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Study on Domestic and Foreign Standards System for Emergency Response to Oil Spill on Waters

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Abstract. In order to improve the level of oil spill emergency response in China and strengthen the study on the oil spill emergency response standardization, the current situation of oil spill emergency response standards at home and abroad are summarized, and domestic and foreign standards for emergency response are compared in six aspects of risk prevention, monitoring alarm, forecast and early warning, emergency equipment, comprehensive assistance and damage assessment. The results show that the standards for oil spill emergency response technology in China still need to be improved, and there is a lack of regulations for performance testing and applications of emergency facilities. This paper points out the deficiency and development direction of the oil spill emergency standards in China. It is necessary to strengthen the preparation and revision of the oil spill emergency standards and further improve the oil spill emergency standards system.

1. Introduction

With the rapid development of the national economy, the amount of imported oil has been increasing continuously in China. 90% of the imported oil is transported by sea vessels into home apart from some oil from Kazakstan and Russian through pipelines or by railways. And a large number of oil transportation is accompanied by the oil spill risk. According to statistics, 2635 oil spill accidents occurred in coastal areas of China between 1973 and 2006, of which 69 were major ship oil spill accidents (with oil spillage over 50t), and the total oil spillage reached 37077t [1-2]. At present, the perfect oil spill emergency response standards system has not been established in China. In case of oil spill emergency accidents, the emergency response personnel mostly rely on their own experience to solve the problem, which may lead to the oil spill emergency response lag or even failure. Therefore, it is necessary to make a comparative analysis of the domestic and foreign oil spill emergency response standards in order to improve the shortage of domestic oil spill emergency technology.

2. Oil spill emergency response technology

As means to minimize the oil spill harm, oil spill emergency response involves forecast and early warning, monitoring and tracking, emergency recovery, consequence assessment and other aspects: Forecast and early warning: Forecast and early warning refers to the technology of forecasting oil spill location by using various techniques. The technology is indispensable in the initial stage and the process of oil spill emergency response. However, the simulation results of oil spill model are calculated according to the field data. The accuracy of the simulation is determined by the perfection of the data.



So the technology has been studied all the time and the experience of its application has been accumulated continuously.

Monitoring and tracking: Monitoring and tracking refers to the technology of quickly tracking oil spill by using various means. The technology can be applied to all stages of the accident and provide reference for the oil spill emergency response. However, the monitoring results are affected by the weather conditions and the surrounding environment of the accident site. And the high cost of the monitoring facilities also limits the application of the technology.

Emergency recovery: Early recovery of oil spill after the accident can prevent serious harm to ecological environment. Oil spill emergency recovery technology can be divided into three types: physical, chemical and biological methods. In practical applications, it is difficult to achieve the purpose of dealing with oil spill by single method. The research and development of new materials should be further strengthened, and fast and effective emergency equipment should be intensively studied to speed up emergency response.

Consequence assessment: Oil spill identification and accurate assessment of the harm extent after the oil spill accident have positive significance to reduce the loss. The main technology in oil spill identification is called "oil fingerprint". But the method is only suitable for fresh oil. At present, the assessment of oil pollution environmental damage is not perfect at home and abroad. It is necessary to establish a set of complete and practical oil pollution damage assessment system. This is the key research direction in the future.

Judging from the situation of oil spill emergency accidents in the past, the insufficient technology and ability of oil spill emergency response in large-scale accidents are insufficient, especially for certain oil spill accidents, because of the lack of uniform and standardized technical standards as the guidance. In addition, with the appearance of new emergency products, the standardization of oil spill treatment should be carried out in time, and the preparation and revision of oil spill standard should be unified, which can avoid the lag of product development and keep up with the development of new oil spill treatment technology.

3. Oil spill emergency response standard system

3.1. Standard classification

According to standard types, the standards can be divided into national standards (GB), industrial standards (including marine work industry standards (HY), China road and waterway transportation industry standards (JT), China petroleum and natural gas industry standards (SY), local standards (DB), International Standardization Organization Standards (ISO), American Petroleum Institute standards (API), American Society Testing and Materials standards (ASTM). National standards and industrial standards dominate in our country, local standards are secondary. The international standards, especially those formulated by the United States, dominate in foreign countries.

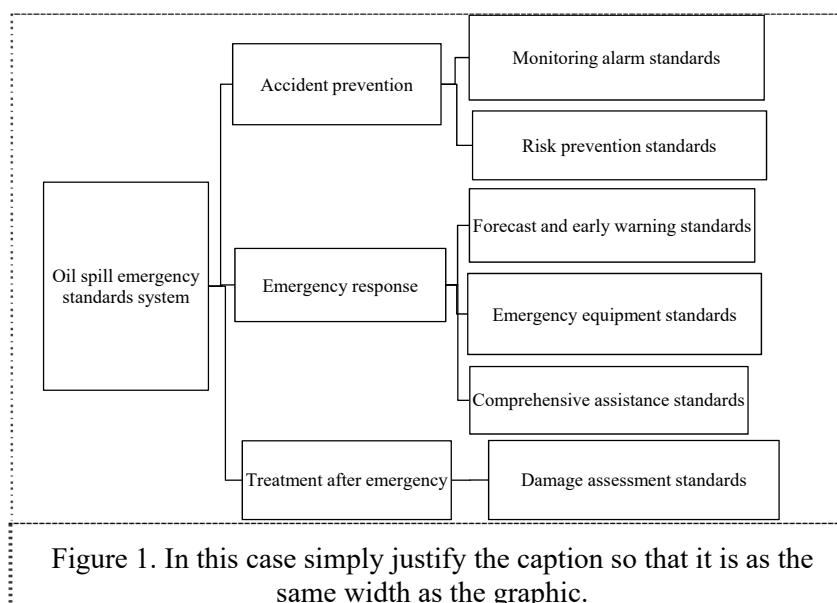
According to emergency response technology, the standards can be divided into six aspects of risk prevention, monitoring alarm, forecast and early warning, emergency equipment, comprehensive assistance and damage assessment. The classification of the standards involved in this study according to the above two classification ways is shown in table 1.

Table 1. The number of domestic and foreign standard types

Classified standard	Number of standard types					
Standard type	National standard	Industrial standard	Local standard	ISO	API	ASTM
	8	30	3	3	19	31
Emergency technology	Risk prevention	Monitoring alarm	Forecast and early warning	Emergency equipment	Comprehensive assistance	Damage assessment
	14	4	2	40	20	14

3.2. Standards system

The oil spill emergency standard system is built according to the framework of marine oil spill emergency equipment standard system [3]. The system is divided into three layers. The first layer is the general oil spill emergency standards. The second layer is classified oil spill emergency standards according to various phases of emergency response. The third layer is further reclassified standards of various phases of emergency response. The classification of the standards according to the techniques supporting emergency response is shown in figure 1:



4. Current situation of domestic and foreign standards

4.1. Current situation of domestic oil spill emergency standards

There are 41 domestic standards on oil spill, mainly including industrial standards formulated by the Ministry of Transport, as well as some national and local standards, of which:

There are 11 standards about risk prevention, mainly including the ship pollutant reception by ports, wharves, loading or unloading stations and ship repair and dismantling organizations, the reception and treatment capacity requirements of ship cleaning operation organizations, and the ability requirements to safely load and unload hazardous cargo, the operational rules for high pollution risk operations on ships, the technical requirements for safety and pollution prevention at waterborne bunker fuel oil stations, the ship oil spill accident response deployment table, the guidelines for ship oil spill emergency response capacity assessment;

There are 3 standards about monitoring alarm, including the technical specifications for emergency monitoring of oil spill pollution in mariculture waters, the technical requirements for surface oil spill tracking buoy systems, and the provision of emergency alarms for offshore petroleum installations;

There is 1 standard about forecast and early warning, which is the impact analysis and prediction technique for pollution accident based on the numerical model;

There are 13 standards about emergency equipment, including technical conditions, application criteria and devices of oil spill dispersant, the application of oil spill herder, sorbents and floating oil bladder, the design and application of oil boom, skimmer, oil absorption boom and emergency unloading device, the requirements on emergency response equipment facilities for oil spill in terminals and ports, and the requirements on emergency equipment and materials for oil spill response vessel;

There are 5 standards about comprehensive assistance, including the terminology relating to oil spill response, the data elements of transportation safety emergency resources and technical requirements of

platforms, the classification for oil pollution accidents for ships, the technical specifications of oil spill effect monitor and evaluation in mariculture areas, and the design specifications on environmental protection for waterway engineering;

There are 8 standards about damage assessment, including the technical guidelines for oil spill damage, risk and emergency capability assessment, the technical specifications for oil spill pollution assessment, the evaluation specifications on hazards of liquid chemicals transported in bulk by shipping, the rapid identification rule for oil spill on water, and the technical regulations of oil fingerprint identification of oil spill based on stable isotope analysis.

4.2. Current situation of foreign oil spill standards

The standards formulated by ASTM and API dominate in the foreign technical standards for oil spill emergency response. These standards almost cover all techniques of oil spill emergency response, including forecast and early warning, concrete implementation and later evaluation, they are the main reference standards in the technical field of oil spill emergency response. There are 53 standards, of which:

There are 3 standards about risk prevention, mainly including the environmental limiting factors of marine oil spill emergency response, the proposal for minimizing environmental impacts of freshwater oil spill, and the classification standard of oil spill control system;

There is 1 standard about monitoring alarm, which is the selection standard of airborne remote sensing system for oil spill monitoring;

There is 1 standard about forecast and early warning, which is the standard practice for development and usage of oil-spill trajectory models;

There are 27 standards about emergency equipment, of which 8 standards are related to chemicals, including the application of chemicals in oil spill emergency response, the application equipment and use environment of oil spill dispersants, the standard guidelines for application equipment, 15 standards are related to emergency machinery devices, including the design and performance requirements of oil boom, the floating weight ratio, the standard specification for connection components and standard test methods for tensile strength characteristics, the guide for the selection of individual protective equipment for oil spill emergency response, the standard test methods for coated fabrics for oil spill control and storage, the shoreline facilities for oil spill emergency response, and four other relevant standards, including standard guidelines for oil spill sampling equipment, the environmental and operational considerations for oil spill site combustion;

There are 15 standards about comprehensive assistance, including the introduction of the fate of oil spill, terminology and technical guidance relating to oil spill and environmental protection, as well as the proceedings of oil spill conferences papers;

There are 6 standards about damage assessment, including the impact assessment of oil spill on the freshwater environment and natural resources, the visual estimation of oil film thickness, the impact of oil spill emergency chemicals on human health, the standard guide for the effectiveness of oil spill recovery systems, the standard practice for identifying oil spill source.

5. Comparison and analysis of domestic and foreign standards

The study compares and analyzes the domestic and foreign technical standards of water oil spill emergency response from the aspects of risk prevention, monitoring alarm, forecasting and early warning, emergency equipment, comprehensive assistance and damage assessment, as shown in table 2.

Table 2. Comparison of the quantity of domestic and foreign oil spill emergency standards

Classification	Domestic	Foreign	Sum
Risk prevention	11	3	14
Monitoring alarm	3	1	4
Forecast and early warning	1	1	2
Emergency equipment	13	27	40
Comprehensive assistance	5	15	20
Damage assessment	8	6	14

5.1. Risk prevention standards

There are 14 risk prevention standards at home and abroad, where 11 standards are domestic standards, covering emergency decontamination, safe loading and unloading, emergency precaution, risk assessment, 3 standards are foreign standards, covering oil spill control and emergency response, as shown in table 3.

Compared with foreign standards:

The advantage of domestic standards is: oil spill risk prevention covers ships, wharves, ports, waterborne bunker fuel oil stations, has a great role in guiding the oil spill risk prevention. Whereas there are only standards for the factors reducing or limiting oil spill pollution in foreign standards.

The disadvantage of domestic standards is: there are no standards for influencing factors of oil spill emergency response, so there is no reference for analyzing the accident damage.

Table 3. Comparison of domestic and foreign risk prevention standards

Domestic standards	JT/T 1081-2016 Requirements on the capability of ship pollution response organization
	JT/T 673-2006 Requirements of receiving and disposing demands of units/enterprises operating ships pollutants disposal and tank cleaning operation
	JT/T 787-2010 Requirements on facilities/equipment/operation for pollution prevention in shipyard and ship recycling
	JT/T 660-2006 Technical requirements for safety and pollution prevention of waterborne bunker fuel oil station
	JT/T 878-2013 The requirements on terminals for the safely loading and unloading of pollution hazardous cargo
	JT/T 879-2013 Requirements on ports, terminals and shipyards for reception capacities of ship's pollutants
	JT/T 451-2017 Requirements on preparedness capabilities to pollution incidents at waters for ports and terminals
	JT/T 1143-2017 Technical Guidelines on Environmental Risk Assessment of Oil Spills at Waters
	GB/T 16559-2010 Muster list for shipboard oil spillage
	JT/T 877-2013 Guidelines on the assessment of ship-source oil spill response capability
	JT/T 1080-2016 Operating procedures of high pollution risk operations of ship
Foreign standards	ASTM F625/F625M-1994 Standard Practice for Classifying Water Bodies for Spill Control Systems
	API PUBL 4706-2001 Environmental Considerations for Marine Oil Spill Response
	API PUBL 4558-1995 Options for Minimizing Environmental Impacts of Freshwater Spill Response

5.2. Monitoring alarm standards

There are 4 monitoring alarm standards at home and abroad, where 3 standards are domestic standards, including emergency monitoring alarm and buoy tracking, 1 standard is foreign standard, which is about remote monitoring of oil spill, as shown in table 4.

Compared with foreign standards:

The advantage of domestic standards is: there are standards for buoy tracking systems in domestic standards, but not in foreign standards.

The disadvantage is: the domestic standards for oil spill remote monitoring are for mariculture waters and offshore oil facilities respectively, which has limitations, but the foreign standards are aimed at the water oil spill with strong applicability.

Table 4. Comparison of domestic and foreign monitoring alarm standards

Domestic standards	DB13/T 2244-2015 Technical specifications for emergency monitoring of oil spill pollution in mariculture waters
	JT/T 910-2014 Technical requirements for surface oil spill tracking buoy system
	SY 6633-2012 Provision of emergency alarms for offshore petroleum installations
Foreign standards	ASTM F2327-2015 Standard Guide for Selection of Airborne Remote Sensing Systems for Detection and Monitoring of Oil on Water

5.3. Forecast and early warning standards

There are two forecast and early warning standards at home and abroad, where 1 standard is domestic standard, being the impact analysis and prediction technique for pollution accident based on the numerical model, the other is foreign standard, being the standard practice for development and usage of oil spill trajectory models, as shown in table 5. The domestic standard is a local standard, and its research is still on the technical level. The standard is only suitable for oil spill prediction in the waters under the jurisdiction of Liaoning Province. The study of the foreign standard has progressed to the formulation of oil spill models and applied to oil spill in various environment with wide scope of application. Therefore, China should speed up the formulation of forecast and early warning standards, be geared to international standards as soon as possible.

Table 5. Comparison of domestic and foreign forecast and early warning standards

Domestic standard	DB21/T 2426-2015 Impact Analysis and Prediction Technique for pollution accident based on the numerical model
Foreign standard	ASTM F2067-2013 Standard Practice for Development and Use of Oil-Spill Trajectory Models

5.4. Emergency equipment standards

There are 40 emergency equipment standards at home and abroad, where 13 standards are domestic standards and 27 standards are foreign standards, as shown in table 6. They all involve dispersants, emergency machinery devices and so on. Both at home and abroad, the formulation of emergency equipment standards is valued. This is mainly due to the variety of emergency equipment and important effect on the accident emergency response. On the whole, compared with foreign standards:

The advantage of domestic standards is: they are clear and has specific target with every standard for one single kind of emergency equipment.

The disadvantage is: many domestic standards only stay on the test of experimental performance with less guidance to field usage.

The specific difference is following:

With regard to the dispersant standards, the domestic standards provide only laboratory testing methods for the performance testing of dispersants without outdoor application effect and environmental benefit. The foreign standards provide methods for determining dispersant performances both in laboratory and outdoor open space. The factors to be taken into account in the application of dispersant in different environment are also specified in detail. For the usage of dispersant, the domestic standards mainly prescribe the technical conditions and the use criterion of dispersant[4]. The foreign standards contain standards for the usage of dispersant for each water body, which is more detailed and more specific than the domestic ones, and have good guiding functions to the field use. For dispersant spraying equipment, the domestic standards only relate to the technical requirements and test methods of equipment performances. And the foreign standards further stipulate the experimental methods and operation control of equipment performances, are more suitable for field applications.

With regard to the oil boom standards, there is only one domestic standard[5], providing the classification, performance requirements and test methods of the oil boom. Although the standard content is systematic and the indicator design and test methods are reasonable, it can only be used as a good guide for laboratory testing, and cannot play a guiding role in the field selection, layout connection application and so on. Further improvement of technical indicators and field evaluation performance test methods are needed. The foreign oil boom standards are relating to the oil boom selection, performance indicators testing and the various connection methods, which is helpful to the oil spill recovery effect.

For other emergency equipment, the domestic standards only involve the experimental performance testing for three types of skimmers (disc, drum and brush). There are no standard for the field application of the skimmers or other oil spill recovery equipment. The foreign standards provide guidance for performance indicators of skimmers and recovery pumps, and the efficiency evaluation method of the

integral oil recovery system, which is of great reference significance to the selection of oil spill recovery equipment.

Table 6. Comparison of domestic and foreign emergency equipment standards

Domestic standards	GB 18188.1-2000 Oil spill dispersant --Technical regulations
	GB 18188.2-2000 Oil spill dispersant-Application criteria
	JT/T 1191-2018 Oil spill herder
	GB/T 34621-2017 Oil boom
	JT/T 560-2004 Sorbents for ship
	JT/T 863-2013 Disc/drum/brush skimmer
	JT/T 864-2013 Oil adsorption boom
	JT/T 865-2013 Oil spill dispersants spraying device
	JT/T 1042-2016 Weir skimmer
	JT/T 1043-2016 Floating oil bladder
	JT/T 451-2009 Requirements on emergency response equipment facilities for oil spill in terminals in ports
	JT/T 1144-2017 Requirements on emergency equipment and materials for oil spill response vessel
	JT/T 866-2013 Emergency unloading device
Foreign standards	ASTM STP1252-95 The Use Of Chemicals In Oil Spill Response
	ASTM F2465/F2465M-2005(2016) Standard Guide for Oil Spill Dispersant Application Equipment: Single-Point Spray Systems
	ASTM F715-2007 Standard Test Methods for Coated Fabrics Used for Oil Spill Control and Storage
	ASTM F1738-2015 Standard Test Method for Determination of Deposition of Aerially Applied Oil Spill Dispersants
	ASTM F962-2004(2010) Standard Specification for Oil Spill Response Boom Connection: Z-Connector
	ASTM F2438-2004(2017) Standard Specification for Oil Spill Response Boom Connection: Slide Connector
	ASTM MNL34-1998 Oil Spill Response Performance Review of Skimmers
	ASTM F1607-1995(2013) Standard Guide for Reporting of Test Performance Data for Oil Spill Response Pumps
	ASTM F1093-99(2018) Standard Test Methods for Tensile Strength Characteristics of Oil Spill Response Boom
	ASTM F2683-2011(2017) Standard Guide for Selection of Booms for Oil-Spill Response
	ASTM F2205-2007(2013) Standard Guide for Ecological Considerations for the Use of Chemical Dispersants in Oil Spill Response: Tropical Environments
	ASTM F1737/F1737M-2015 Standard Guide for Use of Oil Spill Dispersant Application Equipment During Spill Response: Boom and Nozzle Systems
	ASTM F1788-2014 Standard Guide for In-Situ Burning of Oil Spills on Water: Environmental and Operational Considerations
	ASTM F2230-2014 Standard Guide for In-situ Burning of Oil Spills on Water: Ice Conditions
	ASTM F1209-2014 Standard Guide for Ecological Considerations for the Use of Oil Spill Dispersants in Freshwater and Other Inland Environments, Ponds and Sloughs
	ASTM F1210-2014 Standard Guide for Ecological Considerations for the Use of Oil Spill Dispersants in Freshwater and Other Inland Environments, Lakes and Large Water Bodies
	ASTM F1231-2014 Standard Guide for Ecological Considerations for the Use of Oil Spill Dispersants in Freshwater and Other Inland Environments, Rivers and Creeks
	ASTM F1990-2007(2013) Standard Guide for In-Situ Burning of Spilled Oil: Ignition Devices
	ASTM F2152-2007(2013) Standard Guide for In-Situ Burning of Spilled Oil: Fire-Resistant Boom
	ASTM F1460-2007(2013) Standard Practice for Calibrating Oil Spill Dispersant Application Equipment Boom and Nozzle Systems

ASTM F2682-2007(2018) Standard Guide for Determining the Buoyancy to Weight Ratio of Oil Spill Containment Boom
 ASTM F1413-2007(2013) Standard Guide for Oil Spill Dispersant Application Equipment: Boom and Nozzle Systems
 ASTM F1084-08 (2013) Standard Guide for Sampling Oil/Water Mixtures for Oil Spill Recovery Equipment
 API RP 98-2013 Personal Protective Equipment Selection for Oil Spill Responders
 ISO DIS 17325-3-2017 Ships and Marine Technology - Marine Environment Protection - Oil Booms - Part 3: End Connectors
 ISO 17325-1:2014 Ships and Marine Technology — Marine Environment Protection — Oil Booms — Part 1: Design Requirements
 ISO 17325-2:2014 Ships and Marine Technology — Marine Environment Protection — Oil Booms — Part 2: Strength and Performance Requirements

5.5. Comprehensive assistance standards

There are 20 comprehensive assistance standards at home and abroad, where 5 domestic standards mainly cover terminology guidelines, risk assessment, design specifications, technical requirements and other aspects, and 15 foreign standards mainly cover standard guidelines, papers collection and other aspects, as shown in table 7.

Both domestic and foreign standards have provisions for the oil spill emergency response terminology. Compared with the foreign standards:

The advantage of the domestic standards is: there are standards for the pollution grade of ship accidents with certain guiding roles in the oil spill response, while there are no relevant standards abroad.

The disadvantages are: there are only general oil spill response terminology for marine environmental protection and job responsibilities on board ships in the domestic standards with limited guidance for on-site emergency response, while the environmental conditions involved in the foreign standards are more detailed, including the standard guidelines for offshore and shoreline. At the same time, there are no standard for oil spill conferences in China and the records of oil spill conferences are lacking, which means that the early attention to oil spill emergency response in China are not as good as that in foreign countries. In the future, domestic standard system should continue to strengthen the establishment of oil spill emergency response standards.

Table 7. Comparison of domestic and foreign comprehensive assistance standards

Domestic standards	GB/T 21478-2016 Ships and marine technology - Marine environment protection - Terminology relating to oil spill response
	JT/T 458-2001 Classification for oil pollution accidents from ships
	JT/T 1140.2-2017 Data element of transportation security emergency resource—Part 2: Water transportation
	JT/T 1141-2017 Technical requirements of transportation security emergency platform
	JTS 149-2018 Specifications on Environmental Protection Design for Port and Waterway Engineering
Foreign standards	ASTM F2204/F2204M-2016 Standard Guide for Describing Shoreline and Inland Response Techniques
	ASTM F1687-2016 Standard Guide for Terminology and Indices to Describe Oiling Conditions on Shorelines
	API RP 1145-2018 Preparation of Response Plans for Oil Spills from Offshore Facilities
	API PUBL 4691-1999 Fate of Spilled Oil in Marine Waters: Where Does It Go? What Does It Do? How Do Dispersants Affect It?
	API PUBL 4575-1993 Proceedings of the 1991 Oil Spill Conference Infobase - Tutorial and Reference Guide - User's Manual and Software
	API PUBL 4479-1989 Proceedings 1989 Oil Spill Conference Prevention, Behavior, Control, Cleanup
	API PUBL 4687-1999 1999 International Oil Spill Conference Issue Papers: Myths and Realities of Oil Spill Planning and Response: The Challenges of a Large Spill; Judging Oil Spill Response Performance: The Challenge of Competing Perspectives

API PUBL 4452-1987 1987 Oil Spill Conference
 API PUBL 4580-1993 1993 Oil Spill Conference
 API PUBL 46201-1995 International 1995 Oil Spill Conference - Achieving and Maintaining Preparedness
 API PUBL 4651-1997 International Oil Spill Conference Improving Environmental Protection - Progress, Challenges, Responsibilities
 API PUBL 4620-1995 International Oil Spill Conference Proceedings Achieving and Maintaining Preparedness
 API PUBL 4686-1999 1999 Oil Spill Conference Proceedings
 API PUBL 4710 CD-2003 Oil Spill Conference Proceedings
 API PUBL 4529-1991 Oil Spill Conference Prevention, Behavior, Control, Cleanup

5.6. Damage assessment standards

There are 14 damage assessment standards at home and abroad, where 8 domestic standards mainly cover technical specifications, risk assessment and other aspects, and 6 foreign standards mainly cover risk assessment, standard guidelines and other aspects, as shown in table 8.

There are the damage assessment standards for oil spill pollution at home and abroad. Compared with the foreign standards:

The advantage of the domestic standards is: the domestic standards more emphasis on the emergency ability, risk assessment and other aspects of oil spill damage, have strong systematicness and more perfect criteria for oil spill identification methods, including fingerprint identification, rapid identification of oil spill, with good guidance for the oil spill identification.

The disadvantages are: there are no damage assessment involving the effect of oil spill on human health, natural resources, fresh water environment and so on in the domestic standards. At the same time, there are no standard about damage recovery, the oil film thickness estimation at home.

Table 8. Comparison of domestic and foreign damage assessment standards

Domestic standards	DB21/T 2556-2016 Technical guidelines for survey and assessment of oil spill pollution on marine protected area
	HY/T 095-2007 Technical guidelines for ecological damage assessment on marine oil spill
	GB/T 16310.5-1996 Specification on evaluation methods of hazards of liquid chemicals transported in bulk by shipping --Assessment procedure and determination of pollution category
	GB/T 34546.2-2017 Technical guides for marine ecological damage assessment-Part 2:Marine oil spill
	JT/T 1190-2018 Technical regulations of oil fingerprint identification of water oil spill based on stable isotope analysis
	JT/T 862-2013 Rapid identification rule for oil spill on water
	HY 043-1997 Specifications for identification system of spilled oil on the sea
	GB/T 21247—2007 Specifications for identification system of spilled oil on the sea
Foreign standards	ASTM F1780-1997(2010) Standard Guide for Estimating Oil Spill Recovery System Effectiveness
	API PUBL 304-1991 Evaluation of Restoration Alternatives for Natural Resources Injured by Oil Spills
	API PUBL 4689-2001 Chemical Human Health Hazards Associated with Oil Spill Response
	API PUBL 4675-1999 Fate and Environmental Effects of Oil Spills in Freshwater Environments
	ASTM D5739-2006(2013) Standard Practice for Oil Spill Source Identification by Gas Chromatography and Positive Ion Electron Impact Low Resolution Mass Spectrometry
	ASTM F2534-2017 Standard Guide for Visually Estimating Oil Spill Thickness on Water

6. Problems in domestic standards and suggestions for the standards system development

In the oil spill emergency response standards, the domestic can learn from foreign standards. Specifically, the domestic oil spill monitoring alarm standards are comparable to the foreign standards, but there are

no national standards in forecast and early warning in China. This is also the key point that need to be studied when formulating the standard system in the future. In the oil boom standards with systematicness, the standards for selection and connection are still needed. The dispersant standards need to be continuously improved in field testing and operation. In addition, the domestic standards are not yet perfect. For example, there are no oil spill health and safety protection standards, or bioremediation standards in the existing standard system. The studies on the oil spill emergency standards in China are still lagging behind compared with foreign developed countries. It is necessary to strengthen the planning of domestic oil spill emergency response standards, improve the standard system and the oil spill emergency response capability.

7. Conclusion

The oil spill emergency disposal technologies at home and abroad was summarized. The emergency standards was classified and compared from six aspects: risk prevention, monitoring alarm, forecast and early warning, emergency equipment, comprehensive assistance and damage assessment. The corresponding recommendations was put forward for the development of the domestic standard system. The article can provide reference for the establishment of the oil spill emergency standard system

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