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Current Situation and Development Trend of Petrochemical Industry Emergency Logistics

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With the fast development and strategic layout of the petrochemical industry in recent years, the infrastructure of petrochemical logistics also achieved rapid development. The complicated and changeable international situation, climatic anomaly and social harm highlighted the demands of petrochemical emergency logistics. The reserve, transportation and information system, security system and mechanism analysis of petrochemical emergency logistics indicate: China needs to further strengthen the petroleum reserve system construction including refined oil and increase the layout of the supporting dangerous chemicals warehousing of the park; man-made sabotage has become the primary cause for the leakage, fire hazard and explosion accident of domestic long-distance pipelines, so HSE management philosophy and integrity management remain to be strengthened; the regulatory focus of road transportation should transfer to the “soft” security investment of the enterprise, such as tightening employee access conditions and improving employees’ overall quality; the information degree of petrochemical emergency logistics is low and a unified emergency information issue and sharing platform is lacking; the laws, regulations, standards and mechanism of emergency logistics remain to be established and perfected. At last, the paper describes the development prospect of petrochemical industry emergency logistics.

1. Analysis on development situation and layout of the petrochemical industry

The petrochemical industry is the basic industry for the national economy and occupies an important position. China has become a major production and consumption country of petrochemical products in the world. During the 12th Five-Year Plan, the annual growth rate of industrial added value was 9.0%, mainly operating income was 9.19%, and its actual investments reached 14.03%, and the economic volume of China’s petrochemical industry continued to rank at the forefront in the world. In 2015, the total output of national oil and gas was 329 million tons oil equivalent; the output of natural gas reached 127.14 billion cubic meters in 2015 on the basis of first breaking 100 billion cubic meters in 2011; the output of ethylene reached 17.6 million tons. However, China’s oil supply and demand contradiction is still prominent and the degree of dependence on import is on the rise.(Qian and Jiang, 2016)

As China gradually became the world processing center and a consumption power, the all-round large-scale investments of transnational petrochemical enterprises in China and the influence of petrochemical product import trade on China’s petrochemical industrial layout emerged increasingly. China’s petrochemical enterprises have three typical location layout patterns - raw material places, consumption places and ports. Through analyzing the evolution characteristics of China’s petrochemical industrial locations, it indicates that China’s petrochemical industrial distribution shows the trend of large scale space dispersing coexisting with regional spatial agglomeration and the overall arrangement transforming from inland to ports(Dong, 2011). China has formed three most port Petrochemical Industrial centre, namely the Huizhou-Guangzhou-Zhuhai-Maoming-Zhanjiang Pearl River Delta petrochemical industrial belt, the Shanghai-Nanjing-Zhejiang Yangtze River petrochemical industrial area, and the Dalian-Qingdao-Tianjin-Cangzhou circum-Bohai-Sea area, as well as the traditional northwest petrochemical base represented by the Northeast and Lanzhou-Dushanzi. The port chemical industry base is the key area of the spatial strategic transformation of China’s petrochemical industry space during the 12th Five-Year Plan. China’s petrochemical industry base and park development

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pattern has taken shape. Due to the difference of regional advantages, industry basis, construction time and investment pattern, the development level in various regions is unbalanced. Some have begun to take shape. It is still at the development initial stage overall, but has huge potential.

2. Analysis on characteristics and development situation of petrochemical logistics

2.1 Characteristics of petrochemical logistics

The petrochemical supply chain is a complex large system. Compared with other industries, the logistics activity of the petrochemical industry is featured by the commonness of general logistics activities and its uniqueness. The total quantity of the logistics activity of the petrochemical industry is very large, and foreign and domestic crude oil exploitation, long-distance transportation, the diversity of carriers and other factors determined petrochemical logistics is characterized by many sites, long lines, large areas, complex operation and higher security requirement. Particularly the flammable and explosive chemical materials require stricter technical specification and higher equipment specialization degree. The upstream and downstream products of the petrochemical industry are highly relevant, and international political situation, social product supply and demand changes, social energy fluctuation and the cooperative relationship among enterprises all affect petrochemical logistics whenever and wherever possible. The petrochemical logistics system is a dynamic system that meets social needs and adapts to environment capacity.

2.2 Development status of petrochemical industry logistics

China's petrochemical logistics infrastructure construction has achieved rapid development in recent years. With the increase and strategic layout of petrochemical product import, the supporting port and dock construction has achieved rapid development. China's ports remain the first place in the world in the total cargo throughput and the number of big ports above 100 million tons. Relying on the stationing of petrochemical enterprises, the specialized oil unloading docks based on 100,000-300,000 tons and the petroleum transportation system matched with small and medium oil and gas transfer terminals are taking shape. However, "national oil transportation" ships are of weak transportation capacity, backward technologies and external overdependence. At present, many ports have established converge and evacuation system and basically realized paralleled three ways based on waterway and road transportation. But there exists the mixture of converge and evacuation traffic and urban transportation and the role of railways and inland water transportation was not fully played; the functions of ports are singular; the turnover efficiency of cargos is not high and the logistics cost is higher.

Centering on the strategic layout of oil import and petrochemical industry, China has achieved rapid development in oil and gas pipeline construction in recent years. At the end of 2014, the total lengths of the crude oil pipeline, the refined oil pipeline and the natural gas pipeline reached 27, 000 kilometers, 21, 000 kilometers and 69, 000 kilometers. The backbone oil transmission pipeline has begun to take shape, and the key fields built during the period of the 12th Five-Year Plan were mainly regional pipeline and supporting facility construction.

Due to the development of the industry and the refining of market labor division, international petrochemical enterprises are almost seldom engaged in the chemical logistics but outsource the business to the third-party logistics service provider (3PL). In China, due to the restriction of traditional management concepts and industrial development, the domestic petrochemical logistics industry lacks a sophisticated integrated logistics service network platform; the outsourcing risk is very high, so the self-running petrochemical logistics business becomes the main logistics pattern at present. Many ports are not fitted with supporting logistics parks and large logistics enterprises, and the third-party logistics are small, scattered and weak. Many small and medium petrochemical logistics enterprises are insufficient in the investment in technological equipment, low in automation and information degree. They also cannot achieve information sharing with upstream suppliers and downstream consumers, and the information feedback speed is low and affects the operation efficiency of logistics.

3. Analysis on current situation of emergency logistics of petrochemical industry

3.1 Conceptual meaning of petrochemical emergency logistics

Emergency logistics refers to special-type logistics activities caused by sudden factors for the purpose of pursuing maximum time efficiency and minimum casualty loss, including emergency logistics demands generated by sudden factors and emergency logistics supply activities for meeting these logistics demands. Emergency logistics is featured by abruptness, uncertainty, non-conventionality and weak economic efficiency. The author thinks petrochemical emergency logistics refers to special-type logistics activities that minimize losses and conduct effective management on the destruction or interruption of the potential petrochemical supply chain system or caused by factors like sudden natural disasters, social harms (traffic,

fire disaster, oil and gas leakage accident, pipe network destruction and technological hazard), and major sudden events (war, international political disputes, oil crisis, terrorist event, etc). Building and perfecting the petrochemical emergency logistics system is of important significance to ensure energy supply and social security.

3.2 Petrochemical emergency logistics – storage

With the development of the economy and the constantly increasing foreign trade dependence of China's oil, strategic oil reserve construction is an effective means to prevent and respond to major sudden events (large-scale reduction or supply interruption of oil caused by war, international political disputes, etc) and natural disasters.

China's oil strategic reserve started late. At present, the national strategic reserve system is still based on crude oil reserve. China started building strategic bases in Zhenhai, Zhoushan, Huangdao and Dalian from 2003. In 2015, the phase I and II reserve bases in full reserve operation could basically meet the domestic crude oil demands for 60 days, still with a large gap with the future reserve target of 90-120 days. So the construction of the phase II and III oil reserve bases should be accelerated. The more scattered the strategic oil reserve bases, the higher secure they are. The radiation range of oil reserve bases should be considered. In recent years, the earth has been in the high-incidence period of natural disasters such as earthquake and tsunami. When the disaster occurs, the huge natural destructive power impacted the production and supply capacity of petrochemical products in the disaster area; on the other hand, the social rescue work for disasters also forms the intensive incremental demands for oil and gas in short term. In 2008, China's Wen-Chuan earthquake struck, and the Lanzhou-Chengdu-Chongqing pipe and the Baoji-Chengdu Railway that transported 90% of refined oil to Sichuan were damaged. Due to the great demands for power generation and disaster relief transportation, the refined oil consumption for the earthquake stricken area increased more than 40% in May and June. PetroChina had about 140, 000 tons of commercial reserve in Sichuan, sufficient for about 15 days of need. If without the National Reserve Bureau's urgent transfer of refined oil strategic reserve in Chongqing and Gannan, the refined oil supply was likely to be interrupted.

From disaster relief practice and international experience, China needs to set up a perfect and powerful oil reserve system to respond to the attack of emergent natural disasters. China's refined oil reserve is insufficient at present, still not really included in the national oil reserve system so far, so it is necessary and urgent to strengthen refined oil reserve during the 13th Five-Year Plan.(Zhao and Chen, 2011)

China's oil and gas storage and transportation facilities will continue to be in an important development period in the future. According to the Identification of Major Hazard Sources of Dangerous Chemicals (GB18218-2009) and the Guiding Opinions on Major Dangerous Source Supervision and Management Work (AJGXTZ [2004] No. 56), the regulations of the National Reserve Bureau, oil and gas storage and transportation facilities can easily constitute major danger sources. The identification of the danger sources of the oil reserve base suggests fire and explosion are the two main unsafe factors in the oil storage and transportation process. (Zhu, 2010)In recent years, many large oil depot fire and dangerous chemical warehouse accidents have taken place. Particularly, the"7.16" oil depot fire accident of Dalian in 2010 and the"8.12" dangerous goods warehouse fire explosion accident at Tianjin Port in 2015 warned the security management of oil, gas and dangerous goods storage and transportation: China should improve the security conditions of large oil depots, set up four-level oil leakage preventive system, implement step-by-step prevention strategy, lower the probability of accident occurrence, increase necessary emergency equipment, improve the security and reliability of important facilities (including emergency power supply, urgent valve shutoff and pump houses), expand firefighting water and foam liquid reserve, set up the zone defense system, and strictly comply with the Oil Reserve Base Design Specification (GB50737-2011) (Han, 2012) implemented from May 1, 2012.

3.3 Petrochemical emergency logistics – transportation

(1) Current situation and countermeasures of oil and gas pipe network

China's crude oil import mainly comes from Middle East, Africa, etc, very far in distance, and sea transportation is a relatively reasonable way. About 80% of China's imported oil is transported through the Strait of Malacca, and it faces many risks such as war, anti-government armed forces and organizational crimes, petroleum transportation accidents, and international politics and competition. The oil import source and oil transportation line are relatively singular, which increased the risk of national energy security. The construction of China-Russia, China- Kazakhstan and China-Burma oil transmission pipelines improved the security coefficient of the existing crude oil purchase way and transportation mode.

The completion and operation of the West-East natural gas transmission pipeline and the construction of large-scale pipe laying (network) made the research on several key scientific problems involving the geological security of the energy supply system more important and urgent. The assessment and division of regional geological disaster risk levels need to be strengthened, and the short-term, mid-term and long-term plan should be conducted according to the risk level.

The social dangerous factor (man-made sabotage) has become the main cause for the leakage, fire and explosion accidents of domestic long-distance transmission pipelines in China. According to statistics, the main cause for China's oil and gas pipeline accidents is the third-party damage, and punching oil stealing is an important factor, with the accident proportion up to 40%, followed by pipe corrosion, pipe quality, construction quality and sudden natural disasters. (Qian, 2012)The design, construction and operation managers of the pipeline projects should fully recognize the importance of pipeline security.

We should recognize the potential risks that affect the safety of pipelines, set up the new concept of HSE on the basis of the oil and gas pipelines featured by "many sites, long lines and wide areas", take effective security protection measures in project establishment, design, construction and operation management, enhance operation pipeline monitoring.

Integrity management refers to comprehensive integrated management on all factors influencing pipeline integrity. Through integrity management, the management level of pipelines can be improved, to ensure the operation security of pipelines. The integrity management remains to be strengthened.

(2) Current situation and causes of dangerous chemicals road transportation

China has strengthened the supervision on dangerous chemicals in recent years. In 2011, there occurred 66 dangerous chemical accidents, of which, there were 10 accidents occurring in transportation and storage. The absolute quantity was not large, but it would cause baneful influence once occurred.

The concentrated production and diffused demands of dangerous chemicals and the serious shortage of railway capacity increased the freight volume of road dangerous chemicals. Its transportation radius often exceeded the economic radius of road transportation. There exist many limitations on the transportation and assembling of dangerous chemicals, making it difficult to choose transportation means of appropriate carrying capacity in the transportation process and causing and generating potential risks caused by serious overloading.

China still fails to adopt international dangerous goods transportation standards in domestic transportation and many standards are not rectified and adjusted in time. For example, according to the Road Dangerous Goods Transportation Management Regulations, The requirement on enterprises engaged in road dangerous goods transportation is low, which leads to the small enterprises scale and poorly equipped.

The detailed rules in transporting dangerous chemicals on the road are relatively indistinct and weak in technicality and operation.

In addition to the reason of hardware facilities, the main cause is the low professional quality of practitioners. At present, those that are engaged with dangerous article transportation are mainly private and joint-stock companies, featured by strong mobility of drivers and escort personnel, uneven personnel quality and difficult management.(Xiao and Guo, 2012) We should tighten the access conditions of employees of dangerous chemicals enterprises, improve the overall quality of practitioners, perfect the security education training system of dangerous chemical enterprises, strengthen emergency plans and drills, and reinforce the design of dangerous chemical security incentive mechanism.

3.4 Emergency logistics – information system

The information system is the nervous system of emergency logistics and the important condition for modern emergency logistics to survive and develop. The emergency logistics management organization is an integrated comprehensive information system that comprehensively uses the computer and network technology, geographic information technology, communication technology, electronic data interchange technology, automatic identification collection technology, etc, to get and dispose logistics information in real time and accurately and effectively control logistics activities. It can monitor resource information, demands information and the logistics guarantee process.

China's dangerous goods logistics is characterized by low information degree and insufficient sharing of information, which leads to large stocks, transport capacity waste and high logistics cost. Petrochemical enterprises of various scales and types are not balanced in the development of ERP and e-commerce system; the establishment of database is incomplete. The application of modern logistics technologies like the radio frequency identification (RFID), global positioning system (GPS) and geographic information system (GIS) is still very limited to dangerous goods transportation enterprises. Only areas like Shanghai, Jiangsu and Zhejiang enforced the application of the GPS system for dangerous goods transportation vehicles. But the GPS monitoring platforms are independent respectively, not linked to the internet nationwide, which made trans-regional transportation vehicles and drivers hard to be supervised and the emergency department in the local area difficult to be deployed at first time to dispose. The transportation accident information, material character and rescue data are hard to make clear. A unified sudden event logistics information release and sharing platform is lacked, which makes information decentralized and the emergency commanding institutions unable to accurately grasp the detailed information of sudden events and the production and

distribution of materials needed, so that the analytical judgment is inaccurate and correct logistics decisions cannot be made.

3.5 Emergency logistics security system and mechanism

(1) Laws and regulations remain to be established and perfected

The promulgation and implementation of China's Act on Tackling Emergency Affairs marked the initial establishment of the emergency legal system, the publicizing and implementing are far from satisfaction and the standards for the operational supporting laws and regulations also remain to be perfected. Local laws and regulations are urgent to be researched and formulated.

(2) Deficient standards cause mutual fight

The International Chemical Manufacturer Association set up the quality assessment system for chemicals road security and uniformly assessed logistics service providers in quality, security, environment and other aspects. European road transport dangerous articles mainly comply with the Autorisation Dangerous Road (ADR). Compared with European and American developed countries, some domestic standards are obsolete and lack the access qualification assessment standards for dangerous chemical logistics service, checking standards and the management standards and systems. The application approval of new standards is featured by many links, complex procedures and low work efficiency. The regulations and standards related with dangerous chemical logistics are from multiple departments, which not only greatly increased the management cost of enterprises but also often made enterprises at loose ends.

(3) Mechanism remains to be perfected

In China, the three-grade management system is used for oil reserve, with macro management, administrative management and operation department mutually disconnected. The emergency linkage mechanism for China's strategic oil reserve has been set up; China has practiced the dangerous chemical registration system and the dangerous chemical accident emergency plans. Due to the lack of pre-warning assessment mechanism on sudden events, the extent of damage lacks sensitivity. The regional emergency logistics commanding centre that breaks the system was not established, the departments lack efficient coordination, so low in emergency efficiency; the national cross-regional dangerous chemical road transportation joint control mechanism remains to be set up.

Besides, the publicity for dangerous chemical security knowledge is insufficient and people panic when talking about dangerous chemicals. The emergency report and information release mechanism and the whole people joint supervision mechanism should be established.

4. Development trend of petrochemical emergency logistics

(1). With the sustainable development of the national economy, China's petrochemical industry will maintain long-term rapid growth. With the gradual implementation of "logistics industry adjustment and revitalization plan", the importance of petrochemical emergency logistics is gradually highlighted in the national economy and will be greatly developed.

(2). With the construction of the phase II and III reserve bases, China's petroleum strategic reserve will reach the goal of 90 days in 2020; as an important constituent part of the petroleum reserve system, China will increase the refined oil reserve starting from the 12th Five-Year Plan, and the integrated logistics system of park will be accelerated relying on the base and park industrial layout.

(3). Regional pipe network and supporting facility construction will be further perfected and the national scale pipe network will gradually take shape. The marine pipeline technology will see the development acceleration period; the pipeline technology for pipeline security, HSE management philosophy and the integrity management technology will be greatly promoted.

(4). The appearance and large-scale use of internet of things technology represented by RFID equipment and some other intelligent data collection and transmission equipment provided strong guarantee for the full-course monitoring of the petrochemical supply chain and the cross-regional emergency logistics management system.

(5). Refer to the experience of developed countries, The standard systems of petrochemical industry dangerous chemical storage and transportation standards including petrochemical products and the logistics service access qualification auditing standards will attain international standard in the future.

(6). The early-warning and risk assessment mechanism for the natural disasters and sudden events of petrochemical logistics and the national cross-regional petrochemical emergency logistics joint control mechanism will be established; with the establishment of the emergency report and information release mechanism, people's cognitive level will be significantly improved and the linkage supervision mechanism participated by all people will take shape.

(7). Based on scientificity and advancement, various regions research and formulate regional emergency laws and regulations, gradually set up perfect emergency legal system from the central government to local areas,

and guarantee the smooth realization of emergency logistics. Related laws and regulations will be further revised and perfected.

(8). With the perfection of storage and transportation laws and regulations, the qualification requirement for petrochemical logistics practitioners will be stricter, and governments of all levels and enterprises will perfect the safety education training system for dangerous chemicals, strengthen emergency plans and drills and training for employees, and enhance the design of dangerous chemical safety incentive mechanism.

5. Conclusion

With the fast development and strategic layout of petrochemical industry, China has achieved rapid development in the construction of petrochemical logistics infrastructure. Due to complex and changeable international situation and extremely abnormal climate, higher requirements are raised for emergency logistics such as pipe network layout, management and maintenance, and oil and gas storage and transportation. The oil reserve system construction including refined oil needs to be further strengthened, and the dangerous chemical warehousing layout and daily risk management supporting parks needs to be expanded; at present, the unified emergency logistics information release and sharing platform is lacking; the laws, regulations, standards and mechanism for emergency logistics remain to be established and perfected. But with the application of technologies like the logistics network, the improvement of people's cognitive level, and the perfection of the risk early warning and assessment mechanism and joint control mechanism for cross-regional emergency logistics, the scientific management system and the legal and regulation system will be gradually set up for China's emergency logistics.

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