Briefing:
Japan's Nuclear Disaster Continues to Unfold

Jacob Grunberger

On Friday March 11, 2011 at 2:45 pm JST, an earthquake registered as a 9.0 on the Richter Scale occurred near the east coast of Honshu, Japan. The earthquake was comparable in its magnitude to the earthquake that hit Sumatra in 2004, roughly the equivalent of 23,000 Nagasaki bombs being simultaneously detonated.[1] The earthquake and ensuing tsunami destroyed towns and infrastructure, ultimately ending in billions of dollars worth of damage and the confirmed loss of about 16,000 lives.[2]

Located on the northeast coast of Japan, 219 kilometers from Tokyo,[3] the Fukushima Daiichi nuclear power plant run by the Tokyo Electric Power Company (TEPCO) felt the first effects of the event. After the earthquake struck, the proper safety mechanisms tripped, causing all 11 nuclear power reactors to halt the fission process. However, even though the reactors were not running, they were still producing an immense amount of heat.[4] In order to cool the reactors, water had to be circulated over them to prevent overheating and meltdowns. This process also worked to prevent the destruction of the containment apparatuses around the reactors, which guard against radioactive leaks. Despite the earthquake, backup diesel generators were enabling the cooling to occur until the ensuing tsunami struck land. Fukushima Daiichi was designed to withstand tsunami waves of 6 meters, but the waves that hit on March 11 reached 15 meters. Even though most of the reactors successfully went into "cold shutdown," the pumps in the three oldest reactors failed to work, causing the water in the reactors to boil and the nuclear fuel to heat up, leading the cores to begin melting. The high pressure buildup catalyzed an explosion at all three units, releasing radioactive materials into the air.[5] The nuclear event was rated a Level 7 on the International Nuclear Event Scale due to the large amount of radioactive material leaked into the air during the first couple of days. This was a ranking equal to the Chernobyl nuclear accident, which occurred in the former Soviet Ukraine in 1986. Ultimately, emergency workers stabilized the cores by injecting fresh water and seawater into the reactors, halfway up the core.[6]

TEPCO took responsibility for the containment and cleanup of its power plant, especially after it was discovered in April 2011 that radioactive water from plant #2 was leaking into the ocean. According to Greenpeace, the Iodine-131 in the seawater was measured at 7.5 million times the legal limit.[7] In recent months, TEPCO has been met with skepticism over its efforts to contain the disaster, which grew when it was admitted by the company on July 22, 2013, after much denial, that suspicions that plant #1 was leaking contaminated water into the ocean were true. For a more in-depth look into the Fukushima Daiichi disaster and other examples of nuclear meltdowns, see our previous Fund For Peace brief.[a]

It's important to know that even though the incident has not been on the minds of most Americans, major developments have been occurring that not only demonstrate why the U.S. public should care more about this specific incident, but also why a more broad discussion on nuclear power should take place. In the last year, radioactive material has leaked into the oceans, fish with elevated levels of Cesium have been found off of the coast of California,[8] and it has been disclosed that the thyroid radiation exposures that exceeded threshold levels for increased cancer risk was 10 times greater than what was previously disclosed.[9]

Recent Events

Despite its disappearance from the news, the events surrounding Fukushima Daiichi can still be classified as a disaster. To demonstrate the degree to which the situation is still far from containment, the following events from last month have been highlighted. On October 12, TEPCO announced a rising level of Cesium in seawater sampled from the Fukushima harbor of plant #1. The samples tested for a

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combined 10 becquerels of Cesium-134 and Cesium-137 per liter. This was the highest reading since sampling began and equal to the maximum that is permissible to have in drinking water according to the World Health Organization (WHO).[10] Just five days later, an observation well 10 meters north of the site of the August water leak was stated to have the highest levels of radioactivity to date. TEPCO announced that 400,000 becquerels of beta ray sources, including Strontium (which can cause bone cancer and leukemia), were detected per liter. The measured number was 6,500 times the amount collected the previous day. The spike was most likely the result of overflows of contaminated water caused by recent regional typhoons.[11]

TEPCO proved to be less prepared for the typhoons than was previous suggested. On October 20, heavy rain caused water saturated with Strontium (some with Strontium-90 as concentrated as 71 times higher than the safety level) to overflow out of containment areas from 12 of 23 groups of tank.[12] The ensuing tests demonstrated the severity of the overflows as on October 23, TEPCO announced that it had found the highest radiation levels recorded at plant #1 since it had been checking draining ditches in August. The company detected Strontium and other beta ray emitting substances measuring 140,000 becquerels per liter in water. The legal standard for Strontium emissions is 30 becquerels per liter.[13]

Following these readings, TEPCO began to take more rapid measures designed to curb the leakage of such potent materials into the surrounding areas. On October 24, TEPCO stated that it had started transferring pools for rainwater at plant #1 to underground storage tanks that had been previously avoided due to fears that they could have been leaking. According to TEPCO, they had not actually leaked. This action was taken to combat water overflows that had resulted from heavy typhoon rains.[14]

Reactions began to intensify from regulatory bodies as well. On October 28, the Nuclear Regulation Authority (NRA) chairman, Shunichi Tanaka, expressed concerns to TEPCO president, Naomi Hirose, about an increasing number of problems at Fukushima Daiichi, many of which had been caused by human error. TEPCO acknowledged the truth of these sentiments, admitting that tight deadlines were causing mishaps and that there had been trouble finding a stable pool of workers for the plant.[15] A few days later, on October 30, a task force organized by Prime Minister Shinzo Abe's Liberal Democratic Party (LDP) suggested that the decommissioning process for the Fukushima Daiichi nuclear power plant be stripped from TEPCO, creating either a separate sub-company of TEPCO or creating a government-affiliated, but independent, administrative agency.[16]

What's Being Done

The remediation process at Fukushima has been slow and costly. Already, the deadline for cleanup has been pushed back to 2017[17] and Prime Minister Abe has begun to ask for international assistance with the process.[18] It is estimated, when combined with compensation, that the cleanup endeavor will cost US$810 billion.[19] The long -term plan is for the Fukushima Daiichi nuclear power plant to be fully decommissioned. According to TEPCO, this process will be difficult, especially the removal of the melted and damaged reactor cores. As a result, it has been suggested that the decommissioning will take as long as 40 years and will cost as much as US$100 billion.[20] TEPCO has begun to solicit foreign assistance to figure out the best way to decommission the destroyed reactors.[21]

Currently, TEPCO has put measures in place to assist with the short-term cleanup and decommissioning of its power plant. As of November 2013, the Japanese government is contemplating removing TEPCO's mandate to lead this process and shifting it to the government. That said, it is worth noting what is currently being done by TEPCO because currently Tokyo has, however, yet to plan out its own course of action. These measures are separated into two categories: emergency measures and fundamental measures. This data was collected from public TEPCO documents.

Emergency Measures[22]

The first measures to be discussed are the ones to be implemented in the case of emergency contaminations that may arise. These are split into three different courses of action. The first is known as "Preventing outflow of contaminated water into the port." This is described as ground improvement of the contaminated area, pumping up of groundwater, and paving of the ground surfaces. Chemicals will be injected into the ground in order to reduce groundwater permeability. This will be done on the mountainside, as well, to prevent inflow. Pumps will be used to extract excess groundwater to prevent overflowing and the ground surface will be paved to suppress penetrating rainwater. The second is labeled as "Removing contamination sources." This entails the removal of highly radioactive contaminated water inside the security trenches. Branch trenches will be blocked so that contaminated water inside the main Fukushima trench can be drained away. (There is no information publicly available on where the water will be drained.) The final is known as "Suppressing an increase of contaminated water." This entails pumping up groundwater on the mountain-facing side of the building and removing water at locations upstream of the buildings, through a bypass, to reduce the inflow of groundwater into the buildings. Ultimately, the captured water will be stored in dedicated pipes and tanks.

Fundamental Measures[23]

The second measures to be discussed are the ones to be implemented in order to combat long-term contamination. These are also split into three different courses of action. The first has been called "Stopping outflow into the ocean." This process involves installing a sea-side impervious wall. Construction of the wall began in May 2012 and is expected to be complete by September 2014. The wall is being built beyond the existing bank protection and the gap between the two will be filled with landfill. Installation of pump wells will be necessary before the completion to pump up water to be stopped by the impervious wall. The next measure is known as "Suppressing the increase of contaminated water and preventing outflow into the port." This will entail installing a land-side impervious wall using the soil freezing method. The frozen wall will surround the buildings of Fukushima Daiichi. The process will take two years and consists of drilling freezer pipes into the soil and constantly pumping them full of liquid coolant, causing the surrounding soil to freeze and create a natural barrier. The process is being paid for by the Japanese government and will cost approximately US$470 million.[24] The final measure is labeled "Stopping the inflow of groundwater into the reactor buildings." This plan will be implemented by pumping up groundwater through sub-drains. The inflow of groundwater will be contained by restoring sub-drains, which will be used to pump up the groundwater around the buildings. Sub-drains installed deeper into the adjacent mountain will also be restored and will pump up groundwater to prevent downward flow to the bank protection area.

IAEA Report

In October 2013, the Japanese government requested a follow-up to the "International Mission on remediation of large contaminated areas off-site TEPCO Fukushima Daiichi nuclear power plant." The IAEA team ventured to northeast Japan on October 14 and was comprised of 13 international nuclear experts. The objectives of this particular mission were to provide assistance to Japan in assessing the progress made with the remediation of the Special Decontamination Area and the Intensive Contamination Areas, reviewing TEPCO's remediation strategies, and sharing its findings with the international community as lessons learned. In the ensuing October 21 report, the IAEA released a set of recommendations in order to improve the cleanup of the disaster area.[25] Some of the most important are outlined in the following paragraph.

The IAEA acknowledged that TEPCO should seek to include greater participation from the Nuclear Regulation Authority (NRA) in the review of remediation activities, the defining of radiological remediation criteria, and the review of the related safety assessments. Recommendations were made that Japanese institutions improve their efforts to communicate that during remediation situations, any level of individual radiation dose in the range of 1 to 20 milisieverts per year (mSv/y) (a milisievert is the amount of radiation the "dose" received by people26) is acceptable and in line with international standards. That said, the government must do a better job of explaining to the public that 1 mSv/y is a long-term goal and cannot be achieved solely by decontamination work and the IAEA offered its assistance to support Japan in these pursuits. It further asserted that the entire remediation and reconstruction programs should be better communicated in order to improve confidence in the decisions being made. By providing a holistic view, the IAEA believes that TEPCO would allow stakeholders to plan in advance in order to take a less reactive stance to cleanup developments. The IAEA also stated that the cleanup should take into account the natural processes that lead to reduced availability radiocesium to crops, allowing for less soil to be removed and disposed of in order to protect agriculture. Finally, responsible parties must carry out appropriate demonstrations of the safety of the facilities and activities for the management of contaminated materials and must allow for their independent evaluation.

Conclusion

The cleanup and decommissioning process for the Fukushima Daichii nuclear power plant has been slow, expensive, and generally ineffective. This accident has demonstrated that the international community must work to properly assess the costs and benefits of using civilian nuclear power. Over the next few years, there will be enough data to determine the full extent of the environment damage caused by this disaster, but what can be discussed now is how these accidents can be responded to immediately following emergencies. Such questions that have arisen over the last few months are how to properly measure environmental damage, how to communicate the cleanup process to civilians, who should take responsibility for the cleanup and decommissioning of destroyed nuclear power plants, and how to incentivize skilled workers to take jobs at cleanup sites. If nuclear power is to become an energy staple moving forward, these questions must be considered and answered if this supposed panacea to resource crises is to become commonplace.

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