Natech and Case Study Analysis

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***Abstract*—Natural disasters can trigger technological disasters (also known as natechs), interruptions in power lines lead to widespread power outages, dam failures cause mudslides and floods, and rupture of oil and gas pipelines. It may pose a huge risk to the disaster area [1]. This article analyzes the Natech event of the Wenchuan earthquake and the leakage of the Fukushima nuclear power plant caused by the tsunami.**

I. Introduction

Natural disasters are an important cause of industrial production safety accidents and very easy to cause secondary disasters, leading to air, water, soil pollution, and regional safety production accidents, thereby increasing the environmental safety risks of enterprises. This kind of technical accident caused by natural disasters is called Natech. Natech incidents often have extremely serious consequences and complex handling. Accident risks related to Natech must be taken seriously. It is necessary to identify, evaluate, and manage Natech. This thesis will analyze the Natechs caused by the Wenchuan earthquake "Fig. 1" and the Fukushima nuclear power plant event "Fig. 2", which Including case description and setting the boundaries, stakeholders analysis including Indigenous communities, inherent risk determination, causal chain analysis.

Fig. 1. Wenchuan.

Fig. 2. Fukushima nuclear power plant.

II. Case Study 1: Wenchuan

A. Case decription and boundaries

The Wenchuan earthquake occurred at 14:28 pm on May 12, 2008. The epicenter was located in Wenchuan County, Sichuan Province, China. The surface wave magnitude of the earthquake reached 8.2, the bending moment magnitude was 8.3, and the damage area exceeded 100,000 square kilometers. A total of 69,227 people were killed in the earthquake, 17,923 people were missing, 374,643 people were injured to varying degrees, 19,903,300 people lost their houses, and the total number of people affected by the disaster reached 46.256 million [2] [3].

Sichuan is one of the most important phosphate deposits in China. The phosphate deposits in Sichuan are mainly distributed in the Jinhe, Qingping and Mabian areas, only about 100 kilometers away from Wenchuan. None of these three phosphate mines survived the Wenchuan earthquake.

Qingping Phosphate Mine under China National Chemical Corporation is one of the large phosphate mine bases in Sichuan Province. Qingping Phosphorus Mine produces 1 million tons of phosphate per year. It is located at the epicenter of the Wenchuan earthquake. The disaster was extremely serious. More than 180 factories collapsed. The earthquake caused damage to Qingping Phosphorus Mine equipment, production stagnation, and landslides that led to roads, communications, Water and electricity are seriously damaged [4].

In the Qingping Phosphate Mine system, the boundaries of the system are the processing plants that are transported nationwide after the phosphate is mined, the damage to the production equipment caused by the earthquake, and the shortage of resources such as water, electricity and housing.

After the earthquake, the borders of this system, the logistics management department, received support from all of China, so that the Qingping Phosphate Mine returned to normal after a short period of more than a month.

B. Stakeholders analysis

China National Chemical Corporation is the parent company of Qingping Phosphate Mine and the most important stakeholder. Because of the damage to Qingping Phosphate Mine, China National Chemical Corporation also suffered considerable losses. Soon after the earthquake, China National Chemical Corporation sent a support team to help rebuild the Qingping Phosphate Mine and tried its best to minimize the impact of the earthquake. With support, guidance for reconstruction, and financial support, Qingping Phosphorus Mine successfully passed the difficult time, and the loss of China National Chemical Corporation was also minimized.

Qingping Phosphate Mine Company is the biggest victim among the stakeholders. The equipment damage and lack of resources caused by the earthquake resulted in the suspension of production of Qingping Phosphate Mine and the difficulty of restarting Qingping Phosphate Mine. Qingping Phosphate Mine Company first searched and rescued employees of the company, striving to rescue every trapped employee, and sought help from China National Chemical Corporation, and obtained a large loan from the Bank of China, so as to tide over the difficulties after the disaster.On the day of the earthquake, the company set up simple plastic tents to relocate nearly 3,000 people including affected employees, their families and nearby villagers. The leader adopted the method of centralized management and unified allocation of all living materials, and centralized the management and use of the only grain, etc., to the logistics team. After the porridge is boiled out, regardless of the employees, family members or villagers, the first round will be the wounded, sick, and children. , The elderly and women eat first, the second round is the masses of workers who participated in the disaster relief, and finally the managers and leaders at all levels of the mine.In the process of moving to the foot of the mountain, both the company personnel and the villagers who were transferred together, as long as the wounded, women, the elderly and children, will be escorted by young and middle-aged employees organized by the mine. In Hanwang Town, where the Ministry of Mines is located, the company used a basically intact factory building to build a rescue station to relocate people transferred from the mountain and nearby residents, and provide residents with food and medicine for free.

All employees of the company at Qingping Phosphorus Mine were also victims of the earthquake. Most of the factories where they worked were in the earthquake, and explosive and flammable chemicals were left in the ruins. In order to further reduce the disasters caused by the earthquake, the employees actively organized rescues, organized chemical investigation and disposal teams

C. Inherent risk

The chemical industry occupies a very important position in the national economy and is a basic industry and a pillar industry. The chemical production process is complex, and once an accident occurs with the hazardous chemicals involved, the destructive power is huge and the social influence is huge. After the Wenchuan earthquake, Qingping Phosphorus Mine Company repaired the equipment as soon as possible, restored water and electricity supply, and treated the ruins, effectively preventing the leakage of chemicals and the theft of explosives.

If Qingping Phosphate Mine Company does not deal with hazardous chemicals and explosives in a timely manner, it will further aggravate the problem of environmental pollution and pollute people's water, food and other resources. Makes people's living environment worse, leading to greater disasters.

D. Causal chain analysis

Through the causal chain analysis method, we can know the internal connection of the Natech incident in Qingping Phosphate Mine Company. The Wenchuan earthquake occurred, causing most of the company's factories to collapse, causing many workers to be buried in the factories, and huge damage to the machines in production, which led to the initial disaster. Moreover, in many industrial steps, many chemical reagents need to be used, and these chemical reagents are also buried and gradually leaked into the ground.

But Qingping Mining was not destroyed because of this disaster. In the process of reconstruction, Qingping Phosphorus Mine has overcome many difficulties such as transportation, electricity, communication, and poor water supply. Even if the conditions are so difficult, none of the company's employees retreats but is more determined to resume production and rebuild the mine as soon as possible. Confidence and determination. Through the concerted efforts and joint efforts of all employees of the mine, the company's internal highway was quickly completed, which provided a reliable guarantee for the official resumption of production.

III. CASE STUDY 2: FUKUSHIMA NUCLEAR POWER PLANT LEAK

A. Case decription and boundaries

The Fukushima Nuclear Power Plant incident occurred on March 11, 2011. A major accident at the Fukushima Daiichi Nuclear Power Plant in Japan was caused by the earthquake on the northeastern Pacific coast of Japan and the tsunami caused by the earthquake [5]. It is considered the most serious 7-level event by the International Nuclear Event Scale (INES). It is the most serious Natech event caused by the major earthquake.

When the Pacific Earthquake occurred, Fukushima Daiichi Nuclear Power Plant 1-3 was in operation, and Units 4-6 were also shut down for maintenance. After the earthquake, all reactors of Units 1-3 were automatically shut down and power outages occurred, but the crew successfully activated the emergency diesel generators.

However, shortly after the earthquake, a 14-meter-high tsunami hit the nuclear power plant, and the emergency diesel generator was flooded and stopped operating.

Most equipment (such as electrical appliances, water pumps, fuel tanks, and emergency batteries) was damaged or washed away by water, resulting in a complete blackout of nuclear power plants. Because the water pump cannot operate, it cannot continue to inject cooling water into the core, the core is burned out, and the nuclear fuel melts due to its own heat.

When the cladding of the fuel assembly of the unit 1-3 melts, the fuel particles in the cladding fall to the bottom of the reactor, causing the core to melt. The temperature of the molten fuel assembly is very high. It penetrated the bottom of the pressure vessel and melted the insertion hole and seal of the control rod, thus damaging the containment and pipeline of Unit 1.

In addition, the melted core of Units 1-3 released a large amount of hydrogen into the reactor and steam turbine building, causing hydrogen explosions in Units 1, 3 and 4.

A series of incidents in the accident leaked a large amount of radioactive materials in the surrounding environment, including exhaust pressure relief operations, hydrogen explosion, containment damage, pipeline steam leakage and cooling water leakage. Units 1-3 have melted the core again and again.

Soon after the Fukushima nuclear power plant incident, the Japanese government carried out the aftermath. The aftermath work is mainly to keep the temperature of the reactor at a low temperature to prevent the reactor from leaking again.

The specific method is to use a water pump truck and a temporarily assumed water pump to inject cooling water into the core and fuel pool and then drain the water. In the beginning, seawater was used for cooling, and then the freshwater stored in the dam in Okuma-Cho, Fukushima was used instead. In early July, although the work has not yet been completed, the pure water injection has been transformed into a cooling water cycle.

Those on-site staff endured harsh conditions and tremendous pressure. The first 50 people were called the Fukushima 50 Warriors.

B. Stakeholders analysis

Countless people are related to the Fukushima nuclear power plant this time. The first is the relevant government personnel responsible for managing nuclear power plants. They are responsible for managing and monitoring the normal operation of nuclear power plants. Even for this mega-magnitude earthquake, the local management department should have made sufficient preparations. At the beginning of the Fukushima nuclear power plant project, the Fukushima nuclear power plant should have designed its emergency response capabilities to deal with special natural disasters. However, the management failure of relevant government departments also led to this disaster.

The holders of the assets of the Fukushima nuclear power plant have suffered huge losses, and they have also mobilized all the forces in their hands to minimize their economic losses as much as possible.

The second is the senior management of the Fukushima nuclear power plant. They are mainly responsible for this incident. Their supervision and maintenance are not in place, which led to the occurrence of this incident.

Then came the basic level staff of the nuclear power plant. They failed to operate the nuclear power plant. The maintenance personnel did not understand the loopholes in the maintenance system of the nuclear power plant, which led to the occurrence of disasters.

Emergency response personnel after the disaster, they rushed to the disaster site immediately after a major disaster, regardless of personal safety, struggled to the front line, and worked hard to solve the nuclear leakage problem.

C. Inherent risk

Nuclear leakage has inherent risks

The decay of radioactive materials produces ionizing radiation. It destroys the chemical bonds between molecules and atoms in human tissues, and may seriously affect the important biochemical structure and functions of the human body. Our body will try its best to repair these injuries, but sometimes the damage is too serious or involves too many tissues and organs that cannot be repaired. In addition, the human body is also prone to errors in the natural repair process. The most susceptible parts of the human body to radiation damage include the epithelial cells of the gastrointestinal tract and the bone marrow cells that produce blood cells.

The biggest long-term health risk is cancer. Under normal circumstances, when somatic cells are damaged or aged to a certain extent, they will destroy themselves. When this ability to self-eliminate disappears, cells will gain "immortality" and can continue to divide uncontrollably, thereby evolving into cancer. Our body has many mechanisms to prevent cells from becoming cancerous and replace damaged tissues. However, the damage caused by radiation can severely damage these mechanisms of the human body, thereby greatly increasing the risk of cancer. In addition, if the human body cannot well repair the damage caused by radiation and the changes in chemical bonds, our genes may mutate. These mutations will not only increase people's own risk of cancer, but may continue to spread, thus showing the impact of radiation on future generations. These effects include smaller head and brain, defects in eye development, slow growth, and severe cognitive learning deficits.

The unique geographical location and strong safety awareness allow us to enjoy the convenience brought by new energy while avoiding nuclear accidents. Of course, the always vigilant safety alarm needs to ring forever. It is an eternal task to learn from the accident and strengthen the safety management of nuclear facilities.

D. Causal chain analysis

After the control rod was automatically inserted, Unit 1-3, which was still operating during the earthquake, was in an emergency shutdown state. One of the six transmission towers of the nuclear power supply system collapsed in the earthquake and lost external power. There was a lot of water in the power outage factory, and employees had to evacuate urgently.

After losing the external power source, the emergency diesel generator was successfully started within a period of time. The first wave hit the Pacific Ocean, and then hit the nuclear power plant several times. The tsunami crossed the breakwater, severely damaged the facilities of the nuclear power plant, and flooded basements and shafts. The emergency power supply of Unit 1-6 installed in the basement was flooded.

As a result, No. 1, No. 2 and No. 4 units lost all power, and No. 3 and No. 5 units lost AC power, causing the emergency core cooling system and the cooling water circulation pump to fail. In addition, the tsunami destroyed the seawater cooling system. After the core is shut down, nuclear fuel will continue to generate decay heat for a long time. Therefore, if there is a long-term lack of cooling, overheating will occur, leading to serious accidents.

If the fuel rods cannot be cooled, the core temperature will continue to rise. After the cooling water in the core evaporates, the water level will continue to drop, and the steam will cause the pressure in the pressure vessel and containment to rise. Finally, the fuel particle coated tube (zirconium alloy material) melts and chemically reacts with water to produce a large amount of hydrogen. The flying debris generated by the hydrogen explosion not only caused personal injury, but also caused the cable laying of the No. 2 water pump to be interrupted. In addition, the gas ejected during the explosion caused the shedding plate of the No. 2 reactor to fall, and the inside of the reactor building was exposed to the outside.

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