

Risk Assessment related to the Safe Escape from a Car Carrier

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1. Introduction

Since the type and size of a fire cannot be reliably predicted on car carriers, even for those implementing specifically designed fire prevention measures, there always exists the possibility that an unexpected situation may occur in which there is a need to abandon ship. Therefore, even on car carriers with special structural features (accommodation areas above holds, accommodation areas accessed through engine rooms, lifeboats and liferafts located above holds, etc.), a risk assessment should be conducted to determine what additional matters need to be considered and what steps can be taken to ensure the safe escape of the ship's crew in cases where fire-extinguishing efforts have failed. With such situations in mind, the Society is making this "Risk Assessment related to the Safe Escape from a Car Carrier" study on measures designed to ensure the safety of the ship's crew during the process of abandoning ship available for reference purposes. The prerequisites necessary, assumptions made, and methodology adopted are described, and the assessment's results are given in Appendix 1. ClassNK conducted the risk assessment in corporation with shipping company which have experience of operating PCTCs and shipyards which have experience of constructing PCTCs, considering their opinions. It is the hope of the Society that concerned stakeholders will find this study helpful as a guideline when conducting similar risk assessments for their own car carriers.

2. Prerequisites for Implementing Risk Assessment

The three prerequisites (fire size, escape scenarios, and fire spread scenarios for adjacent compartments) for implementing the risk assessment are summarized as follows.

(1) Fire Scale

Since car carriers are typically provided with thermal insulation materials, the fire scale required by the fire performance tests for such materials was assumed in order to evaluate their performance. In this risk assessment, as published in the Lash Fire project (Deliverable D11.1), electric vehicle fires were treated as being larger than the fire scale required for Class A thermal insulation materials. In this study, therefore, it was assumed that a fire will follow the Hydrocarbon Standard Temperature-time Fire Curve.

(2) Fire Scenario

As a fire scenario, it was assumed that the abandoning the ship occurs 23 minutes after the fire breaks out, and a breakdown of this 23 minutes is given below. It was further assumed that the fixed fire-extinguishing system was activated after initial fire-fighting operations had failed. However, a change in fire scale due to the activation of the fixed fire-extinguishing system was not considered.

Fire alarm sounds: 3 minutes

On-site inspection by ship crew: 10 minutes

fire-fighting activities by ship crew: 10 minutes

(3). Fire Spread Scenario for Adjacent Compartments

The temperature assumed inside a compartment adjacent to that where a fire breaks out as well as the temperature assumed for deck bulkhead in said compartment and the ignition time for combustibles located in said compartment are shown in Fig. 1.

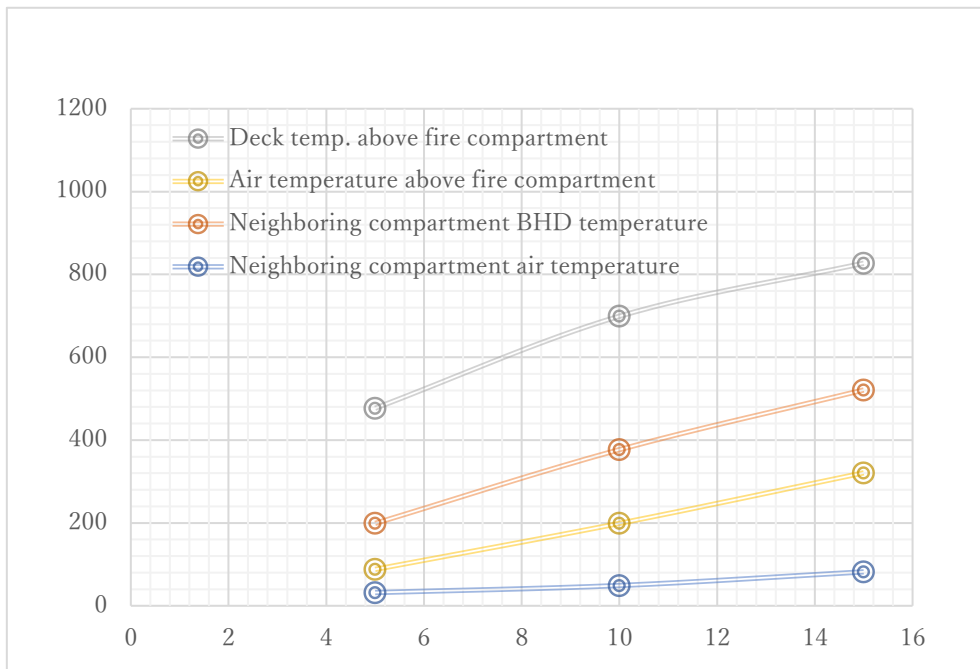


Figure 1 Situation within compartment adjacent to compartment where fire breakouts*

*Compiled based on the material introduced in book *Marine Fire Fighting* (Adams et al., 2000) published by the International Fire Service Training Association

(4). Assumed Effect of Estimated Fire Size on Thermal Protection

The performance of class A thermal protection assumed under the fire scale described above was as follows*.

*See Lash fire project Deliverables D11.1 Table11 for details

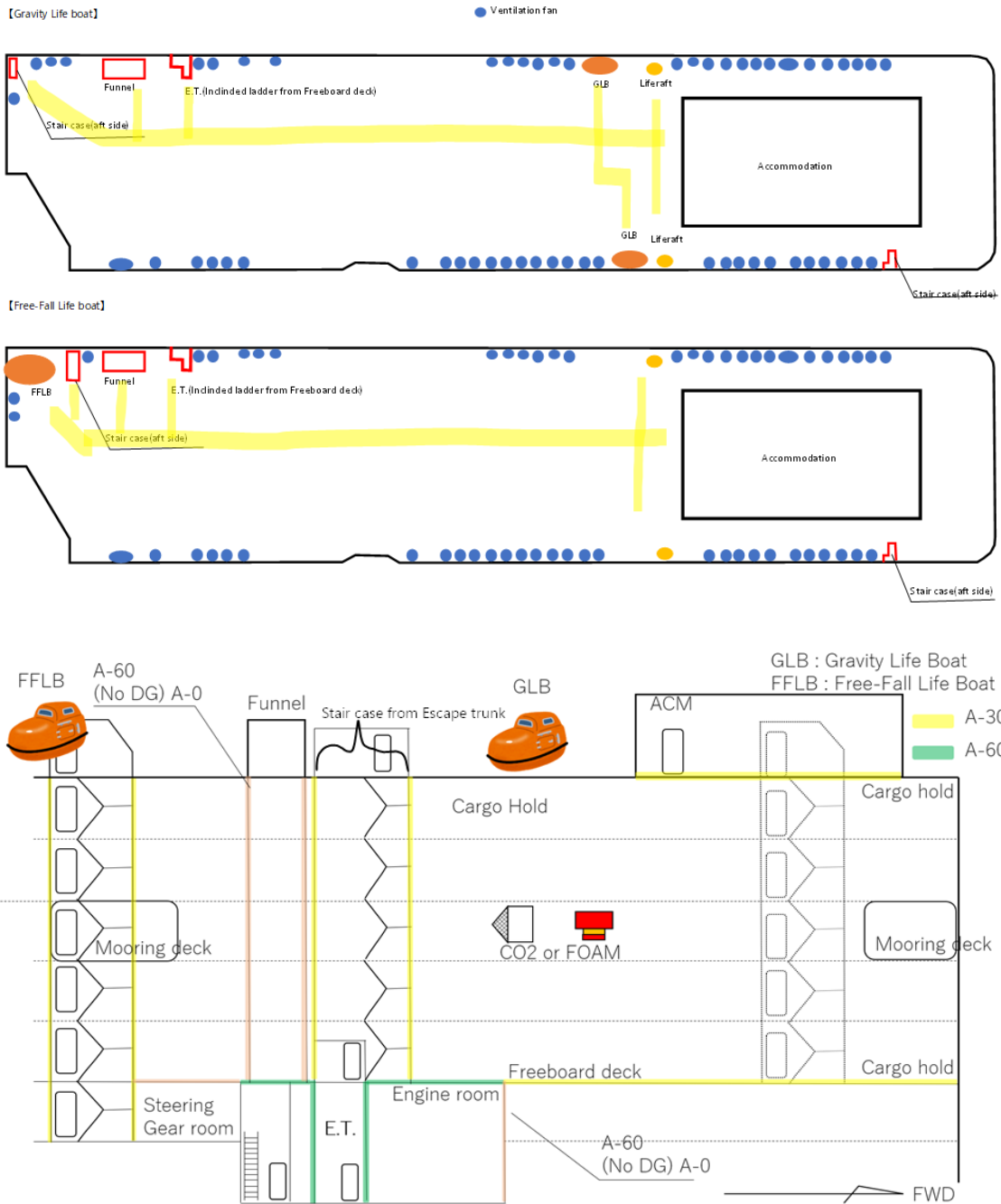
A-60 insulation → equivalent to A-20

A-30 insulation → equivalent to A-11

Based on this, it was assumed that heat transfer to the adjacent compartment would be prevented for 20 minutes in the case of a fire breaking out in a compartment with A-60 insulation. It was also assumed that the bare deck condition did not change thereafter.

(5). Ship Structure Assumed for Risk Assessment

The following two types of ship structures were assumed for risk assessment: a PCC equipped with a gravity-descent lifeboat and a PCC equipped with a free-fall lifeboat.



(6). Escape Routes Subject to Risk Assessment

The list of escape routes subject to risk assessment is given below.

Route names are indicated by [Escape source] - [code].

Escape source: Engine room (ER), cargo hold (HD), accommodation space (ACM)

Risk assessments were also conducted for secondary escape routes (SEC) leading from lifeboats on the upper deck to the bow mooring deck and the stern mooring deck on the assumption that there would be cases in which a lifeboat on the upper might be reachable but is unable to be used. In addition, the risk during the time from

boarding the lifeboat or liferaft until the time reaching the sea surface was evaluated as ESC. The following five patterns were evaluated: gravity lifeboat, free-fall lifeboat, liferaft (upper deck), liferaft (stern mooring deck) and bow mooring deck to sea surface.

【Escape from Engine room】 ER= Engine Room

Name of Escape Route	Escape from	Via 1	Via 2	Via 3	Via 4	Via 5	Escape by	Via parcel number
ER-A	: E/R	Escape trunk	Upper deck				Lifeboat	2
ER-B	: E/R	Steering gear rd	Aft stair case	Upper deck			Lifeboat	3
ER-C	: E/R	Engine casing	Funnel	Upper deck			Lifeboat	3
ER-D	: E/R	Cargo hold	FWD stair case	Upper deck			Lifeboat	3
ER-E	: E/R	Steering gear rd	Aft stair case	Aft mooring deck			Liferaft	3

【Escape from cargo hold】 HD=Hold

Name of Escape Route	Escape from	Via 1	Via 2	Via 3	Via 4	Via 5	Escape by	Via parcel number
HD-A	: Cargo hold	FWD stair case	Upper deck				Lifeboat	2
HD-B	: Cargo hold	Escape trunk	Upper deck				Lifeboat	2
HD-C	: Cargo hold	Aft stair case	Upper deck				Lifeboat	2
HD-D	: Cargo hold	Aft stair case	Aft mooring deck				Liferaft	2

【Escape from accommodation】 ACM=Accommodation

Name of Escape Route	Escape from	Via 1	Via 2	Via 3	Via 4	Via 5	Escape by	Via parcel number
ACM-A	: Accommodation	Upper deck					Lifeboat	1

【Direct access to the compartment of secondary SEC=Secondary Escaping

Name of Escape Route	Escape from	Via 1	Via 2	Via 3	Via 4	Via 5	Escape by	Via parcel number
SEC-A	: Cargo hold	FWD stair case	FWD mooring deck				Dive to the sea	2
SEC-B	: Cargo hold	Escape trunk	Upper deck	Aft stair case	Aft mooring deck		Liferaft	4
SEC-C	: Engine room	Escape trunk	Upper deck	Aft stair case	Aft mooring deck		Liferaft	4
SEC-D	: Engine room	Engine casing	Funnel	Upper deck	Aft stair case	Aft mooring deck	Liferaft	5
SEC-E	: Engine room	Cargo hold	FWD stair case	FWD mooring deck			Dive to the sea	3

【Direct access to the compartment of secondary means of escaping from the upper deck】

Name of Escape Route	Escape from	Via 1	Via 2	Via 3	Via 4	Via 5	Escape by	Via parcel number
SEC-F	: Upper deck	Aft stair case	Aft Mooring deck				Liferaft	2
SEC-G	: Upper deck	FWD stair case	FWD mooring deck				Dive to the sea	2

(7). Risk Classification Method

The risk associated with each scenario was evaluated according to the following criteria. Risk reduction measures were considered necessary for a "Risk Rank" (RR) of three or more.

"Impact"	Risk Rank(RR)			"Probability of Occurrence"
	S	M	L	
L	2	3	4	
M	1	2	3	
S	0	1	2	

Degree of impact (impact on escape if event occurs)

Large: Large impact

Medium: Medium impact

Small: Almost no impact

Probability of occurrence (the hazards that may occur due to cargo hold fires in consideration of ship structure)

Large: Probability of occurrence is high

Medium: Probability of occurrence is moderate.

Small: Probability of occurrence is almost nonexistent.

3. Risk Assessment Results

(1).Summary of Risk Assessment

See **Appendix 1** for details.

A careful review of RR4 reveals the following risks associated with escape routes to the lifeboats and the liferafts.

- The compartment is too hot to pass through.
- The compartment is too full of smoke to pass through.
- The compartment is on fire and cannot be passed through.
- The upper deck is too hot to pass through.

These are all effects caused by heat being transmitted from the cargo hold to the escape route; therefore, measures to reduce these effects are required. In addition, the influence of smoke on escape can be quite large; therefore, it is necessary to consider countermeasures, such as breathing apparatus and ventilation, to reduce the influence of smoke at the time of escape.

The following risks are associated with actually abandoning ship and the stage prior to abandoning ship.

- Decks with lifesaving equipment are deformed by heat and cannot be used.
- Death is caused by impact with the sea surface.

Although it is understood that it is necessary to reduce the effect of heat on lifesaving equipment, it is important to prepare equipment that can be used for secondary means of escape without fail in consideration of jumping overboard from a deck close to the sea surface when the lifesaving equipment of the upper deck cannot be used.

The following risks related to the loss of lighting systems were listed as RR4.

- Cargo hold is too dark to pass through.
- Bow mooring deck is too dark to pass through.

Since emergency lighting equipment is not, in principle, required for cargo holds, the loss of the main lighting system can cause the hold to become quite dark. In cases where the risk of losing such systems is high, countermeasures such as the installation of emergency lighting equipment are necessary.

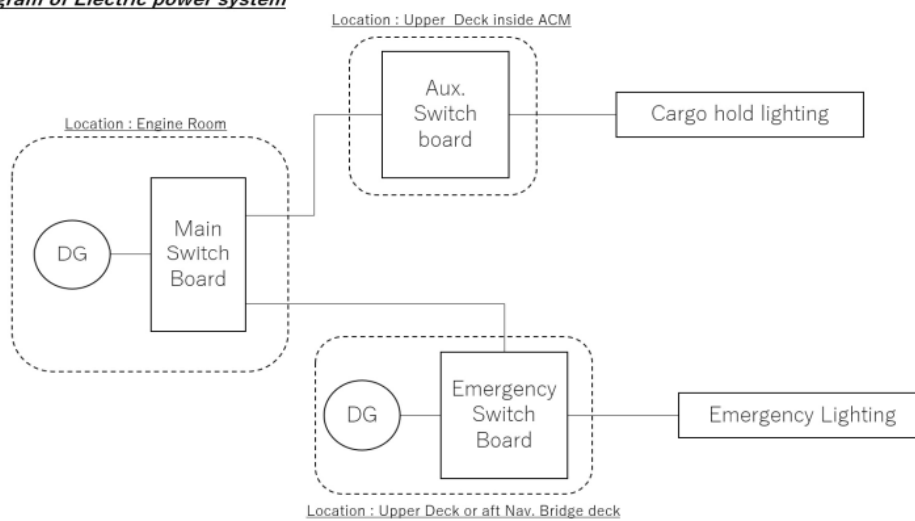
Bow mooring decks are considered to locations where the ship's crew can jump overboard in cases where the lifesaving equipment on the upper deck cannot be used. However, the loss of the main lighting system can make the deck quite dark if there is no emergency lighting system provided. Since it can be difficult if not impossible to escape safely under such conditions, corresponding countermeasures are necessary.

(2). Risk Assessment related to the Loss of Lighting Systems

Since the ship's crew may be required to abandon ship at night or other times when visibility might be poor, the failure of lighting systems (main, emergency or both) would likely increase the chance of injury occurring during escape. This risk assessment evaluated the risks associated with the loss of such systems due to a cargo hold fire and also examined countermeasures which could be implemented as needed. The scenario is described as BLO-, and its results are given in [Appendix 2](#).

Schematic diagram of lighting system

Wiring diagram of Electric power system



APPENDIX 1

ID	Stage	Kind of Risk	Estimated temperature and Estimated ignition time of flammable materials inside the compartment above or neighboring compartment in fire	Reason	Existing safeguard	Before countermeasure applied					Countermeasure and Effectiveness (N) : New ship (E) : Existing ship ⚠️:Countermeasure can be applied to existing ships can also be applied to new ships.	Remark	After countermeasure applied				
						Impact Risk A		Probability of Occurrence Risk A					Risk Rank	Impact Risk A	Probability of Occurrence Risk A		
						L/M/S		L/M/S							L/M/S		
ER-A : Escape route from Engine room. Escape route to lifeboat on upper deck via [stair case from E.T.] and upper deck.																	
ER-A-1	Pass through Engine room	-Difficult to pass thorough engine room due to heat from cargo hold in fire -A fire occurred in the engine room and visibility was poor due to smoke	[Estimated temperature in the compartment and possibility of ignition] Assuming zero heat input from fire in cargo hold above engine room A-0 bulkhead: BHD 521°C, air temperature 82°C A-60 bulkhead: BHD 199°C, air temperature 32°C [Possibility of fire in the compartment] A-0: Cable 0.3 m from bulkhead: Ignition after 40 min A-60: cable 0.3 m from bulkhead: 40 min +20 min = fire after 60 min	-In the case of a fire in a cargo hold with a common bulkhead to the engine room, heat is transferred into the engine room through the bulkhead (there is a possibility that the engine room is A-0 class, so heat input is fast). -The deck is A-60 class and the heat transferred from the fire in cargo hold above engine room is not 0, but it is assumed that there is almost no heat input.	Engine room and Cargo hold: Deck : A-60 class Insulation Bulkhead : A-0 class or A-60 class(in case of carrying Dangerous goods)	M	1	S	0	1	N: Heat insulation is provided at the boundary between the engine room and the cargo hold (H class or A class). E: Exhaust heat by means of ventilation	-When the bulkhead is not insulated, the temperature in the compartment may be high and the influence on escape is considered to be large. However, the degree of influence is considered to be medium because there is almost no risk of ignition of objects in the compartment(engine room). -The ventilation system was not shut down because there was no engine room fire.	M	1	S	0	1
ER-A-2-1	Pass through [stair case from E.T.]	Difficult to pass through the compartment due to high temperature in the compartment.	[Estimated temperature in the compartment and possibility of ignition] [Area Adjacent to Fire Area] -(A-30 class insulation) BHD temperature is 377°C or higher, air temperature is 49°C or higher Cable fires after 52 min (40 min +12 min)	The boundary between "staircase from E.T." and the cargo hold is heated by fire in cargo hold, and heat is transmitted into the escape trunk.	The boundary between the "staircase from E.T." and the cargo hold is A-30 class.	S	0	M	1	1	N: Adoption of A-60 class insulation or H class insulation insulation at the boundary between "staircase from E.T." and the cargo hold ⚡ Duration time of escape can be ensured.	-The probability of occurrence is medium because the area adjacent to the cargo hold is highly likely to be affected by heat. -Since the staircase from the E.T. is an A-30 class fire insulation, the fire insulation performance cannot be expected when assuming a hydrocarbon fire curve, but the assumed air temperature is 49 degrees, which is not considered to be a level that would hinder evacuation, so the degree of influence is considered to be small. -If the cargo hold and the engine room E.T. have a common bulkhead, the vertical ladder grip must not be welded to the common boundary with the cargo hold.	S	0	S	0	0
ER-A-2-2	Pass through [stair case from E.T.]	Smoke fills the compartment.	-	Combustibles in "Staircase from E.T." are burning (due to heat transfer from the boundary).	A self-closing door is used for the "staircase from E.T." (Smoke may not be ingressed into the compartment.)	S	0	S	0	0	E: Wear an escape breathing apparatus for escaping to avoid smoke inhalation -Seafarers working in the engine room are considered to be working in pairs. In the engine room, there are EEBDs on each deck inside engine room. Considering that the EEBD operating time is 15 minutes (according to the manufacturer's data), it is sufficient for evacuation.	-There is no flammable material in the staircase from the E.T. -Smoke from a cargo hold enters through a self-closing door, but even if the tightness of the door is damaged, the amount of entry is not considered to be so large, so the probability of occurrence is small. In addition, the degree of influence is small because the amount of invasion is expected to be small.	S	0	S	0	0
ER-A-3-1	Pass through upper deck	The upper deck is too hot to pass. Crews cannot get together at the muster station.	[Upper part of fire compartment] -(No heat insulation) Deck temperature is at least 800°C, and air temperature is at least 321°C* (*reference values for compartments, just for reference)	The heat of the fire in the cargo hold was transferred to the upper deck, and the deck was too hot to pass.	The boundary between the upper deck and the cargo hold is A-0 class.	L	2	L	2	4	E: If a fire breaks out in the cargo hold, immediately start cooling the upper deck leading to the lifeboat. N: A stage is provided on the upper deck leading to a lifeboat, such as a passage on pipes, to prevent heat from affecting it. N: H class fire insulation is installed on the boundary between the upper deck and the cargo hold.	-If the upper deck with the lifesaving equipment is hot, the lifeboats and the lifesaving rafts cannot be accessed, so the degree of influence is high, and the probability of occurrence is also high because the existing regulations do not require facilities to shut off heat to the upper deck.	L	2	S	0	2
ER-A-3-2	Ditto	Be blocked by smoke on the upper deck.	-	Smoke from the fire in the cargo hold flows from the ventilator to the upper deck, and the upper deck is covered with smoke.	Especially nothing	L	2	M	1	3	E: Adjusting the vessel's direction in order the smoke from the cargo hold does not cover the lifeboat and liferaft. E: Wear breathing apparatus (for all crew members)	By equipping everyone with breathing apparatus for escape, even if the upper deck is filled with smoke, crew can reach the lifeboat/liferaft. -Add scenarios for seafarers' exposure to toxic gases from toxic gas emissions as SPs	L	2	S	0	2
ER-B: An escape route for crew members working in the engine room. Route passing from the engine room to the steering gear room and escaping from the steering gear room through the staircase inside the cargo hold to the lifeboat																	
ER-B-1	Pass thorough inside engine room	Heat in the engine room makes passage in the compartment difficult. A fire occurred in the engine room and visibility was poor.	Refer to "ID : ER-A-1"	Refer to "ID : ER-A-1"	NA		0		0	0				0		0	0
ER-B-2-1	Pass through inside steering gear room	Be too hot to pass through	Heat input from the upper part of the compartment is not considered in this risk assessment.	The bulkhead between the steering gear compartment and the cargo hold is heated and the heat is transmitted to the steering gear compartment	(Foam) : When High Expansion Foam Fire Extinguishing System is Adopted for Fixed Fire Extinguishing System (CO2) : When Carbon Dioxide Extinguishing System is Adopted for Fixed Fire Extinguishing System (Foam) The boundary between the steering gear compartment and the cargo hold is A-60. (CO2)The boundary between the steering gear room and the cargo hold is class A-0.	S	0	S	0	0	E: Exhaust heat by ventilation N: Adoption of A class insulation or H class insulating material at the boundary between the steering gear room and the cargo hold ⚡ Duration time of escape can be ensured.	-The probability of occurrence is small because the heat of the fire is considered to be transmitted upward and difficult to be transmitted to the lower layer. -(CO2) Since the boundary with the cargo hold is A-0, it is assumed that the heat effect is directly received, but it is unlikely to receive the amount of heat that heats up the inside of the compartment, so the occurrence probability is small.	S	0	S	0	0
ER-B-2-2	Ditto	Smoke fills the compartment.	-	Fire occurred in the steering gear room (heat from the bulkhead adjacent to the hold burned combustibles in the steering gear room)	(Foam) The boundary between the steering gear compartment and the cargo hold is A-60. (CO2) The boundary between the wheelhouse and the cargo hold is class A-0.	L	2	M	1	3	N: Adoption of A class insulation or H class insulation insulating material at the boundary between the steering gear room and the cargo hold ⚡ Duration time of escape can be ensured. E: Wear an escape breathing device to avoid smoke inhalation Seafarers working in the engine room are considered to be working in pairs. In the engine room, there are at least two pairs of EEBDs on each deck. Considering that the EEBD operating time is 15 minutes (according to the manufacturer's data), it is sufficient for evacuation.	-(CO2) Since the boundary between steering gear room and the cargo hold is A-0, the thermal effect is directly affected, so there is a possibility that the paint may burn, the wire covering may burn, and this may cause ignition from other objects (Hydraulic fluid, electrical equipment, etc.) -Because a secondary fire may occur, the degree of impact is considered to be high, and the probability of occurrence is considered to be medium (considering the case of CO2).	M	1	S	0	1

APPENDIX 1

ID	Stage	Kind of Risk	Estimated temperature and Estimated ignition time of flammable materials inside the compartment above or neighboring compartment in fire	Reason	Existing safeguard	Before countermeasure applied					Countermeasure and Effectiveness (N) : New ship (E) : Existing ship ※Countermeasure can be applied to existing ships can also be applied to new ships.	Remark	After countermeasure applied				
						Impact Risk A		Probability of Occurrence Risk A					Impact Risk A		Probability of Occurrence Risk A		
						L/M/S		L/M/S		Risk Rank			L/M/S		Risk Rank	L/M/S	
ER-B-3-1	Pass through aft stair case	Be too hot to pass through	[Area Adjacent to Fire Area] -(A-30 fire insulation) BHD temperature is 377°C or higher, air temperature is 49°C or higher Cable fires after 52 min (40 min +12 min)	Heat is transmitted from the boundary between the staircase and the cargo hold, and the staircase becomes hot.	The boundary between the staircase and the cargo hold is class A-30.	M	1	S	0	1	N: Adoption of A class or H class fire insulation material at the boundary between aft stair case and the cargo hold ◆ Duration time of escape can be ensured. ⚡ [Since it is expected that the temperature of a small space, such as a staircase will rise soon after being affected by heat.]	-The probability of occurrence is medium because the area adjacent to the cargo hold is highly likely to be affected by heat. -Since the staircase from the E.T. is an A-30 class thermal insulation, the thermal insulation performance cannot be expected when assuming a hydrocarbon fire curve, but the assumed air temperature is 49 degrees, which is not considered to be a level that would hinder evacuation, so the degree of influence is considered to be small.	S	0	S	0	0
ER-B-3-2	Ditto	Smoke fills the compartment.	-	Smoke entered from the door leading to the stairway and the cargo hold. (Ignition of combustibles in the compartment is unlikely according to ID: ER-B-3-1)	The door between the staircase and the cargo hold shall be of the self-closing type.	S	0	S	0	0	N: Adoption of A class or H class fire insulation material at the boundary between aft stair case and the cargo hold ◆ Duration time of escape can be ensured. E: Wear an escape breathing device to avoid smoke inhalation Seafarers working in the engine room are considered to be working in pairs. In the engine room, there are at least two pairs of EEBDs on each deck. Considering that the EEBD operating time is 15 minutes (according to the manufacturer's data), it is sufficient for evacuation.	-Since it is a self-closing type door, even if smoke enters, it is expected to be a small amount of smoke from a clearance in the door, so the degree of influence is assumed to be small. -Combustibles are less likely to burn	S	0	S	0	0
ER-B-3-3	Ditto	Smoke fills the compartment.	-	CO2 gas enters through the door between the stairway and the cargo hold.	The door between the staircase and the cargo hold shall be of the self-closing type.	M	1	S	0	1	E: If a ship is equipped with carbon dioxide extinguishing systems and passes through the cargo hold after CO2 has been discharged, take an oxygen concentration meter with you. If an alarm is given, turn back and take necessary measures (wearing a breathing apparatus). E: Wear an escape breathing device to avoid breathing in gas. Seafarers working in the engine room are considered to be working in pairs. In the engine room, there are at least two pairs of EEBDs on each deck. Considering that the EEBD operating time is 15 minutes (according to the manufacturer's data), it is sufficient for evacuation.	-Heat can deform the enclosure of the staircase and create gaps in the doors. -The degree of influence is considered to be medium because the leakage of carbon dioxide cannot be identified visually. -If there is a gap, there is a high possibility that CO2 gas enters. (Cargo hold inside pressure is higher than aft stair case.)	S	0	S	0	0
ER-B-3-4	Ditto	The compartment is filled with foam.	-	High expansion foam entered through the door leading to the stairway and cargo hold.	The door between the staircase and the cargo hold shall be of the self-closing type.	S	0	S	0	0	NA	-Since the door is a self-closing type, the probability of inflow of high-expansion foam is small (if there is a gap, it is considered that foam cannot enter). -Even if there is an influx, people can pass through the bubbles (they can crush the bubbles and move forward).	S	0	S	0	0
ER-B-4-1	Pass thorough Upper deck (From door of stair case to lifeboat)	Be too hot to pass through	Refer to "ID : ER-A-3-1"	Refer to "ID : ER-A-3-1"	The boundary between the upper deck and the cargo hold is A-0.		0		0	0	Refer to "ID : ER-A-3-1"		0		0	0	
ER-B-4-2	Ditto	Be blocked by smoke on the upper deck.	-	Refer to "ID : ER-A-3-2"	Nothing in particular		0		0	0	Refer to "ID : ER-A-3-2"		0		0	0	
ER-C: An escape route for crew members working in the engine room. Passing through the engine casing from the engine room, through the funnel entrance on the upper deck, to the upper deck, to the lifeboat.																	
ER-C-1	Passing through Engine room	NA	Refer to "ID : ER-A-1"	Refer to "ID : ER-A-1"	NA		0		0	0			0		0	0	
ER-C-2-1	Passing through Engine casing	Be too hot to pass through	[Area Adjacent to Fire Area] -(No fire insulation) BHD temperature is 521°C or higher, air temperature is 82°C or higher. -(A-60 fire insulation) BHD temperature is 199°C or higher, air temperature is 32°C or higher Time until cable fire -(Not insulated) 40 min. -(A-60) 60 min.	The heat effect in case of fire of cargo hold is received from the common bulkhead.	Class A-0 if dangerous goods are not loaded or are loaded 3 m from the casing bulkhead.	M	1	L	2	3	N: H class heat insulating material is used E: Wear heat resistant clothing	It is unlikely that combustibles in the compartment ignited at the time of evacuation. The temperature in the compartment is 32°C if it is A-60 heat resistant. Without heat protection, the temperature is 82°C, so some measures are necessary. The degree of impact is considered to be medium because some countermeasures are required when there is no fire insulation. Since the cargo hold and the engine casing are adjacent to each other, the probability of occurrence is high.	M	1	S	0	1
ER-C-2-2	Ditto	There is smoke or fire inside the compartment	-	Combustibles in the compartment are igniting.	Class A-0 if dangerous goods are not loaded or are loaded 3 m from the casing bulkhead	S	0	S	0	0	N: H class heat insulating material is used E: Wear an escape breathing device to avoid smoke inhalation Seafarers working in the engine room are considered to be working in pairs. In the engine room, there are at least two pairs of EEBDs on each deck. Considering that the EEBD operating time is 15 minutes (according to the manufacturer's data), it is sufficient for evacuation.	According to ID: ER-C-2-1, it is unlikely that combustibles in the compartment ignited at the time of evacuation.	S	0	S	0	0
ER-C-3-1	Passing through funnel	Be too hot to pass through	[Area Adjacent to Fire Area] -(No heat insulation) BHD temperature is 521°C or higher, air temperature is 82°C or higher. Time until cable fire -(Not insulated) 40 min.	Refer to "ID : ER-C-2-1/ER-C-2-2"			0		0	0		Since the engine casing and the funnel are connected, they are regarded as basically the same compartment.	0		0	0	

APPENDIX 1

ID	Stage	Kind of Risk	Estimated temperature and Estimated ignition time of flammable materials inside the compartment above or neighboring compartment in fire	Reason	Existing safeguard	Before countermeasure applied					Countermeasure and Effectiveness (N) : New ship (E) : Existing ship ※Countermeasure can be applied to existing ships can also be applied to new ships.	Remark	After countermeasure applied				
						Impact Risk A		Probability of Occurrence Risk A					Impact Risk A		Probability of Occurrence Risk A		
						L	M/S	L	M	S			L	M	S	L	M
ER-C-3-2	Ditto	There is smoke or fire inside the compartment	Refer to "ID : ER-A-3-1"	Refer to "ID : ER-C-2-1/ER-C-2-2"		0		0		0	E: Wear an escape breathing device to avoid smoke inhalation Seafarers working in the engine room are considered to be working in pairs. In the engine room, there are at least two pairs of EEBDs on each deck. Considering that the EEBD operating time is 15 minutes (according to the manufacturer's data), it is sufficient for evacuation.	Since the engine casing and the funnel are connected, they are regarded as basically the same compartment.	0		0		0
ER-C-4-1	Passing through upper deck	Be too hot to pass through	Refer to "ID: ER-A-3-2"	Refer to "ID : ER-A-3-1"	The boundary between the upper deck and the cargo hold is A-0.	0		0		0			0		0		0
ER-C-4-2	Ditto	Be blocked by smoke on the upper deck.	-	Refer to "ID: ER-A-3-2"	Nothing in particular	0		0		0			0		0		0
ER-D: 機関室内で作業をしている乗組員の脱出ルート。機関室から貨物艙室を通過して船首階段室を通り救命艇へいくルート																	
ER-D-1	Passing through Engine room	No	Refer to "ID : ER-A-1"	Refer to "ID : ER-A-1"	NA	0		0		0			0		0		0
ER-D-2-1	Passing through Cargo hold	Be too hot to pass through		Because it is fire area	NA	L	2	L	2	4	E: Exclude Escape Route via CARGO HOLD E: Passing through the deck as far as possible from the deck where the fire occurred E: Wear heat-resistant clothing (such as firefighter's outfit) when entering the fire area.	Basically, it is not advisable to pass through fire areas.	M	1	L	2	3
ER-D-2-2	Ditto	Smoke fills the compartment.		Because it is fire area	NA	L	2	L	2	4	E: Exclude Escape Route via CARGO HOLD E: Passing while wearing EEBD In the event of a fire, crew members who return to the engine room to work are considered to work in pairs. In the engine room, there are at least two sets of EEBDs on Engine Room. Considering that the EEBD operating time is 15 minutes (according to the manufacturer's data), it is sufficient for evacuation.	Basically, it is not advisable to pass through fire areas.	M	1	L	2	3
ER-D-3-1	Passing through FWD stair case	Be too hot to pass through		Directly receives radiant heat because it is almost the same compartment as the cargo hold	None (Grid Wall)	L	2	L	2	4	N: Enclosed with steel wall, heat insulation (H class) is constructed. E: Wear heat-resistant clothing (firefighter's equipment) when entering the fire area. *Use FUA for fireproof clothing [Area Adjacent to Fire Area] ·(No heat insulation) BHD temperature is 521°C or higher, air temperature is 82°C or higher. ·(A-30 with heat protection) BHD temperature is 377°C or higher, air temperature is 49°C or higher ·(A-60 with heat protection) BHD temperature is 199°C or higher, air temperature is 32°C or higher.	·The bow stairway may not be surrounded by steel walls	M	1	S	0	1
ER-D-3-2	Ditto	Smoke fills the compartment.		Directly receives radiant heat because it is almost the same compartment as the cargo hold	None (Grid Wall)	L	2	L	2	4	N: Enclosed with steel wall, heat insulation (H class) is constructed. E: Wear EEBD Seafarers working in the engine room are considered to be working in pairs. In the engine room, there are at least two pairs of EEBDs on each deck. Considering that the EEBD operating time is 15 minutes (according to the manufacturer's data), it is sufficient for evacuation.	The bow stairway may not be surrounded by steel walls	M	1	S	0	1
ER-D-4-1	Passing through Upper deck	Be too hot to pass through	Refer to "ID : ER-A-3-1"	Refer to "ID : ER-A-3-1"	The boundary between the upper deck and the cargo hold is A-0.	0		0		0			0		0		0
ER-D-4-2	Ditto	Be blocked by smoke on the upper deck.	Refer to "ID: ER-A-3-2"	Refer to "ID: ER-A-3-2"	Nothing in particular.	0		0		0			0		0		0
ER-E: An escape route for crew members working in the engine room. a route from the engine room to the liferaft on the stem mooring deck via the steering room and the stem staircase																	
ER-E-1	Passing through Engine room	NA		Refer to "ID : ER-A-1"		0		0		0			0		0		0
ER-E-2-1	Passing through Steering gear room	Be too hot to pass through		Refer to "ID : ER-B-2-1"		0		0		0			0		0		0
ER-E-2-2	Ditto	Smoke fills the compartment.		Refer to "ID : ER-B-2-2"		0		0		0			0		0		0
ER-E-3-1	Passing through aft stair case	Be too hot to pass through		Refer to "ID : ER-B-3-1"		0		0		0			0		0		0
ER-E-3-2	Ditto	Smoke fills the compartment.		Refer to "ID : ER-B-3-2"		0		0		0			0		0		0
ER-E-3-3	Ditto	CO2 gases fill the compartment		Refer to "ID : ER-B-3-3"		0		0		0			0		0		0
ER-E-3-4	Ditto	Foam fills the compartment		Refer to "ID : ER-B-3-4"		0		0		0			0		0		0
ER-E-4	Passing through aft mooring deck	Be too hot to pass through	[Upper part of fire compartment] ·(No heat insulation) Deck temperature is at least 800°C and air temperature is at least 321°C. *Air temperature is for Enclosed, so it is a reference value.	If there is a HOLD just below the mooring deck, the heat of the fire in the cargo hold is transmitted to the deck.	NO	L	2	L	2	4	N: A Class / H Class fire insulation applied to the boundary E: Cooling of aft mooring deck		M	1	M	1	2
HD-A : Escape route for crew members (firefighters) working inside the cargo hold. Route to escape to the upper deck through the bow stairway in the cargo hold and to the lifeboat																	
HD-A-1	貨物艙内の通行 Passing through Cargo hold	Be left without access to the stair case	Cargo Hold is in fire	Poor visibility due to full smoke	Especially nothing	L	2	L	2	4	[Poor visibility] E: Ventilation work is carried out and smoke is discharged. E: Deck shows route to stairwell E: Indicate the presence of persons in the cargo hold to other locations by means of a personal alarm safety system or RFID.	The probability of occurrence is high because a fire occurred in the cargo hold. The degree of impact is also the same, and it is considered to be large because it is a fire occurrence area.	M	1	S	0	1

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						Impact Risk A	Probability of Occurrence Risk A				Impact Risk A	Probability of Occurrence Risk A					
						L/M/S	L/M/S	Risk Rank			L/M/S	L/M/S	Risk Rank				
HD-A-2-1	船首階段室 (貨物艙内) の通行 Passing through FWD stair case (inside Cargo Hold)	Directly receives radiant heat because it is almost the same compartment as the cargo hold		Refer to "ID : ER-D-3-1"	Especially nothing	0	0	0			0	0	0				
HD-A-2-2	船首階段室 (貨物艙内) の通行 Ditto	Because the area is almost the same as that of the cargo hold, smoke passes through (lattice wall).		Refer to "ID : ER-D-3-2"	Especially nothing	0	0	0			0	0	0				
HD-A-3-1	上甲板の通行 Passing through upper deck	Be too hot to pass through		Refer to "ID : ER-A-3-1"	Especially nothing	0	0	0			0	0	0				
HD-A-3-2	上甲板の通行 Ditto	Be blocked by smoke on the upper deck.		Refer to "ID: ER-A-3-2"	Especially nothing	0	0	0			0	0	0				
HD-B : Escape route for crew (firefighters) working inside the cargo hold. Route from the cargo hold to the upper deck via the staircase leading to the E.T. and to the lifeboat																	
HD-B-1	貨物艙内の通行 Passing through Cargo hold	Be left without access to the stair case		Refer to "ID : HD-A-1"		0	0	0			0	0	0				
HD-B-2-1	E.T.からの階段室内の通行 Passing through staircase from escape trunk	Be too hot to pass through		Refer to "ID : ER-A-2-1"		0	0	0			0	0	0				
HD-B-2-2	E.T.からの階段室内の通行 Ditto	Smoke fills the compartment.		Refer to "ID : ER-A-2-2"		0	0	0			0	0	0				
HD-B-3-1	上甲板の通行 Passing through upper deck	Be too hot to pass through		Refer to "ID : ER-A-3-1"	The boundary between the upper deck and the cargo hold is A-0.	0	0	0			0	0	0				
HD-B-3-2	上甲板の通行 Ditto	Be blocked by smoke on the upper deck.		Refer to "ID : ER-A-3-2"	Especially nothing	0	0	0			0	0	0				
HD-C : 貨物艙内で作業をしていた乗組員 (消防員) の脱出ルート。貨物艙から船尾階段室を経由して上甲板へ抜け救命艇へ行く																	
HD-C-1	貨物艙内の通行 Passing through Cargo hold	Be left without access to the stair case		Refer to "ID : HD-A-1"		0	0	0			0	0	0				
HD-C-2-1	船尾階段室の通行 Passing through aft stair case	Be too hot to pass through		Refer to "ID : ER-B-3-1"		0	0	0			0	0	0				
HD-C-2-2	船尾階段室の通行 Ditto	Smoke fills the compartment.		Refer to "ID : ER-B-3-2"		0	0	0			0	0	0				
HD-C-2-3	船尾階段室の通行 Ditto	CO2 gases fill the compartment		Refer to "ID : ER-B-3-3"		0	0	0			0	0	0				
HD-C-2-4	船尾階段室の通行 Ditto	Foam fills the compartment		Refer to "ID : ER-B-3-4"		0	0	0			0	0	0				
HD-C-3-1	上甲板の通行 Passing through upper deck	Be too hot to pass through		Refer to "ID : ER-A-3-1"	The boundary between the upper deck and the cargo hold is A-0.	0	0	0			0	0	0				
HD-C-3-2	上甲板の通行 Ditto	Be blocked by smoke on the upper deck.		Refer to "ID: ER-A-3-2"	Especially nothing	0	0	0			0	0	0				
HD-D : 貨物艙内で作業をしていた乗組員 (消防員) の脱出ルート。貨物艙から船尾階段室を経由して船尾係船甲板へ抜け、救命艇で脱出する																	
HD-D-1	貨物艙内の通行 Passing through Cargo hold	Be left without access to the stair case		Refer to "ID : HD-A-1"		0	0	0			0	0	0				
HD-D-2-1	船尾階段室の通行 Passing through aft stair case	Be too hot to pass through		Refer to "ID: ER-D-3-1"		0	0	0			0	0	0				
HD-D-2-1	船尾階段室の通行 Passing through aft stair case	Smoke fills the compartment.		Refer to "ID : ER-D-3-2"		0	0	0			0	0	0				
HD-D-3	船尾係船甲板内の通行 Passing through aft mooring deck	Be too hot to pass through (in case that the cargo hold is located under the aft mooring deck)		Refer to "ID : ER-E-4"		0	0	0			0	0	0				
ACM-A : Escape route for crew members working in the accommodation area and route to the lifeboat from the accommodation door to the upper deck																	
ACM-A-1	Passing through accommodation	Crew cannot move due to fire in accommodation area	[Upper part of fire compartment] -(A-30 with heat protection) Deck temperature is at least 700°C and air temperature is at least 199°C. [Area Adjacent to Fire Area] -(A-30 with heat protection) BHD temperature is 377°C or higher, air temperature is 49°C or higher -(A-60 with heat protection) Deck temperature is at least 477°C and air temperature is at least 88°C. -(A-60 with heat protection) BHD temperature is 199°C or higher, air temperature is 32°C or higher [Time until ignition of combustibles in a compartment adjacent to a compartment where a fire occurred] A-30 For Heat Protection Paper on deck: 3 to 4 minutes +11 minutes = 14 to 15 minutes Paper 0.3 m above deck: 5 minutes + 11 minutes = 16 minutes Paper on top of cabinet: 15 minutes + 11 minutes = 23 minutes Cables near ceiling: 25 min. ± 11 min. = 36 min.	Thermal effects in case of fire from cargo hold	The boundary between the accommodation area and the cargo hold is A-30 class insulation	L	2	L	2	4	N: H class fire insulation is adopted at the boundary between the accommodation area and the cargo hold. ◆ Duration time of escape can be ensured.	In the case of a fire in a cargo hold having a common boundary with a living space, both the probability of occurrence and the degree of impact become large. In the 23 minutes before the evacuation, there is a possibility that a fire broke out in the accommodation area. The temperature in the compartment may also be high. It is considered that the degree of influence and the occurrence probability are not different from those of A-30 heat protection because the heat of the fire is transmitted to the upper part even if A-60 heat protection is constructed.	M	1	M	1	2
ACM-A-2-1	Passing through upper deck	Be too hot to pass through		Refer to "ID : ER-A-3-1"	The boundary between the upper deck and the cargo hold is A-0.	0	0	0			0	0	0				
ACM-A-2-2	Ditto	Be blocked by smoke on the upper deck.		Refer to "ID: ER-A-3-2"	Especially nothing	0	0	0			0	0	0				
SEC-A : 貨物艙から船首階段室を経由して船首係船甲板へ行く																	
SEC-A-1	Passing through Cargo hold			ID : ER-D-2-1/ER-D-2-2参照		0	0	0			0	0	0				
SEC-A-2	Passing through FWD stair case			ID : ER-D-3-1/ER-D-3-2参照		0	0	0			0	0	0				
SEC-A-3	Passing through FWD mooring deck	Be too hot to pass through (in case that the cargo hold is located under the FWD mooring deck)	[Upper part of fire compartment] -(No heat insulation) Deck temperature is at least 800°C and air temperature is at least 321°C. -(A-30 with heat protection) Deck temperature is at least 700°C and air temperature is at least 199°C. -(A-60 with heat protection) Deck temperature is at least 477°C and air temperature is at least 88°C.	If there is a mooring deck on a cargo hold, it will be affected by the heat of the fire in the cargo hold.	The boundary between the cargo hold and the forward mooring deck deck is class A-0.	L	2	L	2	4	N: H class thermal insulation is installed at the boundary with the cargo hold. E: Spray water to cool the deck	When the cargo hold and the cargo hold share a common boundary, the deck temperature is also high, and it is considered that the deck temperature rises so high that the cargo hold cannot pass through. The impact and the probability of occurrence are large.	S	0	S	0	0
SEC-B : Passing from the cargo hold to the upper deck via the "staircase from E.T." and to the stern mooring deck via the stairway																	
SEC-B-1	Passing through Cargo hold			Refer to "ID : ER-D-2-1/ER-D-2-2"		0	0	0			0	0	0				
SEC-B-2	Passing through stair case from escape trunk			Refer to "ID : ER-A-2-1/ER-A-2-2"		0	0	0			0	0	0				
SEC-B-3	Passing through Upper deck			Refer to "ID : ER-A-3-1/ER-A-3-2"		0	0	0			0	0	0				
SEC-B-4	Passing through aft stair case			Refer to "ID : ER-B-3-1/ER-B-3-2/ER-B-3-3/ER-B-3-4"		0	0	0			0	0	0				
SEC-B-5	Ditto			Refer to "ID : ER-E-4"		0	0	0			0	0	0				
SEC-C : エンジナールームから[E.T.からの階段室]を経由して上甲板へ抜け、船尾階段室を通過して船尾係船甲板へ行く																	
SEC-C-1	Passing through Engine room			Refer to "ID : ER-A-1"		0	0	0			0	0	0				
SEC-C-2	Passing through stair case from escape trunk			Refer to "ID : ER-A-2-1/ER-A-2-2"		0	0	0			0	0	0				
SEC-C-3	Passing through Upper deck			Refer to "ID : ER-A-3-1/ER-A-3-2"		0	0	0			0	0	0				
SEC-C-4	Passing through aft stair case			Refer to "ID : ER-B-3-1/ER-B-3-2"		0	0	0			0	0	0				
SEC-C-5	Passing through aft mooring deck			Refer to "ID : ER-E-4"		0	0	0			0	0	0				
SEC-D : エンジナールームからエンジンケーシングを通りファンネルまで登り、上甲板へ抜け、船尾階段室を通過して船尾係船甲板へ行く																	
SEC-D-1	Passing through Engine room			Refer to "ID : ER-A-1"		0	0	0			0	0	0				
SEC-D-2	Passing through Engine casing			Refer to "ID : ER-C-2-1/ER-C-2-2"		0	0	0			0	0	0				
SEC-D-3	Passing through funnel			Refer to "ID : ER-C-3-1/ER-C-3-2"		0	0	0			0	0	0				
SEC-D-4	Passing through upper deck			Refer to "ID : ER-A-3-1/ER-A-3-2"		0	0	0			0	0	0				

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						Impact Risk A	Probability of Occurrence Risk A	Risk Rank			Impact Risk A	Probability of Occurrence Risk A	Risk Rank				
						L/M/S	L/M/S				L/M/S	L/M/S					
SEC-D-5	Passing through aft stair case			Refer to "ID : ER-B-3-1/ER-B-3-2/ER-B-3-3/ER-B-3-4"		0	0	0			0	0	0				
SEC-D-6	Passing through aft mooring deck			Refer to "ID : ER-E-4"		0	0	0			0	0	0				
SEC-E : エンジナルームから貨物艙へ抜け、船首階段室を経由して船首係船甲板へ抜ける																	
SEC-E-1	機関室内の通行 Passing through Engine room			Refer to "ID : ER-A-1"		0	0	0			0	0	0				
SEC-E-2	貨物艙内の通行 Passing through Cargo hold			Refer to "ID : ER-D-2-1/ER-D-2-2"		0	0	0			0	0	0				
SEC-E-3	船首側階段室の通行 Passing through FWD stair case			Refer to "ID : ER-D-3-1/ER-D-3-2"		0	0	0			0	0	0				
SEC-E-4	船首係船甲板の通行 Passing through FWD mooring deck			Refer to "ID : SEC-A-3"		0	0	0			0	0	0				
SEC-F : 上甲板から船尾階段室を通り船尾係船甲板へ行く																	
SEC-F-1	Passing through Upper deck			Refer to "ID : ER-A-3-1/ER-A-3-2"		0	0	0			0	0	0				
SEC-F-2	Passing through aft stair case			Refer to "ID : ER-B-3-1/ER-B-3-2/ER-B-3-3/ER-B-3-4"		0	0	0			0	0	0				
SEC-F-3	Passing through aft mooring deck			Refer to "ID : ER-E-4"		0	0	0			0	0	0				
SEC-G : 上甲板から船首階段室へ抜け、船首係船甲板へ行く																	
SEC-G-1	Passing through Upper deck			Refer to "ID : ER-A-3-1/ER-A-3-2"		0	0	0			0	0	0				
SEC-G-2	Passing through FWD stair case			Refer to "ID : ER-D-3-1/ER-D-3-2"		0	0	0			0	0	0				
SEC-G-3	Passing through FWD mooring deck			Refer to "ID : SEC-A-3"		0	0	0			0	0	0				
ESC-A-G : Getting into the lifeboat and landing: Gravity type lifeboat																	
ESC-A-G-1	Boarding lifeboat	Cannot access/board		The deck is deformed due to the heat from the cargo hold in fire, and crew cannot access to the boarding platform.	Especially nothing	L	2	L	2	4	N: H class thermal insulation is adopted at the boundary between the upper deck and the cargo hold. E: Reduces the effect of heat by sprinkling water ◆ block thermal effects leading to deck deformation [Liferaft is used when a lifeboat is not available.]	This hazard is likely to occur from the estimated deck temperature.	M	1	S	0	1
ESC-A-G-2	Lowering lifeboat	Cannot swing out	[Upper part of fire compartment] ・(No heat insulation) Deck temperature is at least 800°C and air temperature is at least 321°C. ・(A-30 with heat protection) Deck temperature is at least 700°C and air temperature is at least 199°C. ・(A-60 with heat protection) Deck temperature is at least 477°C and air temperature is at least 88°C. [Area Adjacent to Fire Area] ・(No heat insulation) BHD temperature is 521°C or higher, air temperature is 82°C or higher. ・(A-30 with heat protection) BHD temperature is 377°C or higher, air temperature is 49°C or higher ・(A-60 with heat protection) BHD temperature is 199°C or higher, air temperature is 32°C or higher	Heat from the cargo hold in fire deforms the deck and prevents the lifeboat from swinging out.	Especially nothing	L	2	L	2	4	N: H class thermal insulation is adopted at the boundary between the upper deck and the cargo hold. E: Reduces the effect of heat by sprinkling water ◆ block thermal effects leading to deck deformation [Liferaft is used when a lifeboat is not available.]	This hazard is likely to occur from the estimated deck temperature.	M	1	S	0	1
ESC-A-G-3	Ditto	Cannot lower the lifeboat		The hull is too hot to be lowered by the lifeboat.	Especially nothing	M	1	S	0	1	N : Water curtain for cooling outer shell	It is considered that the thermal effect is not so high because the effect is kept at a certain distance from the outer plate. There is almost no radiant heat because open flames are not visible.	S	0	S	0	0
ESC-A-F : Getting into the lifeboat and landing: Free-Fall type lifeboat																	
ESC-A-F-1	Boarding lifeboat(Free-fall)	Cannot board		The deck is deformed due to the heat from the cargo hold, and it cannot reach the boarding stage.	Especially nothing	L	2	L	2	4	N: H class fire insulation shall be applied to the bulkhead and deck boundaries where the lifeboat is affected. E: Reduces the effect of heat by sprinkling water ◆ block thermal effects leading to deck deformation [A LIFERAFT IS USED WHEN A LIFEBOAT IS NOT AVAILABLE.]	Free-fall lifeboats have many adjacent cargo holds and are more susceptible to heat than gravity-type lifeboats. *In the case of a free-fall type lifeboat, it is placed in the shape of cutting into the HOLD due to the approved falling height of the lifeboat, and the range of heat protection and water sprinkling is larger than that of a gravity-descent type lifeboat.	M	1	M	1	2
ESC-A-F-2	Lowering lifeboat(Free-fall)	Cannot lower the lifeboat		Due to the deformation of the deck, the davit is deformed and cannot descend.	Especially nothing	L	2	L	2	4	N: H class fire insulation is applied to the bulkhead and deck boundaries where the lifeboat is affected. E: Reduces the effect of heat by sprinkling water ◆ block thermal effects leading to deck deformation [A LIFERAFT IS USED WHEN A LIFEBOAT IS NOT AVAILABLE.]		M	1	S	0	1
ESCA-F-3	Ditto	Ditto		The stern skin is too hot for the lifeboat.	Especially nothing	S	0	S	0	0		Since it descends in the direction away from the shell plate, it is considered that there is almost no thermal effect accompanying the lifeboat descent, and the occurrence probability and the degree of effect are both small.	S	0	S	0	0
ESC-A-L(u) : Getting into the liferaft : Liferaft located on upper deck																	
ESC-A-L(u)-1	Lowering liferaft	Cannot lower the liferaft due to deformation of davit		Refer to "ID : ESC-A-1"	Especially nothing	0	0	0					0	0	0	0	
ESC-A-L(u)-2	Ditto	Cannot lower the liferaft		Refer to "ID : ESC-A-3"	Especially nothing	0	0	0					0	0	0	0	
ESC-A-L(a) : Getting into the liferaft : Liferaft located on aft mooring deck																	
ESC-A-L(a)-1	Lowering liferaft	Cannot lower the liferaft due to deformation of davit		Refer to "ID : ESC-A-1"	Especially nothing	0	0	0					0	0	0	0	
ESC-A-L(a)-2	Ditto	Cannot lower the liferaft		Refer to "ID : ESC-A-3"	Especially nothing	0	0	0					0	0	0	0	
ESC : Dive into the sea from the bow mooring deck																	
ESC-B-1	Dive into the sea	Suffocated by swallowing seawater before surfacing fracture on impact		High distance to sea level	Especially nothing	L	2	L	2	4	N: A liferaft is also provided on the forward mooring deck. N: Provide a shooter that can slide down to the sea easily	・Marine Evacuation system	S	0	S	0	0
Special : Hazard caused by toxic gas outflow to the upper deck																	
SP-1	During a voyage, etc.	Inhaling toxic fumes (HF) and affecting health	Inhaling toxic gas generated by EV flammable gas blowout (Inhaling HF gas from the vent pipe of the cargo hold at the exposed part, entering the accommodation through the fresh air intake of the accommodation)	Especially nothing	Especially nothing	L	2	L	2	4	N: Fresh air intake for accommodation area are positioned as far as possible from the cargo hold ventilation. ◆ In order to prevent the filling of toxic gases into the accommodation area		M	1	S	0	1

APPENDIX 1

ID	Stage	Kind of Risk	Estimated temperature and Estimated ignition time of flammable materials inside the compartment above or neighboring compartment in fire	Reason	Existing safeguard	Before countermeasure applied					Countermeasure and Effectiveness (N) : New ship (E) : Existing ship ※Countermeasure can be applied to existing ships can also be applied to new ships.	Remark	After countermeasure applied				
						Impact Risk A		Probability of Occurrence Risk A					Impact Risk A		Probability of Occurrence Risk A		
						L/M/S		L/M/S		Risk Rank			L/M/S		Risk Rank	L/M/S	
SP-2	Boarding lifeboat/liferaft etc.	Cannot boarding them	Inhaling toxic gas generated by EV flammable gas blowout (Inhaling HF Gas Outflow from Ventilation Cylinder of Cargo Hold in Exposed Part)	Especially nothing	Especially nothing	S	0	S	0	0	The outflow of toxic gas, together with combustible gas and black smoke from a fire, comes out of the ventilator. Therefore, it is not necessary to take measures that only consider toxic gas.	S	0	S	0	0	

APPENDIX 2

ID	Stage	Presence or absence of main lighting devices	Presence or absence of emergency lighting device	Hazard due to loss of lighting device	Reason	Existing safeguard	Before countermeasure applied			Countermeasure and Effectiveness (N) : New ship (E) : Existing ship ※Countermeasure can be applied to existing ships can also be applied to new ships.	Remark	Remark2	After countermeasure applied						
							Impact RISK A L/M/S	Probability of Occurrence Risk A L/M/S	Risk Rank				Impact RISK A L/M/S	Probability of Occurrence Risk A L/M/S	Risk Rank				
Hazard extraction due to nighttime and/or power loss of lighting device																			
BLO-1	Pass through Engine room	○	○	Especially nothing	Especially nothing		S	0	S	0	0	The lighting of the engine room is supplied from the main switchboard. The risk of damage to the main switchboard and the main generator due to a fire in the cargo hold is low.			0	0	0		
BLO-2	Pass through stair case from escape trunk	○	○	Be too dark to pass through(Fall)	-Damage of Aux. Switch board room cause the lack of power supply to main lighting system. -Damage of Emergency Switch board room cause the lack of power supply to emergency lighting system.		M	1	M	1	2	To prevent double fail; N:Both Aux. The swithc board room and the emergency switch board room shall not be located on the upper deck.	If a switchboard is installed on the upper deck via heat protection, the risk of damage is very high. However, the probability of occurrence was considered to be medium because this section has both normal and emergency lights.		S	0	S	0	0
BLO-3	Pass through upper deck	○	△	Be too dark to pass through(Fall)	-Damage of Aux. Switch board room cause the lack of power supply to main lighting system. -Damage of Emergency Switch board room cause the lack of power supply to emergency lighting system.	Emergency lighting only around lifboard,liferaft etc.	L	2	M	1	3	To prevent double fail; N: Both Aux. The swithc board room and the emergency switch board room shall not be located on the upper deck. -A lighting system is also installed in the escape route on the upper deck, and power is supplied from an emergency generator.			M	1	S	0	1
BLO-4	Pass through steering gear room	○	○	Especially nothing	NA		S	0	S	0	0	To prevent double fail; N:Both Aux. The swithc board room and the emergency switch board room shall not be located on the upper deck.	Lighting in the steering gear room is supplied from the main switchboard. The risk of damage to the main switchboard and the main generator due to a fire in the cargo hold is low.			0		0	0
BLO-5	Pass through aft stair case	○	○	Be too dark to pass through(Fall)	-Damage of Aux. Switch board room cause the lack of power supply to main lighting system. -Damage of Emergency Switch board room cause the lack of power supply to emergency lighting system.		M	1	M	1	2	To prevent double fail; N:Both Aux. The swithc board room and the emergency switch board room shall not be located on the upper deck.	If a switchboard is installed on the upper deck via heat protection, the risk of damage is very high. However, the probability of occurrence was considered to be medium because this section has both normal and emergency lights.		S	0	S	0	0
BLO-6	Pass through engine casing/funnel	○	○	Be too dark to pass through(Fall)	Damage of Aux. Switch board room cause the lack of power supply to main lighting system. -Damage of Emergency Switch board room cause the lack of power supply to emergency lighting system.		S	0	S	0	0	To prevent double fail; N:Both Aux. The swithc board room and the emergency switch board room shall not be located on the upper deck.	Lighting in the steering gear room is supplied from the main switchboard. The risk of damage to the main switchboard and the main generator due to a fire in the cargo hold is low.			0		0	0
BLO-7	Pass through cargo hold	○	×	Be too dark to pass through(Fall)	-Damage of Aux. Switch board room cause the lack of power supply to main lighting system. -Damage of Emergency Switch board room cause the lack of power supply to emergency lighting system.		L	2	L	2	4	N: An emergency lighting system is also provided in the cargo hold. N: The cables of the emergency lighting system shall be fireproof. N: An indicator light (emergency power supply) showing the route to the escape destination is provided in the cargo hold.	There were no emergency lights in the cargo hold, and Aux. Damaged switch board causes dimming. It was judged that the risk was high because there was no emergency lighting.		M	1	S	0	1
BLO-8	Pass through FWD stair case	○	○	Be too dark to pass through(Fall)	-Damage of Aux. Switch board room cause the lack of power supply to main lighting system. -Damage of Emergency Switch board room cause the lack of power supply to emergency lighting system.		M	1	M	1	2	To prevent double fail; N:Both Aux. The swithc board room and the emergency switch board room shall not be located on the upper deck.	If a switchboard is installed on the upper deck via heat protection, the risk of damage is very high. However, the probability of occurrence was considered to be medium because this section has both normal and emergency lights.		S	0	S	0	0
BLO-9	Pass through aft mooring deck	○	△	Be too dark to pass through(Fall)	-Damage of Aux. Switch board room cause the lack of power supply to main lighting system. -Damage of Emergency Switch board room cause the lack of power supply to emergency lighting system.		M	1	M	1	2	To prevent double fail; N:Both Aux. The swithc board room and the emergency switch board room shall not be located on the upper deck. N: Lighting systems are also installed in the escape route on the stern mooring deck, and power is supplied from an emergency generator.	If a switchboard is installed on the upper deck via heat protection, the risk of damage is very high. However, the probability of occurrence was considered to be medium because this section has both normal and emergency lights.		S	0	S	0	0
BLO-10	Pass through FWD mooring deck	○	×	Be too dark to pass through(Fall)	-Damage of Aux. Switch board room cause the lack of power supply to main lighting system. -Damage of Emergency Switch board room cause the lack of power supply to emergency lighting system.		L	2	L	2	4	N: Aux. The swithc board room and the emergency switch board room shall not be located on the upper deck. N: Emergency lighting equipment is also provided on the bow mooring deck. N: Fire resistant if emergency lighting system cable passes through cargo hold	If a switchboard is installed on the upper deck via heat protection, the risk of damage is very high. The risk is high because there are no ordinary lights and emergency lights in this section.		M	1	S	0	1