



Research on Classification of Traffic Organization of Ships Carrying Dangerous

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Abstract. In order to meet the national intrinsically safe management requirements, on the basis of international convention rules and national technical standards, take the Three Gorges locks as an example, consider the special safety management requirements of the locks for fire prevention, explosion and corrosion prevention, and refer to the fire hazard classification standards in the fire prevention specifications of architectural design, and adopt a targeted policy matrix analysis method to optimize the classification of dangerous cargo ships through the locks, and propose technical measures for traffic organization accordingly.

Keywords: Three Gorges · Lock · Classification · Traffic organization

1 Introduction

The Three Gorges Lock has been in operation since 2003. It is an important waterway navigable building in our country. It is the main throat connecting the east, middle and west of shipping in the Yangtze River. It has the characteristics of high political sensitivity, high safety risk, high relevance to people's livelihood and high social concern [1]. After the storage of water in the Three Gorges Reservoir, the conditions of the port and waterway in the reservoir area have been greatly improved, giving full play to the advantages of water transportation. Since 2011, the cargo volume of the Three Gorges Locks has exceeded 100 million tons. At present, the one-way cargo volume has exceeded the designed capacity of 50 million tons for 10 consecutive years. And the cargo volume has exceeded 140 million tons since 2018 [2], which has strongly supported the high-quality development of shipping in Yangtze River [3]. The demand for ships carrying dangerous goods that need to be transported by waterway has also increased year by year [4, 5]. At present, the annual volume of ships carrying dangerous goods through the locks has exceeded 9 million tons [6].

The traffic organization of ships carrying dangerous goods through the locks has always been the focus of the navigation management of the locks. It focuses on the safe and efficiency of ships carrying dangerous goods through locks to prevent fire and explosion. A hierarchical traffic organization model for the ships carrying dangerous goods through the locks has been constructed, and special gates are arranged for the release of

ships carrying flammable and explosive dangerous goods [7], and fire trucks are on duty along the route [8]. The operation of the locks, the public security of shipping and the fire-fighting supervision departments implement fire-fighting supervision, and implement strict management in the whole process and in all directions, effectively ensuring the continuous stability of the water traffic safety situation in the Three Gorges Hub River section [9]. With the increasingly stringent national requirements for intrinsically safe management, it is urgent to study and optimize the organization mode of ships carrying dangerous goods through locks in accordance with the latest regulations, technical standards and the safety management characteristics of the Three Gorges locks.

2 The Main Hazards of Ships Carrying Dangerous Goods Through Locks

The main harmful consequences of accidents on ships carrying dangerous goods include casualties, property damage, and environmental pollution. Compared with general navigation behaviors, the harmful consequences of ships carrying dangerous goods through locks may cause damage to navigable buildings. The primary concern of ships carrying dangerous goods through locks is mainly the impact of possible fire and explosion on the safety of lock equipment and facilities, and the second is the impact of possible cargo leakage on the corrosion of lock equipment and facilities. Other hazard prevention and control requirements are generally consistent with inland river transportation.

Since 2015, a total of 110 different dangerous goods have passed through the Three Gorges Locks, including flammable liquids, substances that are easy to spontaneously ignite, oxidants, toxic substances and corrosive substances. Bulk liquid dangerous goods accounted for more than 99%, mainly gasoline, diesel, crude oil, aviation kerosene, methanol, xylene and other flammable liquids, generally transported by tankers or chemical ships through the lock. Packaged dangerous goods accounted for less than 1% of the cargo volume of dangerous goods through the lock, and no flammable, explosive or corrosive packaged dangerous goods were found to be transported through the lock. No gas dangerous goods and bulk solid dangerous goods passed through the lock. The distribution range of the main hazard classification is shown in Fig. 1.

3 Classification Traffic Organization Technical Requirements

The risk of fire, explosion and corrosion of packaged dangerous goods and solid dangerous goods that are allowed to be transported in bulk is much lower than that of liquid dangerous goods. The “Regulations on the Administration of Domestic Waterway Transportation” make it clear that these two types of dangerous goods can be transported by ordinary cargo ships. Liquid dangerous goods are the main part of existing dangerous goods passing through the lock, and ships carrying liquid dangerous goods are the top priority of the traffic organization.

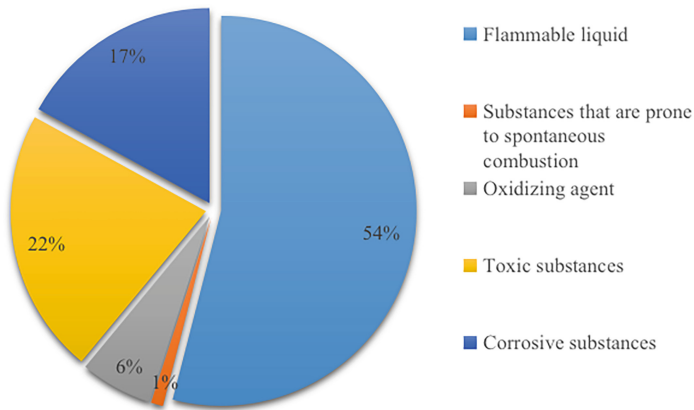


Fig. 1. Hazard distribution map of dangerous goods through the lock

3.1 Limitation of Passing Through the Locks

In accordance with the requirements of relevant laws and regulations, the risk consequences of dangerous goods accidents, the structural safety performance and fire protection design of locks in the event of fire and explosion accidents, etc., In addition to the existing regulations on explosives, highly toxic, radioactive and infectious substances, etc., it is proposed to impose restrictions on passing through the locks in the following situations.

- (1) Ships carrying flammable and explosive liquids and dangerous cargo with a maximum single cabin area greater than the maximum cargo hold area of the lock fire-fighting design reference ship type.
- (2) For dangerous goods that have applied for passing through the lock for the first time, if the safe transportation conditions of passing through the lock are not clear, restrictions on passing through the lock shall be implemented before the safe transportation conditions are evaluated.
- (3) Dangerous goods that cannot use fire-extinguishing media such as water or foam to extinguish the fire are restricted from passing through the lock or under temporary special protective measures.

3.2 Classification of Dangerous Goods Pass Through the Lock

Except for situations where passing through the lock is prohibited and restricted, according to the category of dangerous goods specified in the “Regulations on the Safety Supervision and Administration of Dangerous Goods Carried by Ships”, on the basis of the classification of relevant international conventions and rules, consider the special safety management requirements of locks for fire prevention, explosion and corrosion prevention, and refer to the fire hazard classification standards in the fire prevention specifications of architectural design. According to the form of transportation, dangerous goods passing through the gate are divided into two categories, bulk dangerous goods and packaged dangerous goods, and 10 subcategories. The specific categories are shown in Table 1.

Table 1. Classification of dangerous goods passing through the lock

Mode of transportation	Classification of dangerous goods		category	
Bulk dangerous goods	Bulk liquid	Flammable liquid	Liquids with a flash point of not more than 60°C in MARPOL Convention and IBC Code	
		Non-flammable liquid	Corrosive liquid of lock	Liquid dangerous goods in the MARPOL Convention and IBC Code that will seriously damage or even destroy the lock facilities and equipment when leaking
			Non-Corrosive liquid of lock	Other liquid dangerous goods that will not seriously damage the lock facilities and equipment
Bulk solids		Flammable solids	Flammable solids, substances that are easy to spontaneously ignite, substances that emit flammable gases in case of water, self-reactive substances, solid desensitized explosives, igniting substances, self-heating substances and organic peroxides listed in the IMSBC Code	

(continued)

Table 1. (continued)

Mode of transportation	Classification of dangerous goods		category
	Non-flammable solids	Corrosive solids of locks	The leakage specified in the IMSBC Code will seriously damage or even destroy the solid dangerous cargo of the lock facilities and equipment
		Non-Corrosive solids of locks	Other solid dangerous goods that will not seriously damage the lock facilities and equipment
	Bulk gas		Bulk liquefied gas listed in IGC Code
Packing dangerous goods	Packaging liquid		Packaging liquid dangerous goods in IMDG Code
	Packaging solids		Packaging of solid dangerous goods in IMDG Code
	Packaging gas		Dangerous goods packaged in IMDG Code

3.3 Technical Measures

Focusing on preventing fire and explosion accidents on dangerous goods ships and minimizing the consequences of corrosion hazards caused by the leakage of dangerous goods, traffic organization technical measures such as closed management, release of special locks, restricted side-by-side and limited passage through the same lock are classified. As shown in Table 2.

Ships carrying dangerous goods through the lock should also meet the following technical measures: (1) Dangerous goods ships do not pass through the same lock as passenger ships; (2) Dangerous goods ships with different types of chemical incompatible or applicable fire extinguishing agents pass through different locks; (3) Dangerous goods that apply for passing through the lock for the first time need to be evaluated to determine the traffic organization measures; (4) Arrange special locks for existing bulk flammable liquid dangerous goods ships (including empty ships that have not been

Table 2. Technical measures for traffic organization of dangerous goods ship passing through locks

Mode of transportation	Classification of dangerous goods		Technical measures	
Bulk dangerous goods	Bulk liquid	Flammable liquid	Closed management, special Locks are released, fire protection supervision, leaving enough spacing of herringbone door and ship, the number or volume of ships passing through each lock is determined according to the quantitative risk calculation of dangerous goods ships. No more than 1 ship per lock	
		Non-flammable liquid		No more than 1 dangerous goods variety per lock
	Bulk solids	Flammable solids		There is no record of the cargo passing through the lock, and the traffic organization measures have yet to be evaluated and determined
		Non-flammable solids		
		Corrosive solids of locks		
		Non-Corrosive solids of locks		

(continued)

Table 2. (continued)

Mode of transportation	Classification of dangerous goods	Technical measures
	Bulk gas	There is no record of the cargo passing through the lock, and the traffic organization measures have yet to be evaluated and determined
Packing dangerous goods	Packaging liquid	The requirements for stowage isolation of container transportation should be met. Do not arrange to pass through the same lock as bulk dangerous goods ships, and do not arrange other ships carrying packaged dangerous goods side by side
	Packaging solids	
	Packaging gas	There is no record of the cargo passing through the lock, and the traffic organization measures have yet to be evaluated and determined

washed after unloading) to pass through; (5) Other dangerous goods ships implement limited passage through the same lock.

4 Conclusion

The management of the safe of ships carrying dangerous goods through locks is an important work of multi-departmental and multi-unit cooperation. According to the main differences between the hazardous consequences of ships carrying dangerous goods and the normal course of navigation, fire prevention, explosion prevention and corrosion prevention are the main goals. The existing international convention rules and domestic regulations and technical standards are connected to divided the dangerous goods that pass through the lock into 2 categories and 10 subcategories of bulk dangerous goods and packaged dangerous goods for management, and the technical measures of traffic organization such as closed management, special lock release, restriction of side-by-side and limit of the same gate are proposed. It provides support for the management department to revise and improve the existing regulations and normative documents of the crossing department, which is conducive to ensuring the safety of the operation of the locks, giving full play to the navigation efficiency of busy locks, and improving the safety and security capabilities of Yangtze River shipping.

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