

# The State of Marine Pollution in the Waters adjacent to Shipyards in Korea - 1. Analysis of Pollution Incidents occurred in Shipyards

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## 국내 조선소 주변해역의 해양오염 현황 - 1. 조선소 오염사고 분석

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**Abstract** : Data of pollution incidents which occurred in shipyards of South Korea for 10 years from 2004 to 2013 were collected and analyzed in order to propose the plans for the prevention of pollution incidents in shipyards. Total number of pollution incidents in shipyards was 103 cases over the nation of Korea for the recent 10 years and the average annual number was about 10 cases, and annual cases tended to increase from 8 cases in 2004 to 23 cases in 2010 and then to decrease to 9 cases in 2013. The location data of pollution incidents showed 32 cases in Busan metropolitan city (31%), 30 cases in Jeonnam (29%), 21 cases in Gyeongnam (21%), 5 cases in Jeju (5%), 4 cases in Gangwon (4%), 4 cases in Gyeongbuk (4%), 3 cases in Chungnam (3%) and 3 cases in Incheon metropolitan city (3%). According to the data of work types of shipyards, 60 cases happened during the work of ship repair (58%), 25 cases during the work of ship breakup (24%), 10 cases in the course of ship building (10%) and 8 cases by others (8%). The data of pollutant type showed oil and oily mixtures to be 59 cases (57%), waste paint dust to be 22 cases (21%), iron dust and welding slag to be 13 cases (13%), wastes to be 4 cases (4%), waste FRP powder to be 3 cases (3%), and others to be 2 cases (2%). The plans for the prevention of pollution incidents in shipyards of Korea were proposed as follows; ① Observance of the related laws and regulations, ② Establishment and implementation of action plans to prevent areas dense with shipyards from causing pollution incidents, ③ Establishment and implementation of oil pollution prevention plans in shipyards, especially during the ship repair and breakup works, ④ Preparation of measures to solve civil complaints against pollution incidents in shipyards, and ⑤ Improvement in national management for the control of shipyards.

**Key Words** : Shipyard, Pollution incidents, Ship building, Ship repair, Ship breakup, Oil and oily mixtures, Waste paint dust, Iron dust and welding slag, Waste FRP powder

**요 약** : 최근 10년간(2004~2013년) 국내의 조선소에서 발생한 해양오염사고의 건수를 연도별, 지역별, 조선소 작업별 및 오염물질별로 분석하였고, 이 분석 결과를 바탕으로 조선소 내 오염사고 방지 방안을 제시하였다. 전국의 조선소 내 오염사고는 10년간 총 103건이 발생하여 연평균 10.3건이었고, 연간 발생건수는 2004년 8건에서부터 점증하는 추세를 보이면서 2010년 23건으로 최고를 기록하였다가 다시 감소하는 추세로 바뀌어 2014년 9건을 나타내었다. 지역별 오염사고 건수는 부산이 32건(31%)으로 1위이고, 전남이 30건(29%), 경남이 21건(21%), 제주가 5건(5%), 강원과 경북이 각각 4건(4%), 인천과 충남이 각각 3건(3%)이었다. 조선소 작업별 오염사고 건수는 선박수리 작업이 60건(58%)으로 1위이고, 선박해체 작업이 25건(24%), 선박건조 작업이 10건(10%), 기타가 8건(8%)이었다. 오염물질별 오염사고 건수는 기름 및 유성혼합물이 59건(57%)으로 1위이고, 페인트 가루가 22건(21%), 쇳가루 및 용접슬래그가 13건(13%), 폐기물이 4건(4%), 페FRP 가루가 3건(3%), 기타가 2건(2%)이었다. 국내 조선소 내의 오염사고를 방지하기 위한 방안으로는 ① 관련 법규의 준수, ② 조선소 밀집 지역에 대한 오염사고방지 실행계획의 수립 및 시행, ③ 특히 선박 수리 및 해체 작업을 하는 경우 조선소 내 기름오염방지 방안의 수립 및 시행, ④ 조선소 오염사고에 대한 민원 해결 대책의 마련, ⑤ 조선소 단속에 대한 국가 관리의 개선 등을 제시하였다.

**핵심어** : 조선소, 오염사고, 선박건조, 선박수리, 선박해체, 기름 및 유성혼합물, 페인트 가루, 쇳가루 및 용접슬래그, 페FRP 가루

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## 1. Introduction

While continuing to exploit and use the sea, people have been very negligent of the conservation and management of the sea in Korea. As a result, marine environment has been deteriorating and enormous problems have occurred in making use of the sea. Because marine environmental capacity is not unlimited, marine pollution will be exacerbated, especially in coastal waters if not only land-based urban sewage and industrial wastewater but also various types of pollutants from marine facilities and vessels continue to flow into the sea without any control or regulation. Thus, the measures for marine environment management are necessary to be established (Kim, 2009).

In order to prevent marine pollution and to manage marine environment effectively in Korea, a national system of report on marine facilities was adopted into Marine Environment Management Act and made it obligatory on their owners (including installers and operators, and in cases where such facilities are leased, referring to the lessees of such facilities) to make a report on such facilities to Minister of Oceans and Fisheries of Korea under the provisions of Article 33 of the Act.

The term "marine facility" means facilities or structures determined by the Ordinance of the Ministry of Oceans and Fisheries or the Enforcement Ordinance of Marine Environment Act, which are installed or placed in, or thrown into sea areas (including harbors provided for in subparagraph 1 of Article 2 of the Harbor Act) or between a sea area and land continuously under the provisions of Subsection 17 of Article 2 of the Act and provided in table 1 attached to the Ministerial Ordinance or the Enforcement Ordinance of the Act.

The term "shipyard" means a workplace where ships are built, repaired or broken up and is designated as a marine facility of item Da of subsection 1 by the table 1 attached to the Ministerial Ordinance.

Since the introduction of a modern concept of shipbuilding industry into Korea at the end of the 19th century, the shipbuilding industry had been trivial due to the restoration of independence from Japanese rule in 1945 and the Korean War in 1950. Its foundations for growth was laid by a five-year economic development plan in 1960s and it was selected as the main industry to promote by the governmental economic development plan in 1970s, resulting in remarkable growth under the support of national finance. As Korean shipbuilding industry has leaped to the highest level on an international scale ever since then, the

shipbuilding has played a pivotal role in Korean industry and has made a great contribution to the national economy development of Korea (KOSHIPA, 2014).

The possibility for various types of pollutants from shipyards to flow into coastal sea exists in the processes of building, repair and breakup of ships. As of the end of the year 2009, 45% of total 178 nationwide shipyards were reported to be concentrated around southeastern area of Korea such as Busan metropolitan city and Gyeongnam province (Kim, 2010a). So marine pollution is likely to be intensified in this area.

Therefore, the control of pollutants discharged from the shipyards in the process of building, repair and breakup of ships is required and the current state of pollution incidents occurred in shipyards of Korea are necessary to be analyzed.

There is barely any systematic investigation or research on the pollution incidents of the nationwide shipyards in Korea. Kim and Han(2012) had tried to analyze marine pollution incidents occurred in the waters adjacent to shipyards in Korea using the data of pollution incidents occurred for 5 years. It was, however, pointed out that the data of 5 years were insufficient for the medium and long term analysis of pollution incidents.

In this study, the data of pollution incidents in nationwide shipyards of Korea for 10 years were collected and analyzed. In addition, the measures for the prevention of pollution incidents in shipyards in Korea were suggested. The outcomes of this study are expected to be used as a basic reference to establish national plans for the positive prevention of pollution incidents in nationwide shipyards and around coastal area in Korea.

## 2. Data and Method

### 2.1 Data collection and analysis method

Data of pollution incidents occurred in nationwide shipyards of Korea for 10 years from 2004 to 2013 were collected by Korea Coast Guard, and the number of pollution incidents were categorized and analyzed by year, provincial region, work type of shipyard and type of pollutant.

### 2.2 Facilities for building, repair and breakup of ships

The marine facilities which are stated expressly in table 1 attached to Ministerial Ordinance or Enforcement Ordinance of Marine Environment Management Act are categorized into Subsection 1, Subsection 2 and Subsection 3. Marine facilities designated as Subsection 1 in table 1 attached to Ministerial

Ordinance are classified into 5 different sorts, and the facilities for building, repair and breakup of ships, inter alia, are related to shipyards and referred to as 1-Da facilities. These 1-Da facilities include storage facility, slipway facility and repair facility but exclude mobile facilities.

### 3. Analysis of Pollution Incidents occurred in Shipyards

For 10 years from 2004 to 2013, total number of pollution incidents occurred in nationwide shipyards of Korea were analyzed and shown in categories of year, provincial region, work type of shipyard and pollutant type.

#### 3.1 Number of pollution incidents by year

Total number of pollution incidents occurred in nationwide shipyards for 10 years was found to be 103 cases along the coast lines of South Korea (Fig. 1 and Fig. 2), and the average number of annual incidents was about 10 cases.

As shown in Fig. 1, the number of pollution incidents increased from 8 cases in 2004 and 8 cases in 2005 to 11 cases in 2006, decreased to 8 cases in 2007 and then dropped sharply to 3 cases in 2008 as the lowest. However, it increased back to 15 cases in 2009 and reached 23 cases in 2010 as the highest. And then it decreased back to 13 cases in 2011 and dropped back drastically to 5 cases in 2012. After all, it bounced back to 9 cases in 2013.

For 10 years, the annual number of pollution incidents fluctuated considerably from year to year, and the range of fluctuation in annual number of incidents was 20 cases from 3 cases in 2008 to 23 cases in 2010.

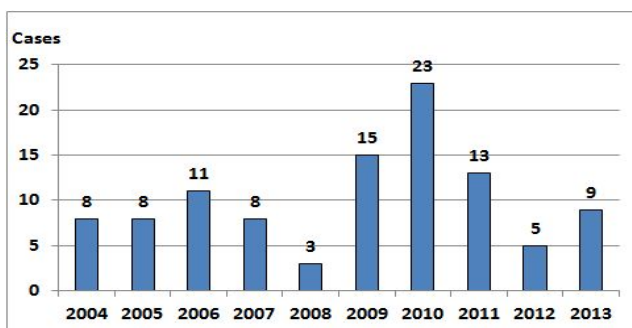


Fig. 1. Annual number of pollution incidents in nationwide shipyards of Korea for 10 years from 2004 to 2013.

In the year 2009, Korean shipping market and ship building market were in boom cycle where shipping freight and ship's price

were relatively high. In such a situation, the number of pollution incidents in shipyards for 3 years from 2009 to 2011 accounted for 50% of total numbers for 10 years from 2004 to 2013.

#### 3.2 Number of pollution incidents by province region

The regional data of total 103 cases of pollution incidents for 10 years showed that Busan ranked the first by 32 cases (31%) followed by Jeonnam with 30 cases (29%), Gyeongnam with 21 cases (21%), Jeju with 5 cases (5%), Gangwon with 4 cases (4%), Gyeongbuk with 4 cases (4%), Chungnam with 3 cases (3%) and Incheon with 3 cases (3%) (Fig. 2, Fig. 3 and Fig. 4).

83 cases (81%) of total 103 cases of nationwide pollution incidents occurred along southern coastal area of Korea for 10 years. According to Kim(2010a), total number of 1-Da facilities was 178 as of the end of the year 2009, accounting for 26.5% of 672 nationwide marine facilities. These 1-Da facilities were reported to be well distributed throughout nationwide coastal areas which are covered by 12 regional maritime affairs and port administrations, and 45% of total 1-Da facilities were concentrated around southeastern area of Korea such as Busan metropolitan city and Gyeongnam province (Kim, 2010b). Kim(2010b) showed that, as of the end of the year 2009, 109 shipyards (61%) of total 178 nationwide shipyards were concentrated along southern coastal area of Korea such as Busan metropolitan city (33 shipyards, 18%), Gyeongnam province (48 shipyards, 27%) and Jeonnam province (28 shipyards, 16%). Busan where 33 shipyards (18% of all nationwide shipyards) were located in 2009, ranked the first in the number of pollution incidents by 32 cases (31% of all cases) for 10 years from 2004 to 2013, and Jeonnam where 28 shipyards (16%) were located in 2009, ranked the second by 30 cases (29%) for 10 years. On the other hand, Gyeongnam ranked the first in the number of shipyard nationwide by 48 shipyards (27%) in 2009, whereas ranked the third in the number of pollution incidents by 21 cases (21%) for 10 years. This means that, in most provincial regions except Gyeongnam, the number of pollution incidents occurred in shipyards of a certain region was generally proportional to the number of shipyards located in the relevant region. It implies that there is a possibility for shipyards to discharge a large amount of various pollutants to nearby coastal sea, especially to southern coastal sea of Korea, in the course of building, repair and breakup of ships. Therefore, the plans of marine environment management around coastal area are to be drawn up, and the measures for the prevention of pollution incidents in shipyards are to be taken in Korea.

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Fig. 2. Locations of metropolitan cities, provinces and major seaports along coasts of South Korea.

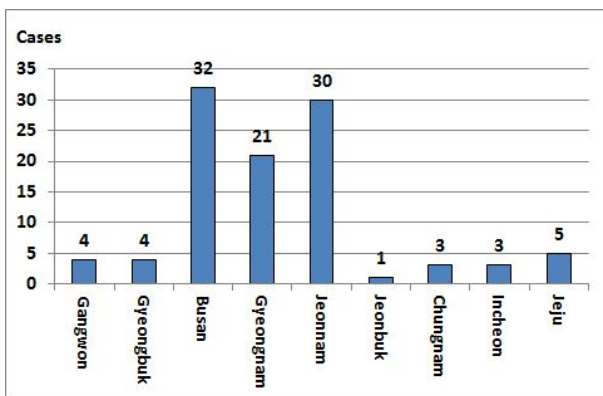


Fig. 3. Number of pollution incidents in shipyards of Korea for 10 years (2004~2013) by region.

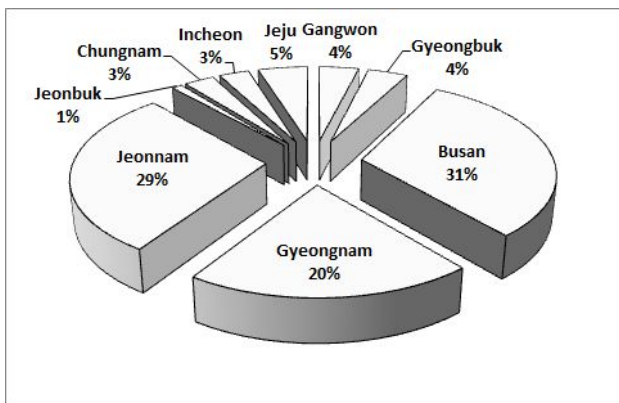


Fig. 4. Percentage of pollution incidents in shipyards of Korea for 10 years (2004~2013) by region.

3.3 Number of pollution incidents by the work type of shipyard

The data of pollution incidents occurred during various types of works in nationwide shipyards for 10 years showed that the number of pollution incidents ranked the first by 60 cases during ship repair work (58%), the second by 25 cases during ship breakup work (24%), the third by 10 cases during ship building work (10%), and the last by 8 cases during other works (8%) (Fig. 5 and Fig. 6).

29 cases occurred for 3 years of 2009 (7 cases, 12%), 2010 (13 cases, 22%) and 2011 (9 cases, 15%) accounting for 49% of 60 cases of pollution incidents during ship repair work for 10 years. 7 cases occurred for the year of 2009 accounting for 28% of 25 cases of pollution incidents during ship breakup work for 10 years. 5 cases occurred for 3 years of 2009 (1 case, 10%), 2010 (3 cases, 30%) and 2011 (2 cases, 20%) accounting for 60% of 10 cases of pollution incidents during ship building work for 10 years. These phenomena were supposed to be closely related with Korean shipping market and ship building market being in boom cycle in the year 2009.

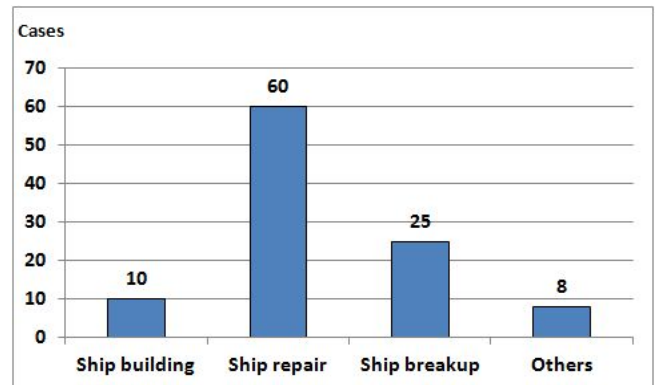


Fig. 5. Number of pollution incidents in Korea for 10 years (2004~2013) by the work type of shipyards.

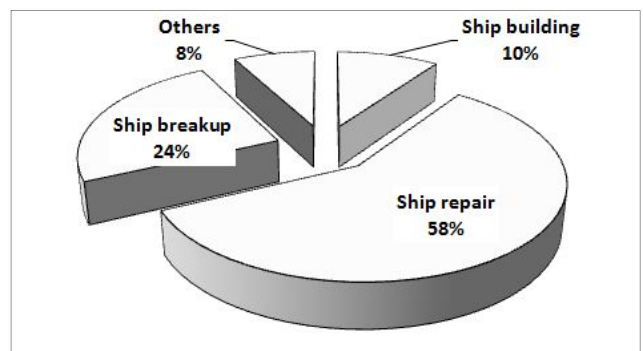


Fig. 6. Percentage of pollution incidents in Korea for 10 years (2004~2013) by the work type of shipyards.

Therefore, the measures for prevention of pollution incidents in shipyards, especially during ship repair and breakup works, are necessary to be taken in Korea.

### 3.4 Number of pollution incidents by the type of pollutant

As shown in Fig. 7 and Fig. 8, the data of pollution incidents occurred by various types of pollutants for 10 years showed that the number of pollution incidents by oil and oily mixtures ranked the first by 59 cases (57%), waste paint dust the second by 22 cases (21%), iron dust and slag the third by 13 cases (13%), wastes the fourth by 4 cases (4%), waste FRP powder by 3 cases (3%), and others the last by 2 cases (2%).

Because various types of oils such as fuel oil, cargo oil, lubricating oil, etc. are usually carried on board the ship, oils are very likely to be discharged when pollution incidents happen in shipyards. It is, therefore, natural for oil and oily mixtures to rank the first of all the types of pollutants. This means that the measures for prevention of oil-related pollution incidents in shipyards are needed to be taken. On the other hand, different kinds of paints are ordinarily applied on the decks, walls, hulls, etc. of ships, and the old paints are normally striped off from the ships before repaint or repair, and hence waste paint dusts stand the second in all the type of pollutants. Iron dust and slag can also appear in the courses of rubbing the rust off the ship and welding works on board the ship. So they ranked the third of all pollutants.

Waste paint dust, and iron dust and slag which fly and distribute over the wide areas adjacent to shipyards bring harm to not only houses, commercial quarters, farms and factories but also seas nearby. So they are the cause of civil complaints, which should be solved by preventive measures.

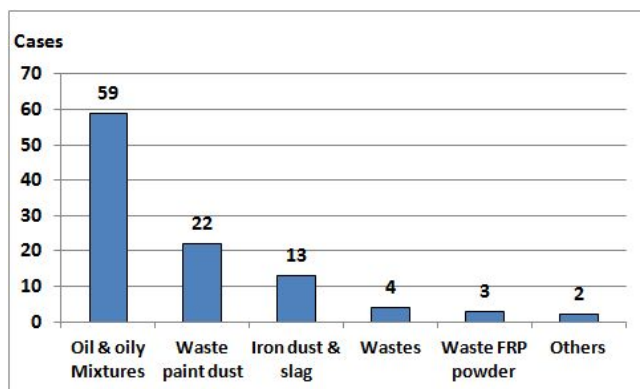


Fig. 7. Number of pollution incidents in shipyards of Korea for 10 years (2004~2013) by pollutant type.

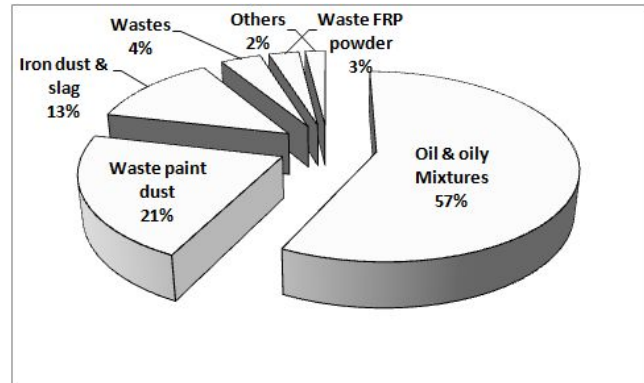


Fig. 8. Percentage of pollution incidents in shipyards of Korea for 10 years (2004~2013) by pollutant type.

## 4. Plans for Prevention of Pollution Incidents in Shipyard

### 4.1 Observance of the related laws and regulations

To reduce and minimize the number of pollution incidents in nationwide shipyards, the relevant laws and regulations such as Marine Environment Management Act, Clean Air Conservation Act, etc. should be obeyed in Korea, as shown in Table 1.

In Marine Environment Management Act, Article 33 (Report on Marine Facilities), Article 34 (Management of Marine Facility Pollutant Registers), Article 35 (Management of Contingency Plan for Pollution by Marine Facilities), Article 36 (Marine Pollution Prevention Manager), Article 111 (Report, etc. on Dismantling of Ships) and Article 121 (Education and Training of Marine Pollution Prevention Managers, etc.) are closely related to the business of shipyards in Korea.

In Clean Air Conservation Act, Article 43 (Regulation on Scattering Dust), Article 44 (Regulation on Volatile Organic Compounds), Article 45 (Regulation on Existing Facilities Emitting Volatile Organic Compounds), Article 82 (Reports, Inspections, etc.), the attached table 14 to Enforcement Ordinance (Standards of Installation of Facilities for Control of Occurrence of Scattering Dust and Necessary Measures) and the like are important for the operation of shipyards in Korea.

Article 15 (Prohibition on Release, etc.) of Water Quality and Aquatic Ecosystem Conservation Act and Article 17 (Restrictions on Traffic for Preserving Water Quality of Water Supply Sources) of Wastes Control Act should be born in mind for the prevention of pollution from shipyards in Korea.

Table 1. The relevant fields, law and regulations, enforcement authorities, related agencies and their duties involved in shipyards of Korea

Relevant Fields	Laws and regulations	Enforcement authorities	Related agencies	Duties
Air quality management	Clean Air Conservation Act	Ministry of Environment	Metropolis, Province, City, County, Borough	Approval and Permission for target facility, and Guidance and Control
Malodor management	Malodor Prevention Act	Ministry of Environment	Metropolis, Province, City, County, Borough	Approval and Permission for target facility, and Guidance and Control
Wastewater management	Water Quality and Aquatic Ecosystem Conservation Act	Ministry of Environment	Metropolis, Province, City, County, Borough	Approval and Permission for target facility, and Guidance and Control
Sewage management	Sewerage Act	Ministry of Environment	Metropolis, Province, City, County, Borough	Approval and Permission for target facility, and Guidance and Control
	Wastes Control Act	Ministry of Environment	Metropolis, Province, City, County, Borough	Approval and Permission for target facility, and Guidance and Control
Solid waste management	Act on the Promotion of Saving and Recycling of Resources	Ministry of Environment	Regional Environmental Management Offices	Approval and Permission for target facility, and Guidance and Control
Soil management	Soil Environment Conservation Act	Ministry of Environment	Metropolis, Province, City, County, Borough	Approval and Permission for target facility, and Guidance and Control
Toxic substances management	Toxic Chemicals Control Act	Ministry of Environment	Metropolis, Province	Approval and Permission for target facility, and Guidance and Control
Noise and vibration management	Noise and Vibration Control Act	Ministry of Environment	City, County, Borough	Approval and Permission for target facility, and Guidance and Control
Persistent Organic Pollutants	Persistent Organic Pollutants Control Act	Ministry of Environment	Metropolis, Province, City, County, Borough	Approval and Permission for target facility, and Guidance and Control
Marine Pollution Prevention	Marine Environment Management Act	Ministry of Oceans and Fisheries	Korea Coast Guard	Approval and Permission for target facility, and Guidance and Control
Response to climate change	Framework Act on Low Carbon, Green Growth	Committee on Green Growth	Ministry of Trade, Industry and Energy	Control of greenhouse gas emissions and energy use
Working Environment Management	Occupational Safety and Health Act	Ministry of Employment and Labor	Regional Employment & Labor Offices	Guidance and Control

#### 4.2 Establishment and implementation of action plans to prevent areas dense with shipyards from causing pollution incidents

As shown in Fig. 3 and Fig. 4, 83 cases (81%) of 103 cases of nationwide pollution incidents occurred along southern coastal area of Korea for 10 years. According to Kim(2010b), as of the end of the year 2009, 109 shipyards (61%) of total 178 nationwide shipyards were concentrated along southern coastal area of Korea such as Busan metropolitan city, Gyeongnam province and Jeonnam province. It is most likely that various types of pollutants from shipyards will enter coastal sea in the processes of building, repair and breakup of ships. Therefore, the action plans for the prevention of pollution incidents in areas dense with shipyards located along southern coast line are needed to be drawn up and to be implemented in Korea.

#### 4.3 Establishment and implementation of oil pollution prevention plans in shipyards, especially during the ship repair and breakup works

As found in Fig. 5 and Fig. 6, the number of pollution incidents in nationwide shipyards for 10 years ranked the first by 60 cases during ship repair work (58%) and it ranked the second by 25 cases during ship breakup work (24%). As shown in Fig. 7 and Fig. 8, 59 cases of oil and oily mixture pollution incidents occurred and accounted for 57% of 103 pollution incidents in nationwide shipyards for 10 years. Therefore, measures to prevent the oil-related pollution incidents in shipyards, especially during the ship repair and breakup works, are needed to be taken.

#### 4.4 Preparation of measures to solve civil complaints against pollution incidents in shipyards

As shown in Fig. 7 and Fig. 8, 22 cases of waste paint dust pollution incidents and 13 cases of iron dust and slag pollution incidents happened in the processes of building, repair and breakup of ships in nationwide shipyards, and accounted for 21% and 13%, respectively, of total 103 pollution incidents in nationwide shipyards for 10 years. The waste paint dust, and iron dust and slag which fly and distribute over the wide areas adjacent to shipyards bring harm to not only houses, commercial quarters, farms and factories but also seas nearby. They are the cause of civil appeals, which should be dealt with preventive measures.

#### 4.5 Improvement in national management for the control of shipyards

Because all shipyards are subject to a lot of relevant laws and regulations, and receive many enforcement authorities' controls and the related agencies' guidances in Korea, as shown Table 1,

domestic major shipyards take a negative attitude with regard to national report system of marine facilities as stipulated in Article 33 (Report on Marine Facilities) of Marine Environment Management Act (Kim, 2010a; 2010b). In such a passive situation, however, most owners of medium and small-sized marine facilities, including installers and operators, made reports on such facilities to the Minister of Oceans and Fisheries voluntarily or reluctantly.

In order for major shipyards to participate in national report system voluntarily and positively, and for the pollution incidents of shipyards to be prevented after all, the national system and method to manage and control the nationwide shipyards which are the marine facilities for building, repairing and disassembling ships should be reformed by amending various shipyard-related laws and regulations in such a way to meet the realistic needs of shipyard business and works.

## 5. Conclusion

Data of pollution incidents which occurred in shipyards of South Korea for 10 years from 2004 to 2013 were collected and analyzed, and the plans to prevent pollution incidents in shipyards were summarized as follows;

(1) Total number of pollution incidents in shipyards was 103 cases over the nation of South Korea for 10 years and the average number of annual incidents was about 10 cases, and annual cases tended to increase from 8 cases in 2004 to 23 cases in 2010 and then tended to decrease to 9 cases in 2013. Annual number of pollution incidents fluctuated considerably from year to year and the range of fluctuation in annual number of incidents was 20 cases from 3 cases in 2008 to 23 cases in 2010 for 10 years.

(2) The location data of pollution incidents showed 32 cases in Busan metropolitan city (31%), 30 cases in Jeonnam (29%), 21 cases in Gyeongnam (21%), 5 cases in Jeju (5%), 4 cases in Gangwon (4%), 4 cases in Gyeongbuk (4%), 3 cases in Chungnam (3%) and 3 cases in Incheon metropolitan city (3%). 83 cases (81%) of total 103 nationwide pollution incidents occurred along southern coastal area of Korea for 10 years.

(3) According to the data of work type of shipyards, 60 cases happened during the work of ship repair (58%), 25 cases during the work of ship breakup (24%), 10 cases in the course of new ship building (10%) and 8 cases by others (8%) for 10 years. 29 cases occurred for 3 years from 2009 to 2011, accounting for 49% of 60 cases of pollution incidents during ship repair work for 10 years.

(4) The data of pollutant types showed oil and oily mixtures to be 59 cases (57%), waste paint dust to be 22 cases (21%), iron dust and welding slag to be 13 cases (13%), wastes to be 4 cases (4%), waste FRP powder to be 3 cases (3%), and others to be 2

cases (2%) for 10 years. Oil and oily mixtures ranked the first of all types of pollutants and accounted for 57% of total pollution incidents.

(5) The plans for the prevention of pollution incidents in nationwide shipyards of Korea were proposed as follows; ① Observance of the related laws and regulations, ② Establishment and implementation of action plans to prevent areas dense with shipyards from causing pollution incidents, ③ Establishment and implementation of oil pollution prevention plans in shipyards, especially during the ship repair and breakup works, ④ Preparation of measures to solve civil complaints against pollution incidents in shipyards, and ⑤ Improvement in national management for the control of shipyards.

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