \right. \quad (15-4)$$

Where: F_x —longitudinal force calculated according to Formula 15-2, kN;

F_y —transverse force calculated according to Formula 15-2, kN;

F_z —vertical force calculated according to Formula 15-2, kN;

n — the number of tying wires included in the calculation. When the vertical securing angle of a lashing wire is greater than 60° , the lashing wire is not included in the sliding balance calculation. Lashing wire with a horizontal securing angle greater than 30° shall not be included in the transverse sliding balance calculation;

μ — friction coefficient, selected according to Table 15-7;

m — vehicle mass, t;

g — acceleration of gravity, taken as 9.81m/s^2 ;

CS — calculated strength of a single securing device, kN, $CS=MSL/\text{safety factor}$, with a safety factor of 1.5. When calculating the longitudinal sliding balance, the longitudinal component force of the transverse lashing wire should not be greater than $0.5CS$;

a — turning arm, m, as shown in Figure 15-2;

b — stabilizer arm, m, as shown in Figure 15-2;

c — mooring arm, m, as shown in Figure 15-2;

f — μ and vertical fixed angle α Function of, $f=\mu \sin \alpha + \cos \alpha$; and

α — As shown in Figure 15-2 for vertical mooring angle.

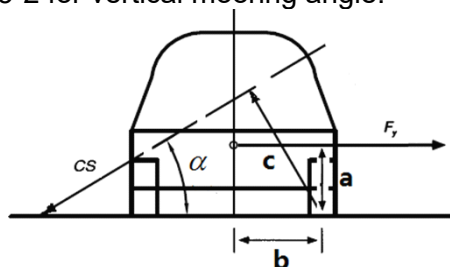


Figure 15-2 Example for Calculation

7) Alternative calculation method

The main differences between the advanced calculation method and alternative calculation method are as follows: (1) The component forces of the transverse and longitudinal lashing wires are considered, which means the horizontal angle of each lashing wire is taken into consideration; (2) The safety factor for calculating the strength CS from MSL is adjusted to 1.35; (3) The moment of the lashing wire against transverse rotation needs to be multiplied by a factor of 0.9.

$$\left\{ \begin{array}{l} \text{Calculation of transverse sliding: } F_y \leq \mu mg + \sum_{i=1}^n CS_i f_{yi} \\ \text{Calculation of transverse tipping: } F_y a \leq bmg + 0.9 \sum_{i=1}^n CS_i c_i \\ \text{Calculation of longitudinal sliding: } F_x \leq \mu(mg - F_z) + \sum_{i=1}^n CS_i f_{xi} \end{array} \right. \quad (15-5)$$

Where: F_x —longitudinal force calculated according to Formula 15-2, kN;
 F_y —transverse force calculated according to Formula 15-2, kN;
 F_z —vertical force calculated according to Formula 15-2, kN;
 n — Number of lanyards included in the calculation, vertical mooring angle α that is less than 45° and horizontal mooring angle β that securing device is greater than 45° should not be used for transverse overturning balance calculations, Vertical mooring angles α and horizontal mooring angle β as shown in Figure 15-3.

μ — Friction coefficient, selected according to Table 15-7;

m — Vehicle mass, t;

g — Acceleration of gravity, taken as 9.81m/s^2 ;

CS— calculated strength of a single securing device, kN, $\text{CS}=\text{MSL}/\text{safety factor}$, with a safety factor of 1.35;

a — Turning arm, m, as shown in Figure 15-2;

b — Stabilizer arm, m, as shown in Figure 15-2;

c — Mooring arm, m, as shown in Figure 15-2;

f_x — A function of μ , vertical mooring angle α and horizontal mooring angle β , $f_x = \cos \alpha \sin \beta + \mu \sin \alpha$;

f_y — A function of μ , vertical mooring angle α and horizontal mooring angle β , $f_y = \cos \alpha \cos \beta + \mu \sin \alpha$;

α — Vertical mooring angle, as shown in Figure 15-3; and

β — The horizontal mooring angle, as shown in Figure 15-3.

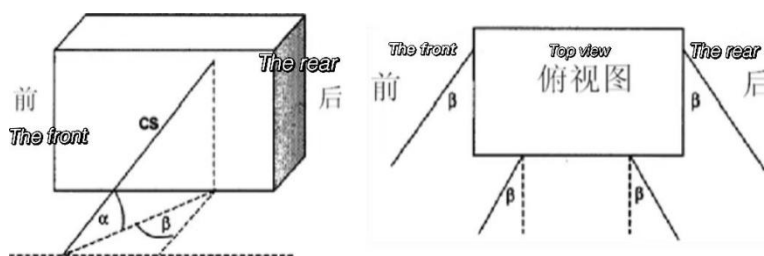


Figure 15-3 Vertical Securing Angle α and horizontal Securing Angle β

8) Calculation of external forces of vehicles on high-speed Ro-Ro passenger ships

For high-speed Ro-Ro passenger ships, the longitudinal force F_x , transverse force F_y , and vertical force F_z acting on the vehicle can be calculated using the following formula:

$$\begin{aligned} F_x &= ma_x \\ F_y &= ma_y \\ F_z &= ma_z \end{aligned} \quad (15-6)$$

Where: m — vehicle mass, t;

a_x — longitudinal acceleration, m/s^2 ;

a_y — transverse acceleration, m/s^2 ;

a_z — vertical acceleration, m/s^2 ;

(1) The vertical acceleration a_z is determined according to the design acceleration of high-speed ships

(2) The transverse acceleration a_y is calculated using the following formula:

$$a_y = \left(\frac{6.28}{T_R} \right)^2 \theta_r r_r \quad (15-7)$$

Where: r_r — the vertical height of the calculated point above the rolling axis, m. The vertical height of the rolling axis from the baseline is determined as follows: the mono-hull ship is taken at a depth of 1/2 type; The catamaran was taken at the waterline. When above the rolling axis, the transverse acceleration should increase by $g \times \sin \theta_r$, $g=9.81\text{m/s}^2$.

T_R — rolling period, s, calculated by the following formula:

$$T_R = \frac{\sqrt{L}}{1.05 + 0.175 \frac{V}{\sqrt{L}}} \quad (15-8)$$

Where: V — maximum speed, knots, the $\frac{V}{\sqrt{L}}$ value need not be greater than 4;

L — ship length between perpendiculars, metres;

θ_r — maximum roll angle, rad, calculated using the following formula:

$$\theta_r = \frac{1.57h_w}{L} \quad (15-9)$$

Where: h_w — wave height at 70% of the maximum speed, m, but the value shall not be less than 0.6 C_w , In the formula C_w is a correction factor, which can be obtained using the following formula. When $L \leq 100m$, $C_w=0.08\delta L$; When $L > 100m$, $C_w=6+0.02\delta L$. δ is the C_w reduction coefficient for the navigation area, which can be obtained according to Table 15-8.

Table 15-8 C_w Reduction Coefficient by Navigation Area δ

Navigation area	Offshore navigation area	Coastal navigation area	Sheltered navigation area
Reduction factor	10%	20%	40%

(3) The longitudinal acceleration a_x is calculated using the following formula:

$$a_x = 2.5 \frac{C_w}{L} \left(0.85 + 0.25 \frac{V}{\sqrt{L}}\right)^2 g \quad (15-10)$$

In the formula, C_w , L , V , and g are all the same as above.

The longitudinal acceleration in the forward half of the ship can be considered simultaneously with the downward vertical acceleration.

When transporting vehicles on an amphibious hovercraft, the acceleration for checking the vehicle securing strength is determined according to Table 15-9, $g=9.81m/s^2$.

Table 15-9 Collision Acceleration

Direction	Forward	Backward	Transverse	Vertical
Collision design acceleration	6g	3g	3g	3g

The strength of the securing device is evaluated using the force balance calculation method in 6 or 7 above. When checking the strength of the securing device of the vehicles on board an amphibious hovercraft, the safety factor of the securing device is taken as 1.

9) Other situations

For other methods of determining motion acceleration and balancing calculations, information should be provided and approved.

Chapter 16 Cargo Management

Section 1 Management of Vehicles and Goods

Different countries have established different management mechanism and systems concerning the management of Ro-Ro vehicles and goods. In this respect, the management mechanism and systems in China is classified as the requirements applying for the management of Ro-Ro vehicles and goods in sea waterway of China, and these for Management of Ro-Ro vehicles and goods in inland waterway of China.

1. Management of Ro-Ro vehicles and goods in sea waterway of China

The *Regulations on the Safety Supervision and Management of Offshore Ro-Ro Ships* (Order No. 23 of the Ministry of Transport of China in 2019) specifies relevant requirements for the management of cargo on Ro-Ro ships sailing in waters under China jurisdiction.

1) Ro-Ro vessels

(1) Ro-Ro vessels shall be inspected by a vessel inspection agency in accordance with the law and obtain corresponding inspection certificates and documents, concerning the following contents:

- ① The performance of the watertight doors at the bow, stern, and side of the Ro-Ro ship;
- ② The carrying capacity of the loading space of a Ro-Ro ship, including the loading capacity of the deck of the loading space and the carrying capacity per square metre;
- ③ Fire protection system and power system for important parts such as loading spaces and passenger cabins of Ro-Ro ships;
- ④ The maximum securing load of the mooring yard, the D-rings on the floor, the D-rings on the roof, and other securing auxiliary devices of the Ro-Ro ship; and
- ⑤ Ro-Ro vessel vehicle and cargo securing manual.

(2) Before sailing, it is necessary to conduct a comprehensive inspection on passengers, cargo, vehicles, safety equipment, watertight doors, and other conditions of the Ro-Ro ship in accordance with the safety operation procedures and relevant requirements, and records should be made;

(3) When a Ro-Ro ship encounters adverse weather and sea conditions during navigation, it is necessary to carefully manoeuvre and operate, strengthen patrols, reinforce cargo and vehicles, prevent cargo shift or collision, and promptly report to the operator and manager of the Ro-Ro ship. When necessary, it shall also report to the maritime administrative agency;

(4) Ro-Ro vessels shall provide an effective ventilation to cargo operation spaces, and determine the hourly air changes for closed Ro-Ro spaces and special spaces in accordance with relevant technical specifications;

(5) The loading location of the vehicle shall be marked with obvious signs. Cargoes shall be evenly stowed on both sides to maintain a transverse balance;

(6) The passenger quota and passenger cabin spaces in a Ro-Ro passenger ship shall be conspicuously marked. The total tickets should be strictly controlled within the approved passenger quota. Ticket-selling for the passengers beyond the quota is always prohibited. It is prohibited to carry passengers in the crew accommodation, loading spaces, safe passages, and other non-cabin spaces of Ro-Ro ships;

(7) Ro-Ro vessels carrying dangerous goods or carrying the vehicles with dangerous goods inside the carriage shall also comply with the *Regulations on the Safety Supervision and Management of Ships Carrying Dangerous Goods*.

2) Operators and managers of Ro-Ro ships

The operator and manager of a Ro-Ro ship should comprehensively consider the carrying capacity and lashing capacity of the loading space of the Ro-Ro ship, clarify the specific plan and requirements for the lashing of the Ro-Ro ship, and should develop a securing manual. Vehicles shall be lashed and secured in accordance with the securing manual. The carrying capacity and vehicle dimensions of in the Ro-Ro cargo space should meet the requirements of the vessel inspection agency.

3) Vehicles, goods, and passengers

(1) Vehicles on a Ro-Ro vessel shall provide the Ro-Ro vessel and port operator with information such as the vehicle identification number and driver contact information. The vehicles carrying cargoes should also provide information such as the name, nature, weight, and volume of the cargoes they loaded. Vehicles travelling on Ro-Ro vessels shall undergo safety inspections at the port in accordance with related regulations. Vehicles which are found to have misrepresented or concealed dangerous goods during inspection shall not be allowed to board the ship. Chinese Ro-Ro vessels shall designate special personnel to inspect the safety of vehicle loading and fill in vehicle safety loading records. The vehicle safety loading record shall be kept on board for at least one month.

(2) Vehicles on a Ro-Ro ship should securely lash the cargo within their carriages, and should be kept in a braking state during water transportation.

(3) Vehicles on Ro-Ro vessels should be in good technical condition, and be parked in designated spaces in-port, as per vehicle types and pre-planned sequence of port of call, waiting for shipment.

(4) When a vehicle intends to embark on or depart from a ship, the Ro-Ro ship and the port operator shall inspect the connection between the wharf and the Ro-Ro ship to ensure the safety of vehicles embarking on or disembarking from the ship. Vehicles shall follow the command of the port operator and the Ro-Ro ship, comply with the safety speed specified by the port operator, and drive in sequence.

(5) Vehicles, drivers, and passengers shall comply with the following regulations:

① The vehicle should enter the designated position in cargo space and shut down the engine during navigation;

② The driver shall not stay in the vehicle during the voyage of the ship, nor shall he stay at the loading place;

③ Passengers are not allowed to stay in the vehicle during boarding and disembarking and during the voyage of the ship, nor are they allowed to stay at the loading place;

④ Special vehicles such as passenger trains, ambulances, escort vehicles, refrigerated vehicles, and fresh food transportation vehicles, are excluded.

(6) Ro-Ro vessels carrying passenger trains shall strengthen the safety management of personnel and cargo during the period of passenger trains on board and during loading and unloading operations. Emergency evacuation procedures for passengers should be developed. The passenger train operator should be informed for this purpose. In the event of an emergency, the Ro-Ro ship shall organize the safe evacuation of passengers in accordance with the emergency evacuation procedures. The passenger train operator shall fully cooperate with the ship for the evacuation operation.

2. Management of Ro-Ro vehicles and goods in inland waterway of China

1) The *Technical Rule for the Statutory Survey of Inland ships 2019*

(1) General provisions

When vehicles are being loaded on Ro-Ro passenger ships and Ro-Ro cargo ships, parking spaces should be arranged according to the principle of even loading on both sides. The vehicles should be located within the vehicle loading space, and effectively fastened.

Passenger ferries are prohibited from carrying motor vehicles other than two-wheeled motorcycles (including electric bicycles) and the tricycles for the disabled. When passengers carry bicycles, motorcycles (including electric bicycles), and tricycles for the disabled, the number of passengers should be accordingly reduced. Bicycles and two wheeled motorcycles (including electric bicycles) should be parked securely in the parking area after boarding.

(2) Ship outfit

Effective measures should be taken to prevent the vehicles in the Ro-Ro space on board from transverse and longitudinal moving, and transverse tipping, so as not to endanger the safety of the ship, vehicles, and personnel.

The vehicle lashing of Class I Ro-Ro passenger ships, Class II Ro-Ro passenger ships, and commercial car Ro-Ro ships shall meet the following requirements:

① The vehicle deck shall be equipped with anti-skating devices;

② The ship shall be equipped with wooden wedges (or other effective measures) to chock off the front or rear wheels of the vehicle and prevent the vehicle from moving forward or backward;

③ During navigation, parking brakes of all the vehicles on board should be engaged; and

④ The ship should be equipped with the securing devices with sufficient strength. The securing manual should include the vehicle securing plan and the evaluation report both of which are developed after a full evaluation. During the evaluation, the combined motions of ship roll, pitch, and heave should be considered.

The vehicle lashing for vehicle/passenger ferry shall meet the following requirements:

① The vehicle deck shall be equipped with anti-skating devices;

② The ship shall be equipped with wooden wedges (or other effective measures) to chock off the front or rear wheels of the vehicle and prevent the vehicle from moving forward or backward;

③ During navigation, parking brakes of all the vehicles on board should be engaged; and

④ In severe weather conditions, effective measures should be taken to ensure a reliable security of vehicles on board.

The vehicle springboard and its lifting devices installed on the ship shall meet the following requirements:

① The vehicle springboard load test shall meet the relevant requirements of the China Classification Society's "Rules for Lifting Equipment for Ships and Offshore Installations" approved and published by the China Maritime Safety Administration according to the prescribed procedures;

② The lifting devices of the vehicle springboard shall meet the relevant requirements of the China Classification Society's "Rules for Lifting Equipment for Ships and Offshore Installations" approved and published by the China Maritime Safety Administration according to the prescribed procedures;

③ Anti-skating devices shall be installed on the vehicle springboard; and

④ The vehicle ramp of Class I and Class II Ro-Ro passenger ships should be picked up and secured in the position during navigation. The danger caused by the vehicle ramp including possible collision with other ships should be minimized.

2) *The Regulations on the Safety Management of Inland Waterway Ferry*

(1) Ferry vessels shall be equipped with passenger carrying spaces to separate vehicles from passengers. At the port of departure, vehicles should be loaded first, and then the passengers can embark the ship. On the contrary, at the port of destination, passengers should disembark the ship first, and then the vehicles can be discharged. It is prohibited to leave personnel in the vehicle except for the driver during ferry sailing. Passengers and large livestock must not be mixed;

(2) Passengers and vehicles shall comply with the safety management regulations of ferry vessels, and during cargo operation period, follow the instructions of local ferry operators. Vehicles should drive at a low speed within the cargo operation area, and follow the loading sequence at the designated location. Vehicles should not cut in. Vehicles with poor braking, abnormal steering systems, or other faults that may affect a safe driving, are not allowed to be drove on ferries;

(3) Before a vehicle carrying dangerous goods being loaded on board, the vehicle driver or the escort should inform the ferry operator of the type and hazard characteristics of the dangerous goods loaded, as well as the safety measures that need to be taken.

Section 2 Management of Dangerous Goods

A great importance to the management of dangerous goods of Ro-Ro ships has been attached by all the countries throughout the world, including China. The *Technical Rule for the*

Statutory Survey of Domestic Seagoing Ships 2020, the *Regulations on the Safety Supervision and Management of Ships Carrying Dangerous Goods*, the *Regulations on the Safety Management of Inland Waterway Ferry*, and the *Regulations on the Administration of Domestic Water Transport* (Order No. 79 of the Ministry of Transport of China in 2016), all set clear requirements for the transportation of dangerous goods by ships in China's waters. The main requirements are given below.

1. The *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020*

According to the requirements for the shipment of dangerous goods in Chapter 6-2 of the *Technical Rule for the Statutory Survey of Domestic Seagoing Ships 2020*: (1) Unless otherwise approved, passenger ships, passenger ferries, and Ro-Ro passenger ships are prohibited from carrying dangerous goods; (2) Dangerous goods stowed on deck only on Ro-Ro ships should not be loaded on closed and open vehicle decks, but only on open decks.

2. The *Regulations on Safety Supervision and Management of Ships Carrying Dangerous Goods*

(1) It is prohibited to transport highly toxic chemicals through closed inland waters and other hazardous chemicals that are prohibited by national regulations from being transported through inland waterway. The transportation of highly toxic chemicals and other hazardous chemicals prohibited by national regulations through other inland waters is prohibited. Passenger and cargo ships or Ro-Ro passenger ships with corresponding qualifications shall not carry passengers when carrying dangerous goods, except for accompanying the escorts and drivers of Ro-Ro vehicles in accordance with relevant regulations. Other passenger ships are prohibited from carrying dangerous goods;

(2) Crew members who engaged in the transportation of dangerous goods on ships shall, in accordance with regulations, shall hold special training certificates, be familiar with the safety knowledge and operating procedures for the transportation of dangerous goods on their ships, and understand the nature of the dangerous goods transported and the safety precautions and emergency processing measures.

3. The *Regulations on the Safety Management of Inland Waterway Ferry*

(1) Ferry ports for transporting dangerous goods vehicles shall be equipped with dedicated passages for dangerous goods vehicles;

(2) Ferry vessels carrying dangerous goods or the vehicles with dangerous goods loaded within the carriages shall hold a certificate of fitness for the carriage of dangerous goods;

(3) When a vehicle carrying dangerous goods is shipped in a ferry, the vehicle driver or the escort shall actively inform the ferry operator of the type and hazard characteristics of the dangerous goods loaded, as well as the safety measures that need to be taken. When vehicles with dangerous goods loaded within the carriages are to be loaded on a ferry, it is necessary to check whether the vehicle holds a Road Transport Certificate that matches the category, item, or name of the dangerous goods being transported. The goods carried on the vehicle should also match the ship's certificate of fitness. A ferry should isolate the storage of dangerous goods in accordance with relevant regulations. A ferry shall not carry passengers and dangerous goods simultaneously. When a ferry carries a vehicle loaded with dangerous goods, the total number of escorts, except the crew, shall not exceed 12. It is strictly prohibited for anyone to conceal, disguise, or smuggle various dangerous goods or polluting hazardous goods. A ferry is not allowed to transport goods prohibited by laws, regulations, and regulations of the Ministry of Transport of China, and is not allowed to carry vehicles loaded with dangerous goods that do not hold the corresponding *Road Transport Certificate* issued by the local administrative branch of Ministry of Transport of China;

(4) If it is found that dangerous goods such as inflammable and explosive goods are mixed with passengers on the same ship, or if the vehicle carrying the dangerous goods is mixed with passenger vehicles on the same ship, the ferry shall not be allowed to sail;

(5) Whoever commits the following illegal acts shall be ordered by the local administrative branch of China Maritime Safety Administration to make corrections, and the owner or operator of the ferry shall be fined not more than 2,000 yuan:

① The ferry which does not hold the corresponding certificate of fitness for dangerous goods to carry dangerous goods;

② The ferry which does not hold the corresponding certificate of fitness for dangerous goods to carry the vehicle loaded with dangerous goods; and

③ The ferry which carries the vehicle that should hold, but actually not hold, a *Road Transport Certificate*.

④ The ferry carrying passengers and dangerous goods at the same time.

4. The *Regulations on the Administration of Domestic Waterway Transportation*

(1) The ships which are put into operation by a waterway transport operator shall meet the following conditions:

The ship should be suitable for the business scope of the waterway transport operator. Those engaged in passenger transportation shall use ordinary passenger ships, passenger and cargo ships, and Ro-Ro passenger ships (collectively referred to as passenger ships) for transportation. Those engaged in the transportation of liquid dangerous goods in bulk shall use liquefied gas carriers, chemical carriers, product oil tankers, and crude oil tankers (collectively referred to as dangerous goods carriers) for transportation. Those engaged in the transportation of ordinary goods, packaged dangerous goods, and bulk solid dangerous goods may use ordinary cargo ships for transportation.

(2) When using passenger and cargo ships or Ro-Ro passenger ships to carry dangerous goods, these ships shall not carry passengers, except for personnel escorting goods on board and the drivers of Ro-Ro vehicles in accordance with relevant regulations.

It can be seen from the above provisions that vessels engaged in the transport of passenger ships, passenger ferries and Ro-Ro passenger ships are prohibited to carry dangerous goods in Chinese waters unless otherwise approved. Ferries carrying dangerous goods (including the vehicles loaded with dangerous goods) shall hold the *Certificate of Fitness for Carrying Dangerous Goods* issued by the competent maritime authority. When ferries carry the vehicles loaded with dangerous goods, they shall not carry passengers at the same time, except for personnel escorting goods on board and the drivers of Ro-Ro vehicles in accordance with relevant regulations. However, the total number of the escorting personnel and the drivers shall not exceed 12.

Part IV Ferry Passengers

Chapter 17 Embarking and Disembarking of Passengers

The safety of passengers' lives is a matter of importance that requires special attention from the time they board the ferries. Firstly, adequate and appropriate safe gangways, fenders and safety nets shall be in place, where necessary, for the safety of the domestic ferry and adequate and safe means of access between the domestic ferry and berth shall be provided. Secondly, crew members need specific work procedures to help passengers establish a sense of security and confidence in the new environment, such as familiarizing passengers with the living environment and the locations for storing lifeboats, checking passengers' boarding pass and listening to public announcements. More importantly, it is necessary for passengers to know the general requirements for safe embarking and disembarking.

Meanwhile, passengers also need to follow the safety management requirements under emergency conditions and familiarize themselves with safety instructions, under the guidance of crew in charge.

Section 1 General Requirements for Passenger Embarking and Disembarking

Passenger embarking and disembarking may face various situations, but one principle must be followed: passengers embarking and disembarking cannot run in parallel with loading and unloading of cargo. In order to ensure the safety of passengers embarking and disembarking, the following aspects should be taken into consideration: establishing a safety system for passengers embarking and disembarking; defining the procedures for passengers embarking and disembarking from the ship; paying attention to passengers in corridors, stairs, and passageways; taking care of the disabled and passengers in need of special assistance; specifying the principles for using lifts and elevators; establishing safety work inspection standards; properly resolving security risks; and specifying the items that passengers are not allowed to carry on board the ship and items that are not allowed to be checked in.

1. Establishing a safety system for passengers embarking and disembarking

To ensure the safety of passengers when embarking and disembarking, a ferry should establish practical safety rules and regulations based on the characteristics of the ship and implement them in daily operations.

(1) To ensure that the ship sails on time, all loading and unloading operations should be completed within the specified time.

(2) When passengers are embarking and disembarking, the boom should not be lifted or fall, and the hatch cover should be closed to ensure the safety of passengers, luggage, and goods.

(3) The crew in charge shall strengthen contact with the passenger station, organize safe embarking and disembarking, accurately grasp the passenger quota, and strictly prohibit overloading.

(4) During the process of embarking and disembarking passengers, the crew in charge should assign special personnel to take care of and command the crossings and intersections within the ship in advance to prevent congestion.

(5) Before passengers' embarking and disembarking, the crew in charge must clearly assign a dedicated person to maintain order, inspect the preparation of doors, ladders, safety nets, and other items, and be specifically responsible for the safety of the stairways.

(6) Under normal circumstances, before departure, the crew in charge has the responsibility to prevent early withdrawal of the ladder and departure, and strictly prevent passengers from crossing the bulwark to board the ship.

(7) Before disembarking, the crew in charge should obtain the consent of the bridge in advance, command the disembarking, and strictly prevent passengers from crossing the bulwark to disembark.

(8) Crew in charge should make every effort to take care of the safety of passengers when embarking and disembarking from the ship, make announcement on the precautions for embarking and disembarking, guide passengers in and out, and actively support the elderly and children.

2. Defining the procedures for passengers to embark and disembark from the ship

(1) If there is a passenger elevator, passengers should get on and off the elevator directly, and they are not allowed to pass through the car cabin.

(2) If passenger elevator is unavailable and passengers must go through the car cabin to get on or off, vehicles should be loaded before passengers getting on and passengers should disembark before unloading.

3. Paying attention to passengers in corridors, stairs, and passageways

Passengers are prone to getting lost on board ferries, for the design of passenger cabins and corridors on ferries is relatively complex. Therefore, guidance provided by crew in charge is badly needed. On board, the escape route near the passenger compartment or the crew accommodation should be kept unobstructed at all times. It is prohibited to stack debris, and the lighting equipment on board should be available.

4. Caring for the disabled and passengers in need of special assistance

Special care should be given to the elderly, weak, sick, and disabled passengers when embarking and disembarking to help them overcome the difficulties of embarking and disembarking. For passengers who are physically challenged, a position close to the main entrance should be reserved as appropriate; at the same time, these locations should be clearly marked with appropriate signs, and the passageway should be free of obstacles.

5. Defining the principles for using lifts and elevators

With the development of the shipbuilding industry, elevators that allow passengers to ride have been installed on passenger ships, but the use of elevators is limited to normal safety conditions. In case of emergency, the captain must make a decision before using the elevator. During the process of abandoning ship, it is prohibited to use lifts and elevators.

1) Use of lifts and elevators

Currently, elevators on domestic ferries are mainly used to carry goods and passengers' luggage, and under no circumstances are they allowed to carry people. Individual Ro-Ro passenger ships are equipped with elevators to carry passengers. Whether it is a cargo elevator or a passenger elevator, it is currently started by a motor, so accidents are prone to occurring in emergency situations.

2) Reduction or even loss of elevator's function in emergency situations

Power failure and motor damage may result in the malfunction of the elevator in an emergency.

When the ship is listing, the vertical direction of the elevator changes at any time, and it fails to carry the crew and passengers normally.

6. Establishing safety work inspection standards

(1) Conduct regular safety education for crew in charge to establish the concept of "safety first";

(2) Carry out safety activities, keep records and promptly resolve unsafe factors identified;

(3) Passenger transport facilities such as upper and lower siporter, side scuttles, side scuttle safety covers, door hooks and bunks should be kept in normal use;

(4) When the wind and waves are strong, reinforcement measures should be taken for moving items, and the implementation of measures for preventing fire, freezing, and skidding should be regularly checked;

(5) Carefully implement the responsibility system for embarking and disembarking of passengers, take good care of the elderly, weak, sick, and disabled passengers, and prevent passengers from falling and bumping;

(6) Regularly publicize the precautions and safety knowledge for passengers on board;

(7) Promote the prevention of passengers from carrying dangerous goods on board and keep congestion under control;

(8) Seriously implement the tableware disinfection system, do not sell spoiled food, and prevent passengers from being poisoned;

(9) Electrical connectors such as bedside lights and switches in the cabin should not be exposed, and relevant switches should be turned off after disembarking;

(10) Avoid using household appliances such as electric stoves in the room;

(11) Carefully check whether there are any lit cigarette butts, kindling, etcetera in the cabin after disembarking of passengers.

7. Properly resolve security risks during embarking and disembarking

Proper handling of security incidents at the port/ship interface is crucial for the safety of both crew and passengers. This is about caring for passengers and public confidence in the safety of maritime scenarios. Both crew members and passengers face the risk of violent crime on board. Holding a legal work permit and boarding pass is the first step in ensuring security.

Generally speaking, shipping companies improve security by installing closed circuit television (CCTV) to ship deck areas. The deployment of ship security Officers and the installation of monitoring systems can effectively prevent and suppress the occurrence of criminal acts on board ships. By providing regular security training to crew members and enhancing public security awareness in the ferry industry, the incidence of security incidents can be effectively reduced.

For ferries, security controls can be implemented in terms of control of passenger when embarking and disembarking, access control and identification, as well as search and screening of passengers, their vehicles, and luggage.

1) Access control and identification

Personnel and their baggage should receive routine inspection and monitoring before embarking. Consideration should be given to checking passengers and their luggage one by one. In situations where the security level is high, an effective passing mechanism should be introduced to more easily identify those authorized to enter the access area with specific work tasks. Passengers are only allowed to enter through designated passages and need to undergo security checks. Access to ships also requires strict control. Crew members should hold relevant passes, and the identity of passengers should be carefully checked.

2) Search and screening of passengers, their vehicles, and luggage

Items brought on board must be inspected to varying degrees based on the level of risk posed by illegal acts to crew members and other passengers. In situations where the security level is high, security searches and screens should be more careful, and trained personnel, equipment, and facilities must be readily available.

8. Specify that items that are not allowed to be carried on board the ship or to be consigned.

1) Specify the items that passengers are not allowed to carry on board

(1) Prohibited goods, flammable, explosive, toxic, corrosive, radioactive, and other dangerous goods that may endanger the safety of persons and property on board;

(2) All kinds of articles with odour, foul smell or other peculiar smell;

(3) A coffin, corpse or skeleton;

Passengers who violate the above three provisions and cause damage shall be liable for compensation.

2) Items that would result in failure in check-in

(1) Prohibited goods, flammable, explosive, toxic, corrosive, radioactive, and other dangerous goods that may endanger the safety of persons and property on board;

(2) Dirty articles, articles that are prone to damaging and polluting other luggage and ship equipment;

(3) Money, gold and silver, jewellery, securities, or other valuables;

(4) Live animals and plants;

(5) A coffin, corpse or skeleton.

Section 2 Safety Instructions

After embarkation, passengers should first understand the passenger safety instructions as soon as possible, especially, the requirements on the safety management of the crowds in emergency situations. Passengers can be made aware through written form (posted at specified locations) and broadcast form (emergency statement) to ensure safety.

1. Passenger safety instructions

At the sixty-fifth session of the IMO MSC held from September 9th to 17th, 1995, the *Guidelines for passenger safety instructions on ro-ro passenger ships (MSC/Circ.681)* were adopted, which provide guidance to shipowners, operators, captains, crew members and interested parties. The passenger safety instructions can be elaborated on from the following four aspects: passenger safety instructions, emergency deployment for passengers, actions to arrive at the assembly station, and marks to identify crew.

1) Basic requirements for safety instructions

(1) Language

① Posted instructions should make maximum possible use of symbols and diagrams in order to minimize "wordiness" and convey essential instructions to passengers regardless of language skills.

② Printed information as well as announcements, should be made in languages likely to be understood by all persons of nationalities on board, but on board ferries where there are a variety of "international" passengers, English should be used as the common language when making communications.

③ Crew members assigned to direct and assist passengers in an emergency should be able to communicate with passengers on the particular route. If necessary, crew members can be trained to have necessary language skills. They may also be trained in basic commands in languages other than their native language and in non-verbal communications.

(2) Signs

The following signs shall comply with the requirements of IMO *Resolution A.760(18)* regarding colour identification, as detailed in *Signs Related to Life-saving Equipment and Arrangements*.

① Assembly stations should be readily identifiable and their purpose should be made known. The routes to the muster stations should be clearly marked. It is also important that normal and emergency exits from enclosed spaces are clearly indicated;

② The colours used in the signs and cabin numbers should contrast with those of the panelling to which they are attached;

③ This guide should be placed in a prominent and continuously illuminated location without other signs;

④ Each assembly stations should be marked with a "assembly station" symbol, and different assembly stations should be distinguished by letters or numbers. If the boarding location is the assembly station, there is no need to distinguish between the assembly station and the boarding location. If the assembly station is not a boarding location, the two locations should also be distinguished;

⑤ In all places where passengers are present, there should be directional signs indicating the assembly station;

⑥ The route to the assembly station should be unobstructed at all times;

⑦ Indication signs should be marked to indicate where to assemble and where to board;

⑧ Doors, windows, and sidescuttles that can be used for escape in emergency situations should have obvious signs related to "emergency exits";

⑨ Each deck on which passengers are located shall be numbered for identification. In addition, it can also be identified by name, and relevant signs should be marked on all passageways and public rooms and be clearly visible.



Figure 17-1 Some safety signs specified by IMO

(3) Methods of providing safety instructions for passengers

It is important to provide passengers with safety instructions and draw their attention to the environment and the contents of the passenger safety instructions. There are many ways to encourage passengers to read the instructions. The crew can issue a brief safety card or origami card to each passenger. Remind passengers to pay attention to the location and content of the emergency notice, and encourage them to read the pamphlet and notice. One of the most effective methods is to attract their attention through public broadcasting. The broadcast shall be conducted in English and in a language determined by the nationality of the majority of passengers. The broadcast should be relatively concise and meet the requirement to convey sufficient information to the audience so that passengers can gather in an orderly manner.

In addition to public broadcasting, other suitable means can be used to ensure that passengers on board are effectively alerted to emergency instructions, such as playing demonstration videos on board or at the terminal; Attaching a piece of paper containing emergency procedures information when selling tickets; Including information on emergency instructions in magazines and brochures distributed to passengers. Under certain circumstances, it is more appropriate to provide safety information at a passenger station than on board a ship. The following methods can also be considered to provide safety information:

- ① Post publicity or display information at passenger stations;
- ② Distribute safety related printed materials regularly in areas with highly frequented vessels;
- ③ Demonstrate how to life jackets in public places on board;
- ④ Provide special information cards, colourful books, and other activities for children. Some children will learn and follow the instructions, as well as teach other children to follow the instructions;
- ⑤ Shipboard cinemas can show movies about safety on board before the movie starts;
- ⑥ Safety instructions can also be posted on the inside of the lavatory door;
- ⑦ Make aware of safety procedures with magazines, articles, or brochures distributed on board.

(4) Safety Notice

Announcements on board should be made after all the passengers have boarded and either prior to or immediately on departure from the berth, while no other announcement or music is allowed to be broadcast. Shops, services, and entertainment should not begin until the announcement is finished. Alternatively, services may be suspended while the announcements are made. Since it is often difficult to gain the full attention of passengers at this early stage during the voyage, it is recommended that this type of announcement should be prefaced by a special signal when the public address system is used and followed by a request for everyone's attention. Such announcements should be relatively brief and compatible with the need to convey enough information to the listener to enable an orderly muster of the passengers to take place if it is necessary. Passengers should be encouraged to look for the assembly stations so they can learn that the location where they came aboard

via the gangway is not the place to go in case of an emergency. Figure 17-2 shows safety instruction broadcast on board a ferry.

Ladies and Gentlemen, would you please listen very carefully to the following safety announcement? ↵

In the unlikely event of an emergency, the general emergency alarm signal will sound. When the alarm sounds you must go to your/the nearest assembly stations. This signal consists of seven or more short blasts followed by one prolonged blast on the ship's whistle or siren and by a similar signal on the alarm bells. ↵

If you are in a location remote from your cabin, please go directly to your/the nearest assembly station. If you are in your cabin or close to your cabin when the signal is heard dress warmly, collect your lifejacket and any essential medication and follow the direction signs to your assembly station. ↵

The assembly stations on this ship are located on [(deck number).....] and can be identified by a square green and white sign and an arrow in each corner pointing inwards to a symbol showing a family group. Look in the vicinity of your cabin door for information on your assembly station. ↵

At an assembly station a crew member will give you a lifejacket, if needed. Put it on. The crew members will help you if necessary. You should remain calm and follow the instructions of the crew members at your station. ↵

Your attention is drawn to the passenger emergency instruction notices and the ship's plans showing escape routes which are posted in the vicinity of the door of your cabin, assembly stations, and in other spaces. ↵

Please read all the safety notices thoroughly and take time now to study the ship's layout, emergency signs, and the escape route from your cabin to your assigned assembly station and to the nearest open deck. ↵

Try on your lifejacket at this time. If you have children travelling with you, ask your steward to get a lifejacket for each child and have the children try it on. ↵

Safety instructions and notices are posted throughout the ship for your protection. It is important that you observe them while on board. ↵

If you have any questions regarding safety, do not hesitate to ask any of the ship's officers or crew.↵

Figure 17-2 Safety Instruction Broadcast

2. Deployment of passengers in case of emergency

1) General emergency alarm signal

In the event of an emergency, the ship's blast or whistle and the ship's alarm bell should send the following warning signals: "Seven or more short sounds followed by a long blast."

2) Action taken after hearing the general emergency alarm signal

(1) Proceed directly to the nearest assembly station, if you are in a location remote from your cabin. The direction sign to assembly station consists of the assembly station sign and an arrow pointing to the appropriate direction;

(2) If you are in your cabin or close to your cabin when the signal is heard, dress warmly, collect your lifejacket and any essential medication and go to your assembly station following the direction signs;

(3) Assist those who need help;

(4) Follow the instructions of crew members and those given through the public address system;

(5) DO NOT return to your cabin to collect your property;

(6) DO NOT use lifts; and

(7) If the nearest exit is blocked, use the alternative exit as marked in the plan, which is shown by a dotted arrow. (see Figure 17-1).

3. Actions taken to arrive at assembly stations

The assembly station is a space where passengers assemble in case of an emergency. Assembly stations are marked by the sign shown in Figure 17-1.

Remain calm and follow the instructions of the crew members at your assembly station who will give you a lifejacket, if needed. Put it on. The crew members will help you if necessary. Lifejackets for children are available. Please see instructions on how to don a lifejacket. You are encouraged to try on your lifejacket.

4. Marks to identify crew

In case of an emergency, passengers must be able to distinguish crew members, who can guide and help them, from other passengers. To facilitate this process, the crew should wear uniforms, uniform working clothes or something with distinctive features, such as caps or vests marked "crew". It is recommended that vests marked "crew" are placed at specific locations, for the use of crew members off duty and without uniform if they are asked to deal with the emergencies.

Chapter 18 Management of the Crowds

After an emergency, the management of passenger order is the key to managing the crowd, and ensuring personal safety is the primary task and goal to solve safety issues. As one of the most important safeguards to prevent serious accidents from happening, the safe evacuation has gradually become the focus of IMO and its Member States. Good order is a prerequisite for a smooth, safe and rapid evacuation of passengers. Disorder and noise make it difficult for crew in charge to convey instructions by using their indicative language, resulting in fear from passengers, passages blockage, and stampede, which will make evacuation team impossible to get access to and finally lead to catastrophic consequences. Therefore, it is crucial to manage the order of passengers when disembarking the ship.

Section 1 Management of the Crowd in Emergency Situations without Abandonment of Ships

The situation where a ferry encounters fire, collision, man overboard or stranding is considered as an emergency regardless of whether the ferry sinks or not. When it is confirmed that the ship is not in danger of sinking, that is, when a non-abandonment situation occurs, time for the rescue operation will be relatively sufficient, but sufficient attention should also be paid to it and emergency arrangements should be strictly followed. As for abandoning ship for survival, keeping order among passengers is a key issue in the crowd management. Therefore, crew members should use procedures to prevent passengers from panicking. In particular, attention should be paid to the management of crowded people in emergency situations where cabin fires, ship flooding or man overboard occurs.

1. Passenger compartment on fire

If cabin fire is detected, crew in charge should immediately take the following measures:

- (1) Break the glass of the fire alarm shield nearest the fire compartment and activate the button;
- (2) Take appropriate actions to call for help and rescue passengers who are blocked in the fire;
- (3) Crew in charge should act quickly and play their roles according to the tasks specified in the Contingency plan. They should be in order and should not be panic;
- (4) Assist passengers with the ability to escape on their own; If there are elderly, weak, sick, and disabled passengers, crew in charge should help them escape, and if conditions permit, try to take out the passengers' belongings.
- (5) After confirming that there are no passengers in the cabin, quickly close the doors and windows, cut off ventilation and prevent the wind which assists fire from spreading downward;
- (6) Transfer passengers and their luggage from the adjacent compartment to a safe area;
- (7) If there is a fire in a small area, such as in individual cabins, it is not advisable to immediately broadcast and notify passengers to avoid unnecessary panic; Crew in charge shall take measures at any time to protect the safety of lives and property of passengers in accordance with instructions.

2. Flooding on Ship

After hearing the water inflow alarm signal, the ship's flood control team should take the leakage stopping tools and equipment to the scene in accordance with the *Emergency Muster List*, and follow the command of the captain to carry out emergency leakage stoppage and rescue.

Priorities and procedures in controlling the flood:

- (1) Crew in charge shall promptly contact the captain and the flood control team leader to know how the leaking progresses, and notify the crew in charge of the passenger transportation department to be in a state of emergency;
- (2) Crew in charge prepares blankets for flood protection;
- (3) Crew in charge shall arrive at the designated location as soon as possible according to the responsibilities specified in the *Emergency Muster List* and *Task Card*; Maintain order

among passengers, follow the arrangements of crew in charge and team leader of flood control at any time, and make arrangement for passengers according to the progress of the leak stoppage.

3. Personnel overboard

Ferries should regularly conduct overboard drills among crew to enable each crew member to understand and familiarize themselves with their roles and responsibilities during life-saving, know the status of their own life-saving equipment, and master the operational skills of life-saving equipment, so that in the event of an emergency, effective measures can be taken immediately and the successful rescue can be ensured when there is someone overboard.

If passengers accidentally fall into the water during the voyage, those who identify them should immediately report to the bridge and throw the lifebuoy nearby to the man overboard; The ship doctor should immediately put on a life jacket and carry first aid kit and get ready for boarding the lifeboat to rescue people. The lifeboat should be launched into water within five minutes; The crew in charge should get blankets and other items ready for use in the emergency lifeboat. If someone falls into the water while the ship is berthing, the person on board should hold the lifeline with one hand and throw the lifebuoy in the downstream direction of the person falling into the water with the other hand; "When there is no current and there is wind, the lifebuoy should be thrown upwind to those who fall into the water. Alternatively, the person on board could also tie the lifeline to a railing and throw a lifebuoy by simultaneously using both hands to save the man overboard. Be careful not to hit drowning passenger with the lifebuoy.

Crew in charge should be responsible for maintaining order according to the requirements of the *Emergency Muster List and Task Card*, and passengers are not allowed to leave their cabin at this time. Passengers outside the cabin should return to their own cabin to prevent passengers from crowding and waiting, which may hinder the smooth progress of the rescue operation. Crew in charge should provide heated beverages, such as milk, sugar, boiled water, etcetera. If passengers have not had food for a long time before being rescued, crew in charge should dilute the beverage and gradually increase the concentration of milk and sugar according to the patient's physical condition. Do not give alcohol or alcoholic beverages to the patient, nor promote the patient's blood circulation by massage, medication, or alcohol rubbing. In addition, heating or warming of the man rescued is absolutely inappropriate.

Passengers who have been rescued from distress, if they are still conscious, should take off all wet clothes and try dry clothes on or wrap themselves with blankets, and rest in an environment with a temperature not exceeding 20°C to gradually recover their temperature. Whether a drowning passenger is rescued or not, a passenger transport record should be filled in, and there should be two or more circumstantial evidence records. The record should be clearly handed over to the station at the port of arrival, and the company's department in charge should be kept informed.

4. Other conditions

Some operations on board ships may have an impact on the safety of passengers, such as the failure in the operation of watertight doors and loading and unloading of toxic and harmful goods. At this time, the crew in charge should pay more attention to the handling of these non-abandonment emergencies resulting from the above-mentioned failure and the care for passengers.

Section 2 Management of the Crowd in Emergency Situations in Case of Ship Abandonment

When the ship encounters serious dangerous situations such as collision, grounding, fire, explosion, bad weather, water leakage from the ship's hull, the rescue of the ship is ineffective, and assistance is inaccessible, the captain will give the order to abandon the ship. The order of abandoning a ship can, to some extent, cause large-scale activities on board by passengers, which can easily lead to unexpected situations such as panic and stampede. Therefore, it is

very important for crew members to be well trained in emergency management, and their professional crowd management capabilities can effectively reduce the occurrence of casualties. It is necessary to make them clear about what to know and how to do when abandoning a ship, how to assist passengers to quickly reach the assembly stations, issues to be noted when abandoning a ship for survival, and matters to be noted when boarding a lifeboat.

1. Knowledge crew members should have and procedures of abandoning a ship

(1) After the captain gives the order of abandoning the ship, the crew should play their roles according to the tasks specified in the *Emergency Muster List* and *Task Card*.

(2) The announcer shall, under the guidance of the head of passenger transport, broadcast the abandon ship emergency statement to passengers. The announcer should repeatedly issue reassuring notices and instructions, and should not use intemperate words to cause confusion among passengers. The crew in charge shall guide the passengers in the cabins to prepare for abandoning the ship.

(3) Use broadcast to guide each crew member's specific work in emergency.

2. Organize and assist passengers to quickly arrive at the assembly station

The crew shall organize and assist passengers to quickly arrive at the assembly station according to the requirements of emergency deployment. When evacuating passengers, the crew should lead the way or give corresponding guidance instructions at some necessary positions, such as corners. During the evacuation, order should be kept among passengers as much as possible to avoid blocking, stampede, and other unexpected situations. Assistance should be provided to persons with disabilities and those in need of special assistance. This section will be explained in detail in Chapter 19.3.

After arriving at the assembly station, the crew should count the number of passengers as soon as possible and designate a person to search the passenger compartment for passengers still stranded in the cabin. When all the people are counted, they can together leave the ship in distress. When abandonment of ship occurs, the crew should strictly observe discipline, keep calm and never be panic. They must follow the passengers and make passengers first board the boat.

3. Factors to be considered when abandoning a ship for survival

Once the people on board successfully abandon the ship, they need to transfer to another mode of transportation - lifeboats or liferafts, or receiving assistance from helicopters or larger rescue ships.

In order to successfully go through the survival stage, attention should be paid to the following issues when the crew or passengers abandon the ship for survival:

(1) If time permits, more clothes, gloves, hats should be worn, etcetera to reduce heat emission from the human body, and take with more blankets, fresh water, food, etcetera;

(2) Life jackets should be quickly put on, as they enable survivors to maintain a floating posture with their faces upward after falling into the water, and enable them to maintain a buoyant state even in a coma;

(3) Keep body dry and allow passengers to board the lifeboats and rafts directly from the ship. Maintain good order. Only when the lifeboats are lowered to the boarding deck can passengers be allowed to board the lifeboats. Passengers should board the lifeboats and rafts in order, so that they can avoid being confused due to scrambling;

(4) When it is necessary to dive at a last resort, try a low position and check whether there are obstacles on the outboard and water surface before diving into the water. Try to avoid jumping into the water from a height of more than five metres; It is prohibited to jump into the water from a high place; Even if it's easy to dive from somewhere, look for a place closer to the water; Jumping into the water from a height of 20 metres or higher means contact with the water at a speed of 80 kilometres per hour, which is equivalent to hitting the concrete ground, will probably result in serious injury or death;

(5) Spend less time in the water and strive to board the raft as soon as possible. If it is not easy to board the raft, do not engage in unnecessary swimming to reduce the body heat; If in a life jacket, try to stay still while in cold water, keep the body in motion to fend off hypothermia;

(6) After jumping into the water, it is necessary to protect hands, feet, and other parts of the body from being attacked by objects to avoid attracting sharks with blood; when encountering a shark, it is best to avoid it. If it is impossible to make the avoidance, give a loud shout, scare the sharks away or hit their most sensitive parts.

(7) When there is a fire on the water surface, try to jump into the water from the windward direction. When taking a breath, first reach out of the water with hands, poke away the flame on the surface, and turn face to the leeward direction when head is in contact with the water;

(8) If there is oil on the water surface, try to keep head above the water surface, shut mouth tightly and prevent oil from splashing into eyes;

(9) When ship is sinking, it will generate vortices. Remember to stay away from the vortices;

(10) If there is no lifeboat, grab any floating object, such as a piece of wood;

After boarding a lifeboat, pay attention to the consequences of hypothermia, shock, and lack of survival skills:

(1) Keep the inside of the boat and raft dry. The survival boat and raft should be covered with a weather canopy. Regardless of severe cold or heat, long-term exposure of the human body should be avoided; In severe cold, people in the boat can cuddle together or cover themselves with blankets and clothing to keep warm, and keep body in motion to maintain blood circulation;

(2) Take turns to take charge of internal and external lookouts, such as looking for ships, aircraft, and drowning person, collecting useful items. Pay attention to the ventilation and take care of the injured persons;

(3) Take fresh water and food according to the ration, avoid unnecessary exercise, take seasickness pills and maintain body moisture;

(4) Do not drink alcohol because it will not help maintain body temperature, but also speed up the loss of body heat;

(5) Never drink seawater or urine, as seawater and urine can make the body lose water even faster and make people feel thirstier;

(6) Keep optimistic to overcome the impact of factors such as cold, anxiety, hunger, thirst, and seasickness, and enhance the will to survive; Give each other confidence and determination to be rescued.

Section 3 Management of Crowds to Assist Passengers Arriving at Assembly Stations

When a ship encounters seriously dangerous situations such as collision, reef strike, fire, explosion, typhoon attack, water leakage from the hull, and when self-rescue is ineffective and it is inaccessible to the aid, the captain should issue an order to abandon the ship, and how to conduct crowd management after guiding passengers to the assembly station on board ferry plays an important role in correctly boarding life-saving equipment and escaping from the ship in distress. Emphasis should be placed on issues such as how to broadcast emergency statements, how to control passengers in critical places, keeping escape routes clear of obstacles, providing assistance to passengers who need special care, searching passenger accommodation to ensure safe evacuation of all persons on board, and assisting the crowds with arriving at assembly stations.

1. Clearly issue a reassuring order - broadcast an emergency statement

After an emergency, both passengers and crew should act in accordance with the *Emergency Muster List*, so it is particularly important to clearly issue reassuring commands. The emergency declaration must be issued under the guidance of crew in charge based on the situation at hand. When broadcasting, it is required to have a stable intonation, appropriate speed and clear articulation. The broadcast should be made in concise language and comforting and indicative statements to prevent passengers from being panic and confused. The sample emergency statement broadcast is as follows:

(1) The outbreak of fire

Dear passengers,

Attention please! Attention please! Time for emergency notice.

The passenger cabin in front of my ship's main deck is on fire. Please return to your own cabin. Passengers in danger please follow the instructions of our crew and do not panic. Our ship is equipped with a sound fire protection system, and it is estimated that the fire will be soon under control. In a moment, we will brief our fire-fighting work later.

Figure 19-1 a Sample of emergency statement broadcast (in case of fire)

(2) Abandonment of a ship

Dear passengers,

Attention please! Attention please! Time for emergency notice

Due to a collision (uncontrollable fire or uncontrollable water leakage) with an unidentified vessel, our hull has been seriously damaged, and we must now use life-saving equipment to leave our vessel. Please don't panic, calm down and follow the instructions as below:

- ① Put on your clothes and life jacket following the crew's demonstration;**
- ② Do not carry large packages;**
- ③ Carry forward the spirit of unity and mutual assistance and take good care of the elderly and children;**
- ④ Please obey the instructions of the crew and we will leave the ship in groups.**

Figure 19-2 a Sample of emergency statement broadcast (when abandoning the ship)

2. Control passengers at corridors, stairs, and passageways

Control passengers in corridors, stairs, and passageways, and passengers near the lifeboat deck should first leave the cabin and take life-saving passageway to the boarding station. Passengers on the same deck should follow the principle of proximity, and the cabin closest to the life-saving passageway should act first. The following should be taken into consideration:

- (1) Instructions for passengers to clearly identify escape routes;
- (2) Keep the passenger flow moving forward;
- (3) Close all gangways or doors on the passenger escape route except for emergency exits;
- (4) Carry emergency lights;
- (5) If passenger's family members are separated, crew should make efforts in keeping them calm. They should first arrive at the assembly station and send a message to other family members elsewhere through inter crew communication facilities to reassure them and convince them that the crew will make every effort to reunite their families;
- (6) Take children's actions into control;
- (7) Do not carry large items, except essential items;

(8) Physically challenged passengers are usually placed in the middle of the queue, with the help of crew members or other passengers.

3. Keep the escape route clear of obstacles and assist passengers to quickly reach the assembly station

On board, whether near the passenger compartment or the crew accommodation, the escape route should be kept unobstructed at all times, and it is prohibited to stack debris, luggage, etcetera. Lighting equipment should be available. During the process of assisting passengers to evacuate, the following issues should be noted:

1) Select a suitable location for evacuating passengers

(1) The crew leads the way and selects a suitable location for evacuating passengers

When passengers evacuate, the crew must lead the way. The crew is not allowed to run to a safe place alone, but should take care of the passengers.

(2) Select the nearest escape route

Crew members generally guide passengers through the planned escape routes based on the location of the cabin they are responsible for. If the original escape route is unavailable, choose the nearest one.

(3) Count the number of evacuees by crosschecking the passenger list

When passengers withdraw to the assembly station and safety zone, the number of passengers should be quickly counted by referring to the accurate number of passengers on the list.

2) Passengers are prohibited from carrying packages

When abandoning a ship, passengers are prohibited from carrying packages, and if necessary, no personal belongings are allowed to be taken to ensure the clear escape route and the final success of the escape.

3) Help the elderly, weak, sick and disabled passengers

Ensure that the elderly, weak, sick, and disabled passengers are escorted or assisted to avoid blocking the passage.

4. Evacuation of persons with disabilities and those requiring special assistance

In emergency situations, the safe transfer of disabled passengers is an important and difficult task. Therefore, it is important to pay attention to the following issues during the safe transfer process.

(1) Crew in charge should quickly identify the number of disabled persons and personnel requiring special assistance in their cabin; the crew in charge shall make unified arrangements;

(2) In the case of family escorting, relatives of the disabled should be escorted to the assembly station to board a raft and escape from the ship in distress;

(3) In the absence of family escort, the passengers nearby should first be mobilized to assist in escaping from danger. If there are still difficulties, the crew in charge and other crew members should assist in escaping from danger;

(4) Emergency stretchers are available on board. If a stretcher is indeed needed, crew in charge should use the stretcher to carry passengers away.

5. Search passenger accommodation

After all passengers have evacuated the accommodation and arrived at the boat deck and safety zone, the crew must search the passenger accommodation to ensure that all passengers have been evacuated to the assembly station.

1) Purpose of searching for passenger accommodation

Individual passengers are still stranded in the cabins due to certain reasons, such as sudden onset of illness, inability to move, unknown circumstances, etcetera, or they are lost or disoriented during action, unable to follow other passengers to the boat deck and assembly station; There are also individual passengers who may seek safety in cabins or other places on the ship where they believe they can escape from danger. Therefore, crew members should fully know the possible locations of passengers, including passenger accommodation and public spaces, and conduct effective searches.

2) Method of searching passenger accommodation

(1) Action must be "quick" because time is particularly limited at this time;

(2) According to the bunks and cabins occupied before the emergency occurs, crew in charge should first search the cabins with passengers;

(3) Shout to identify if there are still passengers in the cabin;

(4) If time permits, the cabin-by-cabin search should be conducted;

(5) All cabins, public places, and other places on board must be searched to ensure that all passengers have arrived at the assembly station;

(6) Follow the ship's emergency procedures and plans, and ensure that all locations have been searched, so as not to waste any time searching repeatedly;

6. Crowd management after arriving at the assembly station

When all personnel on board arrive at the assembly station, the keeping of passenger order should be strengthened to prepare for subsequent passenger disembarkation and evacuation. Clarifications should be made that family members do not need to be on the same lifeboat or liferaft.

(1) Guide the passengers on board to the nearest assembly station. If there is a crowd of people at one assembly station, direct some of passengers to another assembly station;

(2) Count the number of people and strengthen the search to ensure that all passengers have arrived at the assembly station;

(3) After arriving at the assembly station, passengers should remain calm, follow the instructions of the crew, and correctly put on life jackets. If necessary, the crew can help put them on, and children should put on life jackets for children;

(4) Communication means such as public address systems, telephones or intercom should be provided between various assembly stations;

(5) Reassure passengers by explaining to them that the relevant aftermath will be properly dealt with by interested parties.

Chapter 19 Crisis Management

Crisis management is a strategy applied to help ships deal with sudden or critical negative events. For the crisis management of ships carrying passengers, efficient crowd crisis management is crucial. In order to ensure the safety of passengers in crisis situations to the greatest extent, it is very important to provide training on crisis management for the crew on ferries; It is also crucial to apply the knowledge and skills of crisis management training to enhance crew's ability to help passengers keep calm and handle abnormal behaviours during emergency situations; in addition, the crew also need to handle various unexpected situations that occur during transportation.

Section 1 Crisis Management Training

Currently, there are no mandatory requirements for crisis management training at international level, but relevant personnel on ferries can be trained in crisis management in accordance with the relevant requirements of the *STCW Convention* and *STCW Code*. The relevant requirements for crowd management, crisis management and behavioural training are listed in Regulation V/2 of the *STCW Convention* (Training Requirements for Personnel on Passenger Ships) and Section A-V/2 of the *STCW Code*. Meanwhile, some well-known training institutions in the industry have developed a series of courses in accordance with the requirements of the Convention to enable crew to better understand and deal with the behaviour of passengers in crisis. The course explains crisis management on ferries into four stages: warnings, impacts, evacuation and after-action. Due to the different levels of crisis experienced by passengers at different stages, their behaviour patterns will change accordingly. Crew members should be familiar with these changes and take corresponding measures.

1. Warnings

The way people react to warning signals varies depending on the role they play in a given situation. Crew members are trained to give an alarm in the event of abnormal or dangerous situation. On the other hand, passengers need to be instructed by the crew to take appropriate actions. Different attitudes greatly affect their response in emergency situations. For crew who are familiar with emergency scenarios, they respond more effectively than passengers. The crew should give clear instructions to passengers in a timely manner to ensure that passengers can take corresponding actions in an emergency.

2. Impacts

Once the alarm rings, the physical and psychological effects of people in an emergency begin to manifest. This type of crisis situation means that passengers will experience a range of emotions that often make them feel scared and helpless, making them to experience increased stress. Passengers may also begin to imagine the worst scenario, which may further exacerbate their negative emotions and begin to affect their responsiveness. The most important task for the crew is to minimize negative emotions of passengers, but if crew members fail to manage the situation effectively, it is expected that 75% of passengers will not take reasonable measures to address the threat posed by emergency situations. Therefore, crew should communicate effectively with passengers about the actions they need to take in order to mitigate the negative impacts of crisis situations on passengers.

3. Evacuation

During evacuation, clear instructions and effective organization are crucial. In this regard, crew members should understand their own responsibilities, always follow the instructions specified in the ship's emergency response procedures, promptly evacuate passengers, and ensure their safe escape. As mentioned above, passengers react differently in emergency situations, and the crew responsible for safe evacuation may make incorrect assumptions. Therefore, crew members should be familiar with the psychological activities and behaviour of passengers in case of a crisis in order to better evacuate passengers, which includes the following:

(1) Upon hearing the alarm, passengers will act immediately. In fact, unless guided by a crew member, some passengers will not hasten to leave a potentially hazardous area or situation;

(2) The motivation for passengers to escape explains any action they take. In fact, it takes a while for passengers to switch to the escape mode, which requires strong guidance from the crew to make passengers aware of the degree of danger;

(3) Passenger reaction time, anxiety, and group dynamics can affect the required time to evacuate. It takes longer if a person is in anxiety than in normal situation. Therefore, the crew should provide emotional comfort to the passengers, keep them calm, and accelerate the process of safe evacuation;

(4) Passengers are most likely to move towards their nearest exit. But they will move towards the exit that appears to be the safest, most suitable or already familiar;

(5) Fire exit signs help ensure passengers identify safe passage. However, in anxiety, people may ignore surrounding objects such as emergency exit signs. At this time, the crew should give correct instructions to passengers and emphasize the importance of fire exit signs;

(6) People are unlikely to use smoky escape routes. However, if passengers are already familiar with a certain route and believe it is safe, they may choose the route to escape regardless of the risk;

(7) All passengers have the same ability to leave the ship in distress. However, age, experience, and alcohol intake are factors that affect the ability of individual passengers to escape from the ship. Elder and younger people will spend longer time in escaping than experienced passengers. Therefore, the crew should pay special attention to passengers of weak escape ability or insufficient experience without letting one person fall behind;

(8) Crew members should provide clear information to calm down their negative emotions such as anxiety and panic, and help passengers better understand the situation.

Understanding the following behaviours of passengers is the key for crew members, which will enable them to best assist and guide passengers to escape. Passengers typically make the following reactions:

- (1) In an unexpected situation, passengers tend to stiffen and react slowly;
- (2) Passengers will seek an easy escape route and attempt to collect valuables;
- (3) Passengers will begin to lose control and shift from protecting others to self-protection;
- (4) Passengers who behave calmly may act rationally and even seek help;
- (5) Only 25% of passengers will demonstrate rational behaviour and handle emergencies.

4. After-action

At this stage, crew members must be prepared to deal with the consequences of emergency situations and passenger behaviour after the crisis ends. In some cases, crew members have to deal with possible casualties, passengers' reactions after witnessing the crisis and passengers' behaviour when re-boarding after being informed that the crisis has been avoided.

After an emergency, it takes time for the passengers to deal with what happens, and their response speed varies. The crew needs to placate and calm the passengers down in a calm and inspiring manner. They must ease the tension or stress themselves caused by the crisis while remaining rational as passengers will continue to seek guidance from the crew. The instructions of crew members are crucial to crisis management and the long-term impact on passengers. The faster passengers calm down, the sooner they can recover from the shock, and the impact will be minimized.

Section 2 Management of Abnormal Psychology and Behaviour of People in Emergency Situations

When knowing that the ship is in an emergency, passengers may not be willing to accept this cruel reality, and a momentary blow may make some passengers feel puzzled and confused, lose their ability to make rational decision, and become sluggish; Some passengers even lose their rationality, resulting in panic and abnormal behaviour. At this time, the main

task of the crew is to actively and timely make emergency broadcasts and notifications to passengers, and minimize the panic among passengers through face-to-face language communication and professional handling processes.

1. Psychological reactions and behaviours of passengers in emergency situations

When an emergency occurs, there are differences in the psychological state and actions of individuals and groups of passengers.

1) Psychological reaction of passengers in emergency

Passengers may experience some abnormal psychological reactions during an emergency, mainly including the following scenarios.

(1) Passengers as individuals

① Terror, pessimism, despair

When passengers believe that it is impossible for them to survive in this dangerous situation, especially when the chaotic situation of abandoning ship occurs, their terror, pessimism and despair may appear. Some studies have shown that only 15% of people do not feel panic, 70% lose their ability to think rationally, and the remaining 15% completely lose their minds.

② Self-degradation

Individual passengers who are subject to sudden shocks may abandon themselves, disobey commands, disrupt discipline, or disregard morality and take foolish actions; and disorganization and lack of discipline are the biggest obstacles that hinder normal abandonment actions.

(3) Hallucination

A hallucination is a false perception of objects or events involving your senses: sight, sound, smell, touch and taste. Hallucinations seem real, but they're not. Chemical reactions and/or abnormalities in the brain cause hallucinations. For example, "seeing" images and situations that do not exist at all, or "hearing" words that no one has ever said. Under some special circumstances, such as exhaustion, prolonged sleeplessness and persistent hunger, hallucinations may occur; at the same time, persistent pain and emotional excitement, excessive panic and expectation are also factors that can induce hallucinations. Therefore, it is extremely common for victims to hallucinate.

(4) Panic caused by family separation

When a state of emergency occurs and the family members are not being together, the panic seems prominent and obvious among them. It usually manifests as extreme anxiety, looking around, or being eager to look for their family members or relatives.

(2) Passengers in group

① Transmission and spread of inaccurate information

In a crowd, even if the information is correct at the very beginning, there is a high potential that it will lose its accuracy as it is transmitted. Unable to act in a unified manner in accordance with instructions, people's actions are scattered and directionless. In some cases, a number of small groups may form and they act independently.

② Transmission and spread of negative information

Rather than good and positive information, such as "this is what you can do to survive", the worst or most disappointing information, such as "we can't be saved!" tends to be transmitted and spreads more easily. Agitation, shouts, screams and other factors create a situation in which instructions, aid from the outside cannot be received, and accurate discussion or communication within the crowd also becomes impossible.

③ Immobilization of psychology

Once the mindset of a group is fixed, it is much harder to change it than it is to change the mindset of an individual. The passenger group is out of control due to panic. Any stimulus can cause the crowd to move in a wrong direction, and it is difficult for the crew to stop the bad results from happening.

2) Passengers' behavioural response in an emergency

Understanding passenger's behavioural responses in emergency situations is beneficial for crew members to conduct crisis management for passengers, so as to have a targeted view and a timely precaution to prevent accidents from happening.

(1) Looking for relatives

Fellow passengers may not always be together when on board. For example, when emergency occurs, some people may go to the toilet or washroom and are not present in the cabin with their family or friends. Sometimes, they even don't stay together at the very beginning. Therefore, it is reasonable for them to be eager to look for their relatives, friends, or belongings. However, it indeed hinders crisis management.

(2) Blind escape

Due to psychological shocks, individual passengers lose their senses, disobey commands, break discipline and focus solely on their own escape to look for safe places where they believe can escape from danger. It can generally take a certain amount of time before people are able to accept the fact that an emergency is taking place. Their ability of understanding (perception) may be compromised, and they may not respond to instructions in the same way that they would in a non-emergency. When the ship tilts, passengers simply run upward. Getting lost, regardless of the existence of an escape route, is not conducive to the evacuation of passengers.

2. Psychological and behavioural crisis management in emergency situations

It is a key for maintaining a good evacuation order by reducing the psychological pressure of passengers in emergency situations and preventing passengers in abnormal situations from doing what they want to do according to their own will; at the same time, it is necessary to guide passengers and stop "non-standard behaviour".

1) Reduce psychological pressure

In case of an emergency, the environment is an important factor that increases psychological stress, such as shouting when preparing to escape, crowding in the escape routes, busy packing up items and even stampede.

(1) Giving comfort to passengers

Giving comfort to passengers in distress through radio or face-to-face language, telling them that the improved situation may reduce psychological pressures on passengers, as will encouraging mutual assistance and information exchange between passengers. Encouraging passengers to believe in the life-saving ability of the ship will strengthen the confidence in the rescue. Crew members should use loudspeakers and other tools to repeatedly provide clear instructions to passengers to further reduce psychological pressure. (Caution: the using of threats, intimidation, or heavy-handed instructions will increase the stress among the crew, and only worsen the state of panic felt by the passengers). Refer to the Basic Crowd Management Guidebook for the Crew of Passenger Ships for further instructions.

(2) Help passengers

When an emergency occurs, some passengers' comprehension ability may be weakened by varying degrees, and they may not respond as they would normally do. At this time, the timely help of the crew is necessary to alleviate passengers' psychological burden and restore their normal psychological response as soon as possible.

2) Stop "non-standard behaviour" of passengers

When a ship encounters an emergency, especially when abandoning the ship, time and space are quite limited, and the requirements of passengers behaviour should be different from those in ordinary circumstances.

(1) Do not seek family members or friends

Passengers may not stay with their family members and friends when on board, so when emergency occurs, they tend to look for their companions. This searching behaviour can easily lead to disorder, and their goals to survive may not be achieved. Passengers should be made aware of the orderly evacuation and that they will meet their family and friends at the assembly station.

(2) Prohibit passengers from carrying personal belongings (especially heavy items)

Except for money, securities, important documents, and valuables, other items are not allowed to be carried. Too large and heavy items are inconvenient to handle, because they can easily block the escape route, and the space for lifeboats or liferafts is also very limited.

(3) Do not act alone

Passengers should be stopped from running, moving, or blindly escaping alone. These actions can result in destabilization, and their survival goals may not necessarily be achieved.

3. Psychological characteristics and management of crew members in emergency situations

The psychological response of crew members in emergency situations varies greatly due to their different professional qualities. If the quality of the crew training is good, the crew will be loyal to their duties during emergencies, they may quickly run to the designated emergency positions according to the Contingency Plan and fully and accurately complete the tasks. Crew members with insufficient education and training will not have the above performance, and they may have the following negative psychological phenomena in emergency situations, which are mainly reflected in:

1) Poor role awareness

Inadequate training and understanding of the individual's role in the overall emergency situation, a lack of attention to duty and self-discipline, indifference to one's responsibilities and obligations, not being careful during drills and being in a hurry during emergencies.

2) Nervousness

The term "nervousness" here refers to negative nervousness that is overly intense. It often leads to panic, confusion, and intellectual decline and even dumbfounding, which is a harmful psychological phenomenon of abnormal tension.

3) Pessimism and despair

Faced with an emergency, they may have little confidence in overcoming the shipwreck through the overall efforts of the crew, misjudge the situation, and passively go over the distress and stand idly by. People with this mindset often find it difficult to improve their ability in dealing with the emergencies, which is a highly harmful and destructive psychological phenomenon.

4) Fear

This is a state of mind that people will be in a hurry to escape from danger or harm, suffering from "inability". In emergency situations, there may be the phenomenon of escaping without permission, and this psychological spread will have unpredictable and catastrophic consequences in emergency situations.

Any of the above situations will lead to the inability of the crew to obtain accurate information, confusion in communication, inability to make appropriate decisions, and confusion in issuing the commands, which will result in the inability of the crew to provide accurate instructions to passengers during the evacuation.

Therefore, it is very important to strengthen the education and training of crew, strengthen contingency drill and improve the quality of crew to overcome the negative psychological phenomena that may occur in emergency situations.

Section 3 Handling Accidents Occurred during Transportation

During transportation, accidents occasionally occur to passengers, such as illness, injury, or death. At the same time, the liability for compensation caused by casualties also deserves attention.

1. Treatment of illness, injury, or death of passengers

When a passenger experiences illness or injury on board, the ferry crew shall make every effort to take care of him or her, fill in the passenger transport record if necessary, and hand over the passenger to the port ahead. If a passenger dies on board, the ferry crew should fill in the passenger transport record and hand over the dead passenger to the port ahead and notify the public security department. Where passengers are critically ill, injured, dead, or missing on board, the passenger transport record filled in shall specify the name, gender, age,

characteristics, mailing address, and relevant information of the person, accurately record the time, location, the whole incident, and truthfully report the measures taken and results of the ferry crew's efforts.

The passenger transport record should obtain circumstantial evidence from two or more people. Doctor's diagnosis and treatment record is also needed, and it should be signed by the passenger himself or a peer; The aftercare team shall organize the shipowner and other relevant departments to handle matters such as passenger placement, medical treatment of the injured, reception of family members, and disposal of the dead body.

2. Liability

If the personal injury or death of passengers or the loss or damage to their own luggage is caused by the sinking, collision, stranding, explosion, or fire of the ferry, or a defect in the ferry, the carrier shall be deemed to have been at fault unless he proves to the contrary evidence. The loss or damage of passengers' checked baggage, regardless of the accident, shall be considered as a fault unless the carrier or port operator proves to the counterevidence.

If the carrier or port operator proves that the personal injury or death of the passenger was caused by the fault of the passenger himself or by the joint fault of the passenger and the carrier or port operator, the liability of the carrier or port operator may be exempted or mitigated accordingly.

The carrier and the port operator shall not be liable for the death or injury of passengers due to illness, suicide, brawl, or criminal acts, as well as the missing persons caused by non-fault of the carrier or the port operator. The expenses for salvage, rescue, medical treatment, communication, temporary port call, and all aftercare expenses incurred due to passengers' reasons shall be borne by the passengers themselves.

Bibliography

- [1] IMO. 2008. International Code of Safety for High-Speed Craft
- [2] IMO. International Life-Saving Appliance Code – Resolution MSC.48(66)
- [3] IMO. Performance Standards for Shipborne BeiDou Satellite Navigation System (BDS) Receiver Equipment - Resolution MSC.379(93)
- [4] IMO. Adoption of the Revised Performance Standards for Electronic Chart Display and Information Systems (ECDIS) - Resolution MSC.232(82)
- [5] IMO. 2021. STCW Convention and STCW Code
- [6] IMO. 2020. Guidelines for securing arrangements for the transport of road vehicles on Ro-Ro ships.
- [7] IMO. 2022. Resolution MSC.518(105) – Model Regulations on Domestic Ferry Safety
- [8] IMO. 2022. MSC 105/INF.16 Information on Strengthening Shore-Based Information Autonomous Monitoring to Improve Ferry Safety
- [9] IMO. 2022. MSC 105/INF.17 Introduction of A New Type of Life-Saving Equipment for Ferries in The Yangtze River of China
- [10] IMO. 2022. MSC 105/INF.18 Introduction on The Ferry Hull Colouring and Marking Transformation Project of China
- [11] The Maritime Human Resource Institute, Japan. 2018. Basic Crowd Management Guidebook for the Crew of Passenger Ships.
- [12] Osman Turan. 2015. CRISIS MANAGEMENT
- [13] SHIPOWNERS. 2018. Crowd-and-Crisis-Management
- [14] David J. House. Marine Ferry Transports (An Operator’s Guide). 2002. Witherby & Co. Ltd.
- [15] Marine Insight. 2019. Risk Assessment for Ships: A General Overview
- [16] INTERFERRY. 2022. Ferry Industry Facts
- [17] Priadi, Antoni & Sita, Lili & Selasdini, Vidia & Wulandari, Retno. 2018. Ro – Ro Ferry safety: do the passengers aware the safety aspects during voyage?
- [18] Neil W. Baird. 2018. Fatal Ferry Accidents, Their Causes, and How to Prevent Them
- [19] Bernard Aritua, Lu Cheng, Richard Van Liere, and Harrie De Leijer. 2020. Blue Routes for a New Era-Developing Inland Waterways Transportation in China. Washington: World Bank Group.
- [20] China Maritime Service Centre. 2020. Safety Knowledge and Operation of Inland Passenger Ships. Dalian: Dalian Maritime University Press
- [21] China Maritime Service Centre. 2012. Operation and Management of Passenger Ships. Beijing: China Communications Press
- [22] He Qinghua, Lv Hongguang. 2021. Introduction to Marine Navigation (2nd Ed). Dalian: Dalian Maritime University Press
- [23] Yang Linjia. 2023. Ship Handling. Dalian: Dalian Maritime University Press