ISSN: 2472-3703 DOI: 10.6911/WSRJ.202009_6(9).0004

Investigation and Research Report on Ship Fire

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Abstract

Set in ship fire in the production process of enterprises in recent years, this paper discussed the present condition of catastrophic events of ship fire and the characteristics of ship fire, analyzed the potential dangers and hazard factors in ship use management and safety production, etc., and made the safety checklist on the basis of risk analysis. Finally, the author offers countermeasures and suggestions against fire.

Keywords

Ship fire, safety production, safety checklist.

1. BASIC SITUATION OF THE EVALUATION OBJECT

Ship is not only an important tool for water transportation in human society, but also an important carrier for shipping and logistics in production and life. The problem of ship fire has also become the focus studied and discussed by safety scholars. First, the hull structure is complex, the environment is narrow, a certain number of flammable and explosive objects are usually stored on the ship, and there are many sources of danger. In addition, at present, most of the ship equipment is outdated in my country, owing to the backwardness of fire protection technology in early stage, the design standards in the manufacturing process are relatively low, which cause the fire-resistant limit of ship building materials to do not reach the existing standards. More importantly, due to the particularity of the ship's environment, sea rescue is much more difficult than land rescue. When ship fire occurs, it usually depends on the ship's rescue equipment and manpower for self-rescue, how to reduce the casualties and property losses caused by the ship fire has become a huge problem in the safety field.

2. SELECTIONS OF EVALUATION METHODS AND EVALUATION PROCEDURES

2.1. Evaluation Purpose

According to China's "safety first, prevention primary" production management policy, prevention must be put on the first and safety work must be put in front to reduce the possibility of accidents, and minimize the loss caused by accidents. Similarly, the key point of ship fire is prevention in advance, through the studies on ship fire principles, the identification of danger source on board, fire rescue measures, and the effectiveness of ship fire prevention is further improved. This evaluation records the dangerous factors existing in the ship's navigation process through field assessment and investigation of the ship, formulate a safety checklist, the purpose is to establish the scientific evaluation system for the ship's safety and make own reasonable suggestions for the ship's fire safety work.

2.2. Evaluation Basis

By consulting the analysis of ship fire accidents in recent years as well as the contents of ship fire explosion engineering on the official website of Maritime Safety Administration of the

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202009_6(9).0004

People's Republic of China, it can be known that the causes of ship fire are mainly divided into the following types.

(1) Human factors

Human factors usually include the incompetence of crew on board, no relevant safety training, the illegal operation in the operating area, weak fire awareness, and do not have relevant escape and fire prevention skills. In the analysis of the ''7•2'' “Haishun 9” accidents in Xiamen, a person on board did not have any competent certificate or training certificate, and engaged in related work against the rules. It is an indirect cause of the accident.

(2) Unsafe state of facilities on board

a. Line aging. For ships with a long vessel age, the wires of the equipment on board are often prone to short-circuit or under high-load electricity usage, which causes some line current to be too large, overheated line and directly generate sparks to ignite nearby combustible materials and causes fire.

b. Leakage of dangerous products. Liquefied petroleum gas, diesel oil, and flammable objects are usually stored on the ship. Once these objects leak, encountering open fire or dark fire will cause fire. And as more dangerous goods are stored on the ship, more serious accident consequences may occur

c. Equipment friction static electricity. In some operating environments on board, there is a certain amount of flammable gas in the air, if the crew does not strictly follow the operation process, static electricity may be generated due to improper operation during the operation, which may ignite the flammable gas in the air and cause fire.

d. Improper use of daily articles. The use of high-power electrical appliances in the crew rest area is easy to cause electrical overload and sparks in the line, the use of open flame mosquito coils in the crew living area, or lighting equipment is used to bake clothes, etc., which can easily cause the burning of combustible objects around the equipment, and lead to fire.

(3) High temperature environment

Owing to the particularity of ship operations, crew members usually need to complete operations under high temperature environments. High temperature is also one of the causes of ship fire. First of all, the high temperature environment is easy to cause the explosion of combustibles in the air, especially in poorly ventilated environments. In addition, for chemicals stored in ship, high temperature will promote the oxidation reaction of chemicals; and heat is generated simultaneously to cause spontaneous combustion during the reaction. Due to the physical phenomenon of "expansion caused by heat and contraction caused by cold", as the temperature of the chemicals rises, the volume becomes larger in the container. When the pressure of the container is too high, it is easy to explode.

(4) Problems with management

The lack of management responsibility is also one of the indirect causes of ship fire. Problems with management include:

a. There is no clear responsibility system, the division of responsibilities among crew members is unclear when fire occurs, and it is easy for crew members to become incompetent. Without relevant skills training, illegal operations are carried out and the fire is not controlled in time.

b. Emergency drills are not in place and the fire safety awareness is weak. In many cases, there are improper emergency measures when facing fire, the response is not fast enough, and the action is chaotic. The emergency work is not in place, and shows that the emergency drills are not in place and the safety work is superficial.

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c. The safety inspection work of shipping company is not in place. Before the "4•1""Shengtai" fire accident occurred in Wusong, Shanghai, the crew found that the kitchen fire door was opened for a long time and the fire alarm was closed for a long time during the fire inspection, but three is no relevant punishment or specific rectification opinions. When fire occurred, the fire alarm system was turned off; the crew failed to deal with the fire the first time, and missed the opportunity to extinguish a fire.

2.3. Evaluation Procedures

2.3.1 Early procedure

The evaluation object and scope are made clear, mainly including on-site inspection and collection of related materials, and also need to consult the accident cases of related accident types, as well as the fire protection standards and laws and regulations of relevant equipment at home and abroad, and the evaluation standard that meets the actual situation is initially formed.

2.3.2 Identification and analysis of dangerous and harmful factors

According to the on-site situation of the selected evaluation objects, through the pre-danger analysis and evaluation of its fire extinguisher system, fire main, fire extinguisher, escape equipment, personal protective equipment of firefighters, etc. The dangerous and harmful factors are identified, the possible accident consequences are predicted, improvement is made for the dangerous and harmful factors of different levels of danger, and prepare for the further prevention of accidents. The methods of danger identification include brainstorm, preliminary danger assessment (PHA), event tree analysis (FTA), fault tree analysis (ETA), potential failure mode and effect analysis (FMEA).

2.3.3 Select safety evaluation method

At present, there are more mature evaluation methods in the safety field, such as safety checklists, formal safety assessment (FSA), fuzzy comprehensive evaluation, gray theory, etc. The safety evaluation method needs to be selected according to the actual situation, category and complexity of danger identification. The safety evaluation methods can be divided into three directions: quantitative, semi-quantitative and qualitative. We need to choose safety evaluation methods with strong operability and objective evaluation standards according to the actual situation.

2.3.4 Safety evaluation

According to the theory in the formal safety assessment (FSA) of safety engineering principles, the danger degree is equal to the product of the probability of accident occurrence and consequence severity. Through the risk matrix (semi-quantitative), or the specific losses caused by the accident and the occurrence frequency of accident of(quantitative), two methods are used to determine the danger degree of danger source. Risk classification is carried out according to the danger degree, and different prevention and treatment measures are taken for different levels of danger source.

2.3.5 Put forward safety countermeasures and suggestions

After the danger sources are graded according to danger, according to the grading results, different measures and specific suggestions are made for different results, some factors in the grading results need to be focused on prevention and control, some are within the controllable range, and some are negligible. There are three standards.

1. For ineradicable risks, we need to prepare relevant emergency plans to minimize losses after accident occurred.

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2. For high-risk factors, we need to make clear the specific standards of related equipment and processes, through strict control and scientific management of the process, the risk of accidents is minimized as much as possible.

3. For low-risk elements and acceptable risks, specific monitoring methods are also needed to prevent the risk value of accidents from being increased due to human or environmental factors.

2.3.6 Form safety evaluation conclusion

The safety evaluation conclusion is the summary of the safety evaluation work; the conclusion should include the major safety dangers existing in this evaluation target, and whether the evaluation target meets the evaluation standards in advance, and whether it complies with the relevant national laws, regulations and process technology standards. In allusion to the hidden safety peril, specific measures are given to make the safety assessment more scientific and practical.

2.3.7 Prepare the corresponding safety evaluation report.

The safety evaluation should be consistent with the real situation, the evaluation results are objective, effective, and practical, and experts should be organized to conduct reviews.

3. SAFETY EVALUATION METHODS

The evaluation method selected in this research report is to lay down safety checklist.

3.1. Safety Checklist

Safety Checklist Analysis (SCA) is currently the most widely used and widely applicable evaluation method among many safety evaluation methods. The safety checklist adopts the viewpoint of system engineering, and conducts safety check on the evaluation target according to the known process standards and codes of conduct. The safety checklist can be used in all stages of the project; the usage method is simple and effective, the evaluation range is all-round to avoid omissions in the inspection work. Safety checklist is one of the important means of safety management.

3.2. Basis for Formulation

The basis for formulating the safety checklist mainly has the following basis:

1. Investigation and analysis of ship fire accidents announced by the official website of Maritime Safety Administration of the People's Republic of China.

2 Technical Regulations for Statutory Check of Domestic Seagoing Vessel (2020) of Maritime Safety Administration of the People's Republic of China.

3. IMO International Fire Safety System Regulations.

4. Through the potential failure mode and effect analysis (FMEA), "bottom-up" analysis mode, the potential failure mode of each process and subsystem of the ship fire protection is found, and the possible consequences are analyzed.

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3.3. Safety Checklist

single item	sub-item	check requirement	evaluation result	
			yes	no
fire detection and fire alarm system	fire alarm	Whether there is a plan showing its position		
		Whether it can act immediately under any circumstances		
		Whether the power supply used by the equipment is less than 2 sets, and whether one set is used for emergency power supplied by independent wire		
		Whether the setting of the alarm button is divided into several partition		
		When the manual alarm button acts, whether there is an audible and visual fire alarm system on the indicating device		
	fire detection equipment	Whether there is a plan showing its position		
		Whether the setting of the detector button is divided into several partition		
		Whether there is an audible and visual fire alarm system on the indicating device		
		Whether there is information near each indicator to make clear the position of the partition protected by the device		
fixed gas fire extinguisher system	high-pressure carbon dioxide system	Whether the volume of released free gas is greater than 30% of the total volume of the largest warehouse		
		Whether the carbon dioxide container is a seamless steel cylinder, and whether the hydraulic test pressure is 24.5MPa		
		Whether each carbon dioxide bottle is clearly marked with the following items: container weight, volume, hydraulic test pressure, test date, factory number and check mark		
		Whether there is obvious color difference between the color of the container body and the word "carbon dioxide"		
	low pressure carbon dioxide fire extinguisher system	Whether the system control device and the refrigerating plant are located in the same space as the storage container		
		Whether the amount of carbon dioxide required is stored in the container with 1.8MPa to 2.2MPa working pressure		
		Does the system have: 1. Pressure gauge; 2. High-pressure alarm: not exceed the setting value of the release valve 3. Low-pressure alarm: not less than 1.8MPa 4. Filling container branch pipe with stop valve 5. Exhaust pipe 6. Liquid carbon dioxide volume indicator mounted on the container 7. Two safety valves		
	steam fire extinguisher system	Whether the total volume of the largest protected space per hour is not less than 1kg steam per 0.75m3		
gun and fire extinguisher water hose and water fire main, fire hydrant,	fire main pipe	Whether there is any leak		
		Whether the pipeline is corroded		
		Whether the diameter meets the maximum water output required by two fire pumps working in parallel		
		Whether there is drainage facility		
	fire hydrant	Whether there is no less than 2 water jets ejected from different fire hydrants		
		Whether the position of fire hydrants is easy to connect to the fire hose		

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single item	sub-item	check requirement	evaluation result	
			yes	no
		Whether each fire hydrant is equipped with one fire hose and one water gun		
	fire hose and water gun	Whether there is corrosion		
		Whether each fire hose is equipped with one water gun and necessary joints		
		Whether the length of the fire hose is enough to spray the water column to any residence that may need to be used		
		Whether all firefighting water guns are approved dual-use type with shut-off equipment (spray/water column type)		
	fire extinguisher	Whether it produces a certain amount of poisonous gas under the expected use conditions		
		Whether each dry powder or carbon dioxide fire extinguisher have at least 5kg capacity		
		Whether one of the portable fire extinguishers used anywhere is stored near the entrance		
		Whether there is blockage or corrosion		
		Whether note the filling date on the cylinder		
		Whether all fire extinguishers are within the validity period		
lifesaving appliance	throwing equipment for lifesaving and rescue	Whether there is pneumatic rescue thrower		
		Whether there is pneumatic rescue thrower		
		Whether there is portable gun type cable gun		
	personal life-saving appliance	Whether the number of life buoys meet the latest standards of the Maritime Safety Administration		
		Whether the number of life jackets meet at least 1 per person		
communications		Whether there is qualified radio operator		
		Whether the distress control panel is installed on the bridge		
		Whether there is VHF setting		
		Whether there is NAVTEX		
		Whether there is lifeboat raft bidirectional VHF-radio telephone		
		Whether there is on-site (aeronautical) bidirectional VHF wireless telephone setting		

4. COUNTERMEASURES AND SUGGESTIONS

4.1. Perfecting the Ship Firefighting System

"Safety is not a small matter, nip in the bud", and "put safety in front" are the most effective ways to reduce accident losses. According to provision of ship emergency deployment system, all service ships must require the ship's unit to carry out at least one fire drill every month, so as to effectively improve the crew's reaction to fire accidents. And every ship needs to formulate the fire safety system, each crew member conducts operation in accordance with the system requirements, and each crew member is obliged to undertake the task of ship fire prevention. The reasonable system is conducive to standardize fire protection standards and procedures. According to the statistics afterwards, many large-scale fire accidents were caused by improper firefighting measures when fire was found, therefore, fire drills must not be formalism, go through the motions, practice exercises must be paid attention to, and the location of the fake fire should be often changed, for example: machine warehouse, cargo warehouse, living area, deck, etc. The strict fire control system is conducive to increase the crew's awareness of fire

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prevention, standardize fire extinguishing behaviors, and have further understanding for the prevention and control of ship fire through regular fire drills.

4.2. Improving Ship Firefighting Organization

The ship firefighting organization is to deploy personnel from various departments on board to form firefighting teams, the grouping condition of firefighting teams and the number of personnel depend on the size and type of the ship. According to the production standards and requirements of relevant departments in our country, every ship should have a sound firefighting organization. A sound ship firefighting organization can effectively eliminate the fire at the budding stage, and it is also the most effective way to prevent the fire from further expanding. In general, the firefighting teams are divided into the following groups: (1) the command team in the charge of the captain and the second mate, the captain acts as the general commander to maintain contact with the outside world and manipulate the ship based on the actual situation. The second mate assists the captain to work, displays the fire signal, and is responsible for external communication. (2) The first mate is responsible for the action team, after hearing the fire, immediately bring the nearby fire extinguisher, bucket, and yellow sand to choose the appropriate fire extinguishing method based on the fire situation. (3) The chief engineer acts as the engine room group, maintains contact with the bridge, prepares and controls the main engine, and ensures the normal operation of the ship equipment and firefighting equipment during the fire. (4) The medical staff forms ambulance teams to provide rescue for the wounded, and prepare emergency medical equipment such as stretchers and lifeboats.

4.3. Strengthening Ship Firefighting Training

According to the principles of combustion, it is relatively easy to extinguish the fire in the initial stage, if the flame is not extinguished in the early stage, once the fire reaches full combustion, flashover will cause huge property losses and casualties. Therefore, ship firefighting practice should be regarded as a regular task, which has a significant effect on improving the crew's firefighting awareness and strengthening the crew's firefighting skills. The crew should be familiar with the specific process of ship firefighting, including reporting the fire situation, orderly extinguishing the fire, preventing secondary fires, etc., and also mastering firefighting equipment. Ship firefighting training is divided into general firefighting training and organized firefighting training. (1) General firefighting training. is usually organized by the first mate, and the crew is required to master basic firefighting knowledge and fire principles, determine the cause of fire, choose appropriate fire extinguisher equipment, and the disposal steps when the fire occurs, discover the dangerous situation, and master first aid skills. (2) Organization of firefighting training. They are mainly the organization and implementation of specific firefighting operations. All team members are required to be familiar with the duties of the team, follow the command tasks when fires occur, and carry out firefighting operations in good order and well arranged. Crew should be familiar with the location of fire extinguisher equipment, fire site investigation and reporting methods, the normal steps to extinguish the fire, the search and rescue methods in the cabin, the power disconnection steps in the fire area, the fire site cleaning, prevention of re-ignition and other steps.

5. CONCLUSION AND PROSPECT

According to the trace intersecting theory, accidents are often caused by unsafe behaviors of people and unsafe conditions of objects. Human unsafe behaviors are the cause of most accidents. Therefore, regular safety drills, standard of the crew's behaviors, and improvement of the crew's safety awareness are the primary tasks of safety work. Secondly, regularly

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checking whether the firefighting equipment meets the requirements and whether the emergency escape equipment is sufficient are also non-negligible part of the safety work. Putting safety work in front and nip in the bud are the most effective ways to reduce accident losses. As a major problem in the safety field, ship fire prevention still has many shortcomings, how to improve the ship fire-resistant limit by improving the ship material structure, and how to enrich the rescue ways for ship fires require further studies of relevant safety scholars.

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