Target Container Selection Method for Maritime Inspection on Dangerous Cargo Container

Peng Wu [a], Haibo Xia, Jianjun Wu[b], Mingming Liu

Mechant Marine College, Shanghai Maritime University, Shanghai 201306, China

[a]wu0704@foxmail.com, [b]jjwu@shmtu.edu.cn

Abstract

Based on the risk analysis of the container system for ship carrying dangerous cargo container, the accident tree analysis method is used in combination with typical cases to analyze the risk factors of the system and determine the accident factors of transportation for ship carrying dangerous cargo container.;Based on the implementation of the container selection method by means of information technology, the risk factors of ship carrying dangerous cargo container and the port EDI information were combined to systematically identify 19 container selection factors. Combining with professional judgement, establish the correlation between container selection factor and transportation risk factor, and provide data basis for the container selection method. For the Maritime Safety Administration, the Port Authority in dangerous cargo container opening inspection and target selection work has provided the feasibility and operability strong methods, which will promote the port safety supervision and management department to improve the efficiency of container inspections.

Keywords

Ships carrying dangerous cargo; container inspection; maritime supervision; risk factors associate.

1. Introduction

Container shipping is the most popular and active transportation mode in the world. However, in recent years, there have been a number of significant safety accidents such as fires and explosions of dangerous cargo container in the world, which have caused significant damage to the safety of ship and the environment. In 2013, four container ships owned by Maersk had successively caught fire. The International Council of Shopping Centers has conducted surveys on the world's top 100 import and export traders, among which the issue of container safety has become the focus of attention, and how to achieve more efficient and safety turnaround of shipping container has become the real problem for the world, Chunlin Shi(2011)[1].

The risk of ship carrying dangerous cargo containers is becoming increasingly prominent. However, facing plenty of dangerous cargo containers entering and leaving port, how to screen out high-risk inspection target container has always been a technical problem, Zhaoqing Liu(2014)[2]. Taking the Ningbo-Zhoushan Port as an example, as the fifth largest container shipping port in the world and the third largest port in China, according to incomplete statistics, only in the first half of 2016, there were about 9000 vessels carrying dangerous cargo containers entering and leaving port, totaling 260000TEUs, nearly 4 million tons of dangerous cargo, Redus, R(2007)[3]. There are hundreds of species such as ammonium nitrate, liquid ammonia, pentafluoroethane, sulfamic acid, glacial acetic acid Im, H. & Song, K(2006)[4]. Domestic and foreign scholars and researchers have done a lot of research on the selection of target container for dangerous cargo container, Orphan, V(2005)[5]. Due to the complexity and diversity of cargo transportation of dangerous cargo container, there is still no widely accepted target container screening method ,Jones, J(2006)[6], Gozani, T(2006)[7].

Boros te al. proposed to use the decision tree model to analyze each case, screen out the inspection target container, and combine sensors to further optimize the screening method, Boros,E(2006)[8]. Ramirez et al. proposed a probabilistic discovery algorithm based on a general decision tree model to

optimize the screening of the target containers, Ramirez-Marquez JE(2008)[9] Kumar, S. and Verruso, J. developed a decision-making assistance framework for US port container transport based on failure-effect model and critical analysis, Kumar,S.&Verruso(2008)[10]. Liu Chengbin et al. introduced the use of "multi-layered" screening and risk management techniques by the US Coast Guard to implement container selection management. Based on more than 300 standards, cargo information data was analyzed to determine container risk values, and high-risk value containers were identified as inspections target container, Chengbin Liu(2008)[11]. Qiu Huazan proposed the successful experience of using the artificial search for false reports of dangerous cargo container, established the target container evaluation index system. At the same time, the neural network evaluation method was used to establish the nonlinear target container evaluation model, and the case verification was carried out to improve the check effectiveness of container opening , Huazan Qiu(2010)[12].

This paper focuses on the analysis of 60 typical accident case data, use basic accident event as a bridge, and uses accident tree analysis to determine the accident risk factors for ship carrying dangerous cargo container transportation, combining the risk factors and port electronic data exchange information to determine 19 container selection factors; To establish the correlation between the container selection factors and the transportation risk factors, and to judge the container selection factor of ship carrying dangerous cargo container. Through the method of evaluating the evaluation factor, a certain number of high-value containers are selected as the target container to be examined.

2. Conventional Method for Inspection of Dangerous Cargo Container on Board

At present, the maritime department carrying out opening inspection on which has been damaged or leaked, has been reported as a packing quality problem, and has been reported to be inconsistent with the actual declared goods, and has been inspected by poor integrity inspector.

Artificial screening is the main method of selecting target container now. Although the accuracy of the discriminate is high, the efficiency is low. The container selection method based on honesty as the deciding factor has low accuracy, and it will be caught in the circle of "bad is always bad". At present, it can only be used as one of the optimization factors for manual judgement.

There are some maritime supervisory department that use the "safety management system for container ships carrying dangerous cargo" to import the "International Maritime Dangerous Goods Codes" and the domestic dangerous goods list into the system, and the system will automatically link it with the information obtained from the EDI Center of the port or the regulatory authority. Comparing self-constructed suspicious fields to narrow the scope of inspection, supplemented by manual judgement, and determine the final target container.

In addition, some maritime supervisory department rely on the "Dangerous Goods Management System" developed at the e-port to focus on the e-filing function of cargo, the container will also be listed as the inspection scope that for the first time declared, the first declaration of the declarer, the first inspection of the inspector, the first time to export. It also used manual judgement to determine the final target container to be checked. This is a new attempt.

3. Analysis of Container Selection Factors for the Inspection of Dangerous Container on Board

3.1 Accident Factor Analysis of Ship Carrying Dangerous Cargo Container

Data sources: The accident cases selected in the paper are derived from the accidents of ship carrying dangerous cargo container in Chinese sea area, which are random and comprehensive. Through collecting a total of 60 cases of typical accidents of ship carrying dangerous cargo container, ship carrying dangerous cargo container accidents can be basically classified into five basic types of accidents: gas leaks, liquid leaks, solid leaks, damp spontaneous combustion, and spontaneous combustion.

Based on the analysis of the causes of accidents by accident investigation agencies, this paper concludes and summarizes the causes of ship carrying dangerous cargo container accident including: improper packaging, improper loading, high environment temperature, and bumps in the transportation. Then, based on the analysis of the basic events of the cause of accidents on board, in general, the basic factors for the cause of ship carrying container can be determined. The detailed contents are shown in Figure 1.
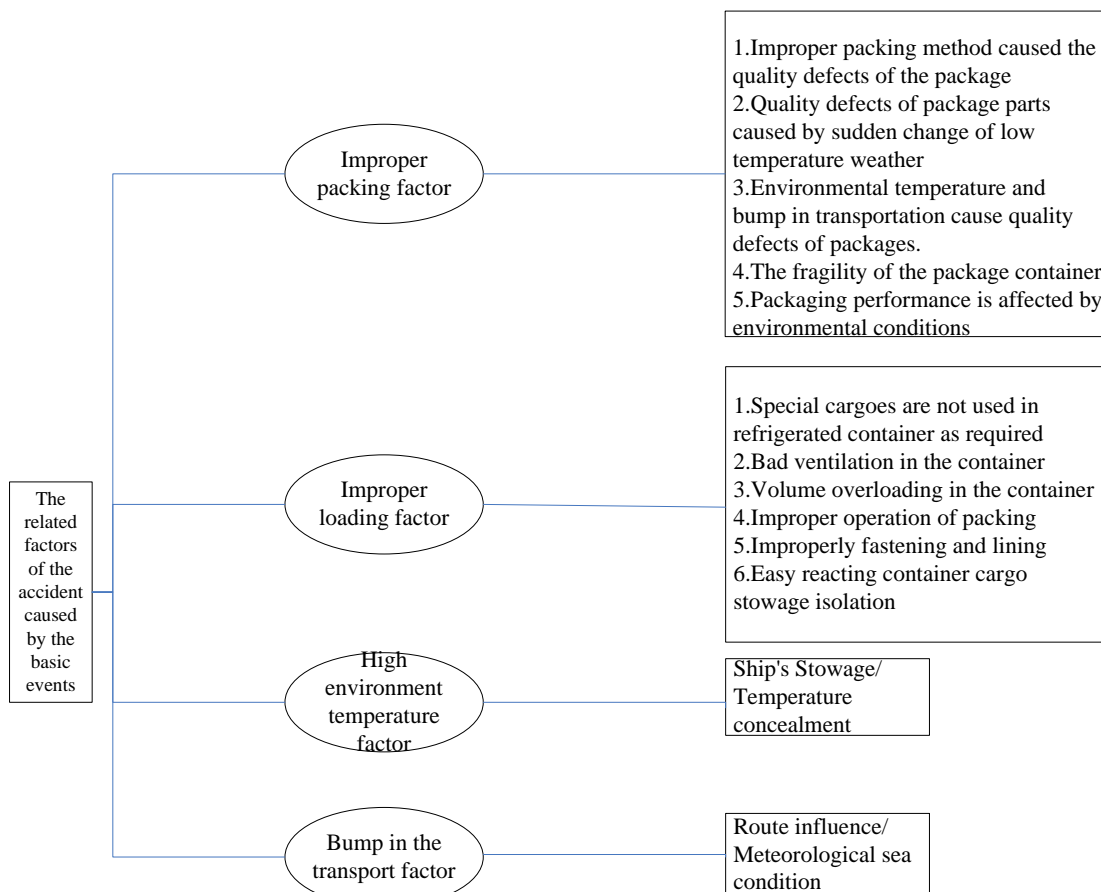

Figure 1. Accident cause factor of container with dangerous cargo on board

3.2 Container Selection Factor Analysis of Ship Carrying Dangerous Cargo Container

It is directly related to the selection effect of the target container for determining whether the index of ship's dangerous cargo container selection is scientific and reasonable. For this reason, the container selection indicators should be streamlined, independent, representative, and operable.

Based on the analysis of basic factor of the cause of the accident, the risk factors of the ship carrying dangerous cargo container and the port EDI information should be combined on the basic of the convenient and informational means to carry out the container selection method. Take the "sensitive container" as an example: by collecting the stowage chart of the container ship, it is possible to mark the tank position close to the heating fuel tank in the stowage cabin, in the cabin or on the back deck of the cabin near the engine room heat source in summer, the deck top of the daylight direct radiation on the deck in summer, the outside of the starboard side and so on. "High" sensitive container, gradually accumulate and establish database. The "CTN. NO. - container number" column in the "CTN. NO. container" column of the port EDI system information can obtain the information of the container number. By inquiring the electronic manifest, it can be informed whether the container is loaded in the sensitive container position. With the above factors mentioned above, the factor for determining the container selection for carrying dangerous cargo is determined as shown in Figure 2.
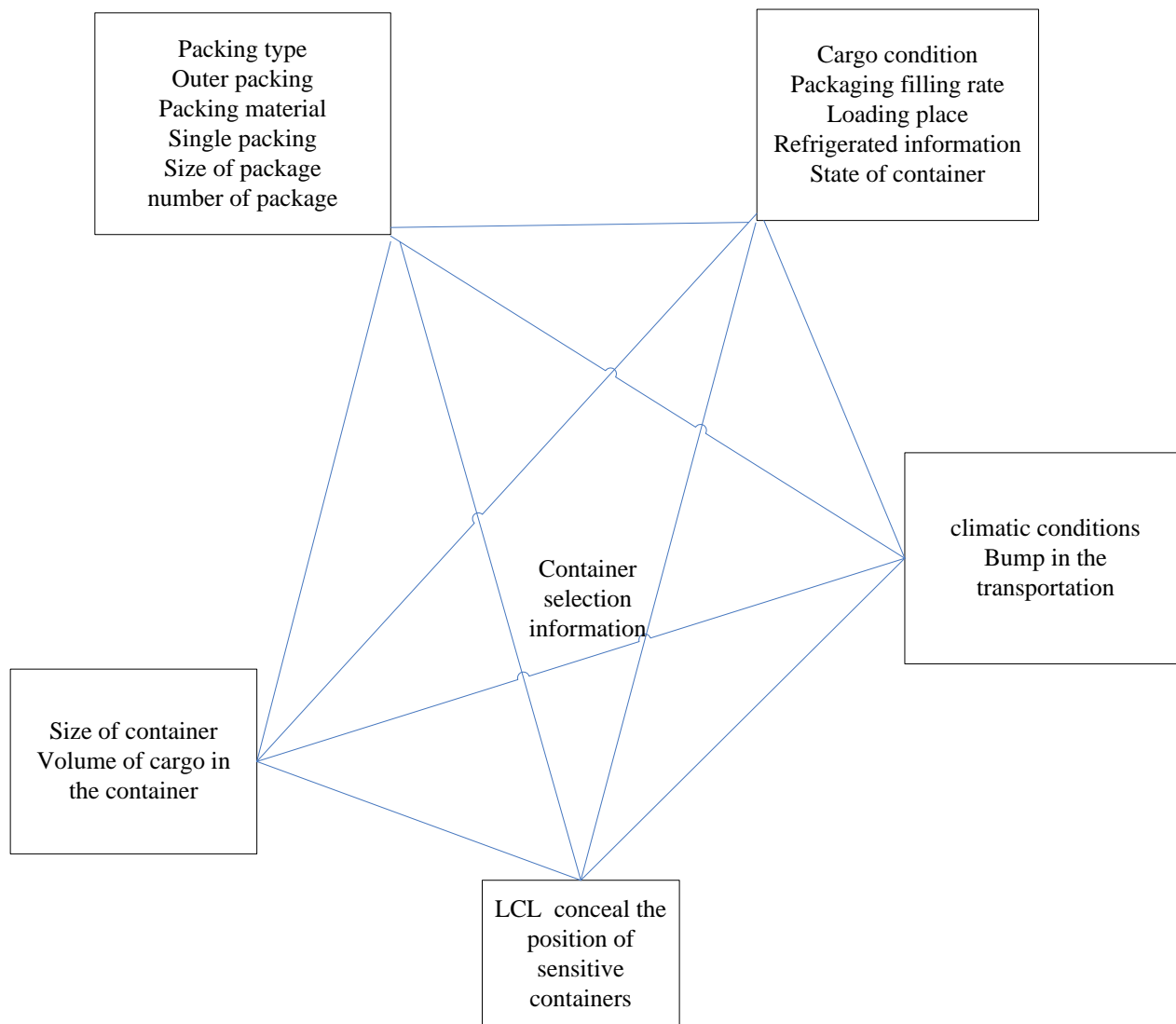
Figure 2. Container selection factor of ship carrying dangerous cargo container during transportation

3.3 Correlation Analysis Between Transportation Risk Factor and Container Selection Factor of Ship Carrying Dangerous Cargo Container

Figure 1 information: combined with typical cases, the accident tree analysis method is used to analyze the system risk factors, and then to determine the risk factors for ship carrying dangerous cargo container transportation; Figure 2 information: on the basis of the application of information means to carry out the container selection method, the risk factors of ship carrying dangerous goods container are combined with the port EDI information to systematically find out 19 container selection factors. That is: mapping the risk causing factors of ship carrying dangerous cargo container to the port EDI information system, so as to determine 19 container selection factors.

The correlation analysis of the transportation risk of ship carrying dangerous cargo container and the container selection factors, taking "transportation bump" as an example: the container ship has a large number of containers on deck, large wind area above the waterline, and the ship is prone to roll under the action of wind and waves. The container position on deck is close to half of the total, the center of gravity is higher than that of the general ship, the height of initial stability is low, and the restoring moment is small, which makes it swaying n the wind and waves long, so that the goods are bumped safely. Therefore, in bad weather, the cargo in the container may be damaged by bumping in transit. The "bumpy" risk factor is mapped to the container selection factor in the weather condition and bumpy in the way of transportation. Through comprehensive analysis, we get the container correlation diagram of ship carrying dangerous goods container, as shown in Figure 3.
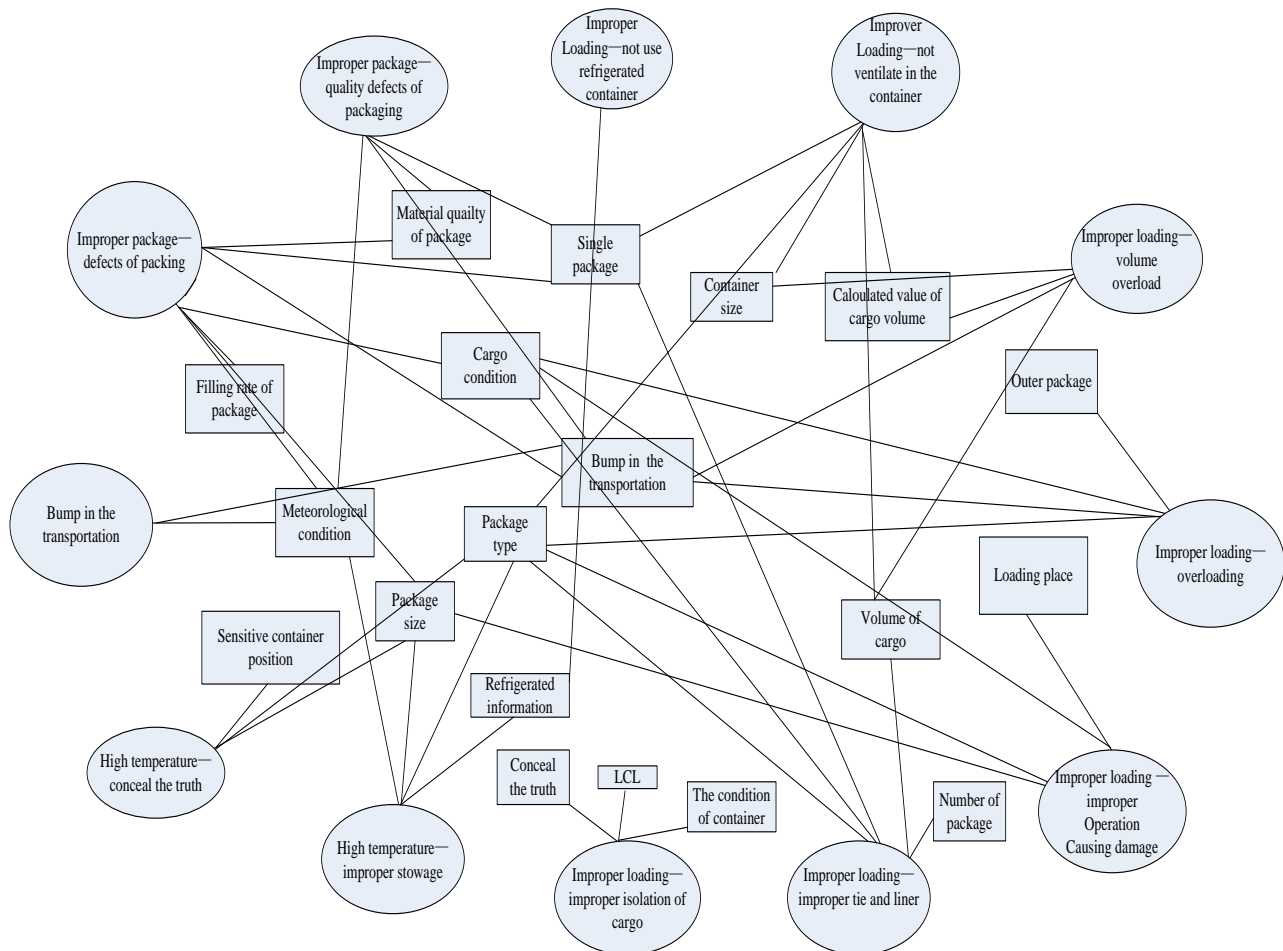
Figure 3. Ship transportation of container with dangerous cargo risk factor associated with selected containers of factor analysis

4. The Evaluation of the Factors for the Container Inspection and Selection of Ship Carrying Dangerous Container

4.1 Evaluation Design of Container Selection Factor

Based on the above analysis conclusions, in order to quantify and filter out containers with high dangerous values as the target containers to be inspected, the value of factors that may cause dangerous cargoes to fail to meet the conditions for safe transportation will be compiled into tables and judged, taking into account the extensiveness of cargoes in containerized transport, the following table uses the "factor of cargo - all cargo" evaluation table as an example.

The evaluation standard of the table design, according to the degree of importance of checking the container selection factor of the ship carrying dangerous cargo container, assign different scores.

Some of the factors in the cargo factor can be obtained through the use of information technology in the EDI data center of the port, and some of the evaluation factors are manually resolved.

The evaluation of all cargoes is carried out according to the items listed in the table of evaluation factors in Table 1. Similarly, the supervisory department needs to collect and maintain similar characteristic information to facilitate information comparison and search.

Table 1. Cargo factor - all cargoes "evaluation factor table:

NO	Evaluation factor	Evaluation
1	The relevant information of this cargoes is similar to that of a dangerous cargo that has been investigated and violated	0/10
2	The relevant information of the cargoes is similar to that of a dangerous cargo exported or prohibited by a producer, and has been imported in this port	0/10
3	The relevant information of the cargoes is similar to that of a dangerous cargo imported or prohibited by a certain port of destination and has been shipped in this port	0/10
4	The relevant information of this cargoes is similar to that of a dangerous cargo that is banned or restricted from import and export in this port and has been imported and exported in this port	0/10
5	The relevant information of this cargoes is similar to a dangerous cargo that is banned or restricted from entering and exiting in this port, and there are a large number of traders, or manufacturers, or market demand in the surrounding area.	0/10
6	The relevant information of the cargoes is similar to that of a dangerous cargo which is restricted by the route of the carrier	0/10
7	The relevant information of the cargo is similar to that of a dangerous cargo which is banned by the ship, and the route of the carrier is irreplaceable.	0/10
8	The relevant information of this cargo is similar to a dangerous cargo that was previously rejected by the ship	0/10
9	The shipment was submitted by the shipper to the carrier with a "non-dangerous letter of guarantee	0/10
10	The cargoes are suspected of dangerous chemicals	0/10
11	The dangerous cargo has the characteristics of small mass transport	0/1
12	There are multiple freight forwarders, or shipping agents, or traders.	0/1
13	The cargoes are shipped from overseas (far from the source) to our port for export.	0/1
14	The cargoes came from other provinces and foreign countries, especially the nearby ports that can be shipped but not selected.	0/1
15	The cargoes are first transported or supervised	0/1
16	The cargoes are transported by door-to-door	0/1

(1)For the first 10 items, we must check the target container, counting 10 points.

(2)Comply with 1 item for each of the 11-16 items, and obtain a total of n points and then convert n/6*10 to assign points, for example, 3 points for the evaluation of the items in Table 11-16, converted to 3/6*10=5 point

(3)16 items in total, but the score of more than 10 points is 10

According to the number of values, after sorting by size, the regulatory unit can choose a container with a certain number of values according to needs as the target container to be inspected.

4.2 Optimization of Physical form Selection of Cargo

According to the typical case of accident, according to the physical form, the number of events and the hazard level of the dangerous cargo in the accident, the accident risk of the dangerous cargo of

different physical forms is analyzed, and the risk order of the dangerous cargo of different physical forms is analyzed.

(1)Liquid, solid powder and solid dangerous cargo accidents accumulate considerable economic losses.

(2)The cumulative economic loss of gas dangerous cargo accidents is less.

(3)The specially major and major accidents are the occurrence of liquid, solid powder and solid.

Therefore, the physical form of dangerous cargo decreases in sequence according to the sequential risk of liquid (A), solid powder (B), solid (C) and gas (D). This order can be used as a reference for optimizing the selection of container results, and can further identify and reduce the scope of the target container.

The risk control of ship carrying dangerous cargo container is focused on source management. It should start with the factors of cargo, logistics companies and regulatory authorities, and carry out necessary risk control, as follows:

(1) The risk control of the relevant factors of the cargo is mainly to control the declaration, packing and packing of dangerous cargoes.

(2)The logistics enterprises, including the carrier (ship or ship company), manufacturers, traders, freight forwarders and freight stations should strengthen the training of professional knowledge of dangerous cargo transportation. It should be implemented as soon as possible for the platform of water and land linkage corporate platform so as to eliminate the fluke violations of enterprises

(3)The regulatory departments, including maritime, port, customs, public security, security supervision and state inspection departments, should further integrate the information of the import and export of cargoes, advance the information method to check the illegal activities of container dangerous cargoes, jointly select the container for inspection, and jointly maintain the order of dangerous cargo transportation in the port.

5. Conclusion

The selection of the inspection target container requires a comprehensive analysis of the cause of the accident and the combination of risk factors and container selection factors to form a scientific and effective decision method for the selection of the target container. Finally, dangerous cargoes containers that are suspected of high risk are screened out, the scope of manual screening is reduced, and supervision work load is reduced. And, improve supervision effectiveness, check the problem container from the source, reduce container shipping accidents.

In the next stage, for a more comprehensive and systematic identification of risk factor of ship carrying dangerous cargo container, we are supposed to combine with the port EDI information, so as to achieve the work of informative container selection of ship carrying dangerous cargo container.

Acknowledgements

References

[1] Chunlin Shi: Review and Prospect of China's Container Shipping Safety Protection, Containerization (2011) No.22, p.5-9.

[2] Zhaoqing Liu: (Cargo transport assembly installed in the rules of practical operation) and its history, Containerization (2014) No.10, p.28-31.

[3]   Redus, R., Alioto, M., Sperry, D: VeriTainer radiation detector for intermodal shipping containers, Nuclear Instruments and Methods in Physics Research A (2007) No.579, p.384–387.

[4]   Im, H. & Song, K: Applications of prompt gamma ray neutron activation analysis: Detection of illicit materials, Applied Spectroscopy Reviews (2006) No.44, p.317-334.

[5]   Orphan, V., Muenchau, E., Gormley, J. & Richardson, R: Advanced y ray technology for scanning cargo containers, Applied Radiation and Isotopes (2005) No.63, p.723-732.

[6]   Jones, J., Norman, D., Haskell, K., Sterbentz, J., Yoon, W., Watson, S., Johnson, J., Zabriskie, J., Bennett, B., Watson, R., Moss, C. & Frank, H: Detection of shielded nuclear material in a cargo container, Nuclear Instruments & Methods in Physics Research Section A (2006) No.562, p.1085-1088.

[7]   Gozani, T: Principles and applications of neutron-based inspection techniques, Nuclear Instruments & Methods in Physics Research (2007) No.261, p.311-315.

[8]   Boros, E., Fedzhora, L., Kantor, P., Saeger, K. andStroud, P: Large scale LP model for finding optimal container inspection strategies, Rutcor research report (2010) No.56, p.404-420.

[9]   Ramirez-Marquez JE: Port-of-entry safety via there liability optimization of container Inspection strategy through an evolutionary approach, Reliability Engineering and System Safety (2008) No.93, p.1698–709.

[10] Kumar, S.&Verruso, J: Risk assessment for the security of inbound containers at U.S. ports: A failure mode effects and criticality analysis approach, Transportation Journal (2008) No.47, p.26-41.

[11] Chengbin Liu, Yinglei Zhao. How to solve the dilemma of container supervision for dangerous goods in foreign trade. China water transport(2008)No.5,p.14-15.

[12] Huazan Qiu, Luling Chen, Dong Wei, Baolin Xie: Unpacking inspection target container selection mechanism of shipping carrying dangerous cargo container, China maritime safety (2010) No.6, p.48-51.