Chapter 5: The Logistics of Responding to a Nuclear Emergency

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Introduction: The Fukushima nuclear accident was a defeat of logistics

The Fukushima Daiichi Nuclear Power Plant accident that occurred on March 11, 2011 revealed a flaw in both the hardware and software provisions of the electric power company, which is expected to be "primarily responsible for responding to an accident"[1]. Not only were all the AC power supplies lost due to flooding by the tsunami and the three reactor cores go into meltdown, it also became dysfunctional in terms of what should be the results of daily training, such as who was responsible for commanding the accident response and sharing information. Furthermore, because the nuclear power plant where the accident occurred (on-site) and the response base (off-site) were not well coordinated, the supply of necessary materials and equipment for accident response was delayed, and even after equipment arrived at the site, the nuclear power station staff were unable to operate it, the spread of the accident unable to be curbed. In other words, logistics did not work effectively in response to the Fukushima Daiichi nuclear accident. In this chapter, we analyse the factors that caused logistics to malfunction, and examine how Japanese and other overseas nuclear power plant operators perceived the problem after the accident and implemented improvement measures.

Logistics is a military term that refers to general operations related to the procurement, supply, maintenance, and repair of military equipment and the transportation, deployment, and management of personnel and equipment. It consists of three elements: supply, transportation, and management. Soldier capabilities are classified into self-sufficient, locally procured, and supply base types.[2] As mechanization has progressed, however, the self-sufficient and locally procured types are no longer effective means of combat. In the Fukushima Daiichi Nuclear Power Plant accident, in addition to being incapable of self-sufficiency or local procurement both in terms of equipment and personnel deployment, the power company's head office as well as the government's backup systems were undeveloped.

Not only in terms of remorse for the Fukushima Daiichi Nuclear Power Plant accident, but also in many historical cases, a lack of understanding about the importance of logistics has influenced the fate of Japan. One typical example is the former Japanese Army in the Pacific War, which took logistics lightly and suffered one defeat after another[3]. It is no exaggeration to say that logistics in

[1] Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company, 2012, p.5.
[2] Heitan [Military Logistics] in *Encyclopedia Britannica Japan*. Accessed May 13, 2020.
[3] Funabashi, 2014.

preparation for emergencies is the most important issue in Japan's national crisis management.

In the wake of the accident and following its investigation by various committees, the Nuclear Regulation Authority was established in Japan in September 2012, separate from and independent to the Nuclear Power Utilization and Promotion Department[4]. Overseas countries that use nuclear energy also reviewed their regulatory standards and strengthened safety. Reading the new regulatory standards in Japan and abroad, you will not find any substantial difference from the perspective of "lessons learnt" from the accident: "businesses must strengthen their prior preparations in order to stop a nuclear power plant runaway."[5] However, regarding how "learning" is linked to actual "lessons", interesting differences can be observed at home and abroad.

Looking mainly at the nuclear accident response team (Force d'Action Rapide Nucléaire: FARN) set up by French electric power companies as an overseas case and the Nuclear Emergency Support Center (Mihama, Fukui Prefecture) as a domestic case, we will examine the problems of information sharing at the time of an accident, and then focus on specific examples of efforts to improve logistics capabilities by electric power companies in Japan and the world. Finally, by highlighting the differences between Japan and overseas, especially differences in business and government preparedness for a "worst case", we will consider how Japan should improve its emergency and response capabilities.

1. To make or break the site: logistics is the key

Even if a supply network for goods and equipment from off-site to on-site is set up, it is impossible to supply the necessary materials at the required time if information cannot be shared between on- and off-site, and the on-site side does not have the ability to gather and appropriately convey information on the reactor situation and the predicted progress of an accident. In highly specialized science and technology facilities such as nuclear power plants, the work is often overly specialized and manualized, which leads to unexpected situations. What did the operator learn from the information gathering and logistics problems in the Fukushima Daiichi Nuclear Power Station emergency response headquarters at the time of the accident, and how has the emergency system been revised?

Difficulties in sharing information in an emergency

If equipment and personnel cannot be procured at the disaster site, the provision of a supply system is another component of logistics capabilities, and it is important that appropriate information is communicated and shared on-site and off-site. In the response to the Fukushima Daiichi Nuclear Power Plant accident, however, it was severely pointed out that information sharing did not work well and led to a delay in the response.

As described in detail in Chapter 2, at the time of the Fukushima Daiichi Nuclear Power Plant accident, there was not sufficient communication between the shift supervisor, who is the general manager of the central control room, and the main engine operator responsible for operating the nuclear reactor regarding whether the Unit 1 cooling system (Isolation Condenser: IC) was operating or not[6]. As a result, although the operators in the central control room were leaning towards a judgment that the "IC was not working", this perception was not conveyed to the emergency control headquarters (in the anti-seismic building) as the general consensus of the control room. The Fukushima Daiichi

[4] Nuclear Regulation Authority, 2016.
[5] Autorité de Sûreté Nucléaire (2017) Follow-up Seminar in Paris. November.
[6] The Technical Committee on Nuclear Power Safety Management in Niigata, 2015.

nuclear accident highlighted not only the difficulty of communicating between on-site and off-site, but also the difficulty of sharing information within the power plant. The reality was that information sharing did not work well among the 27 people, including the director, deputy director and emergency response team manager, seated around the round table in the anti-seismic building, or even among the operators in the central control room controlling the reactor.

About one and a half hours after the loss of all AC power due to the tsunami and the shutdown of the emergency diesel generator at 17:15 on March 11, 2011, an officer from the technical group (analysing the fuel situation in the reactor and the progress of the accident), which was one of twelve emergency countermeasure groups, presented some important information over the microphone at the round table.

"Accident progress prediction at Unit 1 from the technical team: Minus 150 cm at downscale. If the water injection is stopped, it will reach TAF (Top of Active Fuel) in an hour's time."[7]

As stated, immediately prior to this, information that the water level of Unit 1 was "TAF + 250 cm" had been sent from the main control room to the anti-seismic building. It meant that the water level had fallen 400 cm to TAF minus 150 cm in an hour. It was a crucial analysis and prediction that suggested the IC was not working.

However, according to the interview record of (then) Director Masao Yoshida conducted by the Government Accident Investigation, this important information was not shared at all at the round table. When an officer in charge of the accident investigation committee asked about this information, Director Yoshida replied "I didn't hear it", and when the officer showed him the technical team's statement in a chronology obtained from TEPCO, he was at a loss saying, "He must have said it, I suppose", finally hinting at regret that important information had not been shared, saying, "A team leader needs to speak more forcefully."[8]

The emergency response team leaders who were present at this scene recall that the round table of the anti-seismic building ceased to function as a base for gathering information and issuing commands for two reasons.

One was that each group moved vertically and disjointedly, and were unable to cooperate. "Each team was desperate to respond to their own top priority issues and couldn't grasp the overall situation", said an executive, who worked as team leader for the restoration team restoring power and opening the vent valve.[9] At around 17:00 on March 11, Director Yoshida gave top priority to confirming the safety of staff and reporting to regulatory agencies and local governments, and held a meeting with the public relations group with his back to the round table. This recovery team leader said, "I had left the round table and was working on a power recovery plan in the small meeting room next door." Another veteran restoration team leader, who had worked at Fukushima Daiichi Nuclear Power Plant for more than 30 years, called to the small meeting room, saying "let's listen to the information at the round table", but this same group leader revealed that he too "did not remember the remarks of the technical group".[10]

Why did they miss grasping important information even after returning to the round table? Another

[7] Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company, 2011b, p.4.
[8] Ibid. pp.3–7.
[9] Interview with recovery team leader, November, 2016; Ibid., September, 2017; Ibid., April, 2018.
[10] Interview with recovery team leader, September, 2017; Ibid., April, 2018.

reason was that even when an unexpected situation occurred, the group leaders of each group reported according to the manual and could not prioritize information. Immediately after the disaster, the leaders of each group obediently kept to the manual and continued to pass along information unrelated to the accident response over the microphone. The aforementioned recovery team leader explains, "Each team was competing for the microphone, and they were waiting for the microphone to be available." Before and after the remarks of the technical team, non-urgent information such as "buses are being arranged" was constantly being released, and the most important information at that time, which was the prediction of water level change, was buried.

The round table method, in which the director and all the countermeasure group leaders meet together, was considered an indispensable system for sharing information under a premise that work was excessively subdivided, each group having its own technology and work procedures unfamiliar to other groups. In fact, even at the Fukushima Daiichi nuclear accident, a total of 27 directors, deputy directors, and group leaders surrounded the round table, but as the information flood continued, no one could identify the important information. In other words, the noise and the signal were indistinguishable.

In an emergency situation in which unexpected events occur in quick succession, it is not easy even for people in the same group to share information by reporting and confirming their understanding.

The evils of logistics manuals

One of the characteristics of a nuclear power plant where the system is manualized in great detail is that, by repeating training, it becomes possible to fully implement the manual and improve work efficiency. However, the flexibility that allows the organization to respond to unexpected situations tends to be lost in such a system. Not only in information sharing but also in logistics, such characteristics delayed the response to the unexpected. Director Yoshida testified in detail on this during an interview with the Government Accident Investigation. Although somewhat lengthy, it is quoted in full.

"As to whether people in the materials team understood the specifications, they didn't. Since it's the job of the materials team to gather things and they don't know the detailed technical specifications, the recovery team has to provide the specifications. For example, they have to specify how many batteries of what voltage, and how many kW the power supply car has, which makes it pretty difficult. You tell the materials team you want a power supply car or batteries, which the materials team acknowledges, and they then tell the recovery team to hand over the specifications, so the recovery team gives our materials team the specifications, and then, the response is a matter-of-fact one with our materials team telling the materials team at head office to send us such-and-such."[11]

Going by Yoshida's statement, it would be impossible to expect the necessary equipment and materials to arrive at the necessary timing if this kind of exchange was conducted in an emergency. It is easy to understand the reason why the French nuclear accident response force (FARN), which will be described later, emphasizes the importance of standardizing equipment and training so that the necessary gear can be brought in no matter where an accident occurs.

While the countermeasures headquarters in the anti-seismic building was ordering materials in keeping with the manual, the central control room, which was the front line of the accident response, was plunged into complete darkness with the loss of all power, and their dissatisfaction with and

[11] Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company, 2011a, pp.26–27.

distrust of the anti-seismic building grew as basic materials such as batteries ordered many hours ago failed to turn up. The main engine operator of Unit 2 at the time of the accident commented on the atmosphere in the central control room during this time, especially the agitation of the younger operators, "they were whispering to each other, headquarters over at the anti-seismic building is going to abandon us."[12]

The ice drop strategy that completely melted

On the other hand, some cases can be observed in the crisis response to the Fukushima Daiichi Nuclear Power Plant where materials themselves and transportation work were wasted due to material arrangements that did not sufficiently consider the feasibility.

On March 13, 2011, the cooling function of Unit 3 ceased before dawn, making water injection and reactor cooling urgent issues. After many parties including Fukushima Daiichi, the offsite center and Tokyo head office spoke via video conference concerning water sources, water injection measures by fire engines, and what to do about outdoor tasks when the dose increased, at around 8:28 the idea of dumping ice in was proposed by an executive of the Fukushima Daiichi Nuclear Power Station, who was at the local countermeasure's headquarters at the offsite center. The following exchange subsequently took place between head office executives, Director Yoshida, and (then) Managing Director Akio Komori.

Headquarters Government Office Liaison Group: "Anyway, you have to think in parallel, you know, dropping in ice or something."
Director Yoshida: "OK, well then, aaah, get ice. Ice, get it."
Managing Director Komori: "Would that be the materials group? A large amount. Perhaps even head office?"
Director Yoshida: "Materials team, excuse me for a Fmoment. How much would we need, for Unit 1, the more the better, but it'll be difficult to get it in, so I'd be grateful if you could work out the amount and coordinate with the materials team."
Managing Director Komori: "Head office materials team, it may be necessary to procure ice, regardless of whether or not it can be shipped to the power station immediately."[13]

On the same day, a total of 2 tons of ice were ordered from a supplier in Saitama Prefecture, and were transported to the Fukushima Daini Nuclear Power Plant by a helicopter company that was a TEPCO affiliate. As far as the videoconference proceedings are concerned, discussions about the use of ice for the cooling of the spent fuel pool can be seen, but no evidence showed that the details were sufficiently agreed upon. As a result of prioritizing the ice shipment before solidifying concrete measures, everything melted before it could be put into practice. This example of ordering materials without fully considering the feasibility, with every employee sharing the goal of cooling the reactor all the while, tells almost tragically the story of a lack of preparedness for countering an unexpected event in the reactor.

What actions did electric power companies and the government actually take after the Fukushima Daiichi nuclear power plant accident to overcome the many problems witnessed in information sharing and logistics as well as dealing with the unexpected?

Breaking away from fake training

The lack of preparedness for the unexpected was patently clear when looking at the sham made of emergency drills and accident management training before the Fukushima Daiichi nuclear accident.

[12] Interview with main operator, March, 2016.
[13] NHK TV Conference, March 13, 2011 p.75.

Two former recovery team leaders said, “To put it extremely, staff were like scripted actors. In that sense, there is a lot to regret in terms of pre-accident preparation.” “Sometimes the director would adlib something not in the script like ‘Actually, isn’t this kind of phenomenon happening?’ He may have thought the training was too stylized.”[14]

Given the limitations of being unable to respond to the unexpected using their conventional method of predicting damage based on a given assumption and enhancing advance preparations, TEPCO did introduce the Incident Command System (ICS) used in the United States as a standardized emergency response organizational system. Under the ICS, the field commander is at the top, and the number of people reporting directly is three to seven people. Operations in the United States show that the number of people one person can directly issue directives to in an emergency is seven people, and TEPCO has abolished its round table method where a total of 27 group leaders, the nuclear power station director and the deputy director met together.

In the new emergency organization, the power station director is still in charge of the accident response, but he actually issues commands to the reactor recovery supervisors (two per unit), and five other people from information, materials, and general affairs. In addition, the mission of each person in charge is clarified, as are the skills and requirements of people in those positions, education/training to fulfil these requirements being mandated.[15]

After the Fukushima Daiichi accident, TEPCO established an in-house accident investigation committee and published a final report in the summer of 2012. However, as noted in Chapter 2, after its release, engineers unconvinced because it “was just an excuse about the accident response from start to finish”, newly launched a Nuclear Reform Task Force. In March 2013, they put together the so-called Anegawa Plan analyzing the failure of communication concerning Unit 1’s IC and proposing the introduction of ICS. This was based on the idea that, “After the Three Mile Island accident in 1979 in the United States, the personnel system was modified to add experience as a shift supervisor responsible for operating the nuclear reactor as a prerequisite for becoming the director of a nuclear power plant. This should also be considered in Japan.”

However, introducing this into Japan requires an even greater reform of the personnel system that in the United States. The shift supervisor is considered to be a major managerial, non-career (high school graduate) position, while the director is considered to be a post for people who have studied nuclear engineering at university engineering faculties. In the case of the United States and France, if the post becomes vacant due to personnel changes, operators of Navy nuclear submarines can be brought in, but this is not possible in Japan.

The current situation is one where in order to create an organization permeated to the very bottom by the right people fulfilling their duties, and sharing information and responding quickly in an emergency, “blind training with no scenarios has to be repeated continually, and each person has to master how to respond” (recovery team leader[16]). Although creating a flexible organization is endorsed, this is not to say laying down detailed responses in the manual is completely denied. The ability to fully implement the manual through repeated training is the first step of crisis management. How can flexibility also be embedded in the organization to realize responses to the unexpected? This remains an issue in system safety and resilience engineering ten years after the accident.

Yotaro Hatamura, who served as the chairman of the Government Accident Investigation, said,

[14] Interview with recovery team leader, September, 2017; Ibid., April, 2018.
[15] TEPCO, 2013, p.84.
[16] Interview with recovery team leader, April, 2018.

"There is still a lack of awareness in Japan that things that don't come to mind can happen. Training staff is important, but it's more necessary for the director class to be made aware of the unexpected through training so they can respond to unexpected events."[17] Overseas experts also warn that not only the power operators but also the regulatory agencies that supervise the power operators are still too unaware. Charles Casto, head of the U.S. team dispatched to Japan from the U.S. Nuclear Regulatory Commission (NRC) at the time of the Fukushima Daiichi Nuclear Power Plant accident, said, "I would like you to note in writing the seriousness of the fact that the Japanese regulators only assume their role is for normal times. In the event of an emergency, I think the essence of the problem is that regulators have not well thought out what they are to do. They will never leave their bureaucratic mentality behind. As for training, I don't think there is thorough training and expectations on what role the regulatory authorities should play."[18]

2. Onagawa Nuclear Power Plant and Fukushima Daini: a victory for information sharing and logistics

Fukushima Daini: the tactics of experienced reactor operators

At the Fukushima Daiichi Nuclear Power Station, information sharing and logistics did not function in the event of an unexpected accident. In comparison, both Fukushima Daini and Onagawa responded to the unexpected situation with quick action at the accident site. Can we not learn lessons about rapid information sharing and logistics from that response?

Although the Fukushima Daini Nuclear Power Plant escaped a meltdown, the water temperature in the pressure suppression pool increased in Units 1, 2, and 4, forcing them to report an Article 15 event under the Nuclear Emergency Special Measures Act that triggers the declaration of a nuclear emergency by the Prime Minister. In particular, as Unit 1 developed into a situation where venting would be required in another two hours, they had to go so far as to implementing cooling the containment vessel (dry well spray), "a first for world nuclear reactors" (then Superintendent Naohiro Masuda[19]). Although the situation was better than at the Fukushima Daiichi Nuclear Power Plant, it was still an extremely serious accident that would have rocked the world even if the event on March 11, 2011 involved only a single accident at the Fukushima Daini Nuclear Power Plant.

Like the Fukushima Daiichi Nuclear Power Plant, the Fukushima Daini Nuclear Power Plant faced an unexpected emergency. But in terms of crisis management, there was a huge difference between the two nuclear power plants. At Daini, communication was smooth between the emergency countermeasures room in the anti-seismic building and the central control room that controlled the reactor.

A staff member with experience in nuclear reactor operations was dispatched from the countermeasures room to the control room to serve as a liaison. If you are an experienced operator, you can accurately understand what kind of operation is being performed in the control room, and convey the situation and response of the reactor to the countermeasures room without disturbing the crisis response by the control room's shift manager and operators. According to Masuda, the idea was that of the power generation team chief in the countermeasures room (the power generation team is mainly in charge of communication with the main control room), who had experience as an operator in the control room. Masuda said, "The power generation team manager was a professional at operating the nuclear reactor, so I approved it. According to him, there was no way the operators

[17] Interview with Yotaro Hatamura, September 18, 2019.
[18] Interview with Charles Casto, August 26, 2019.
[19] Interview with Naohiro Masuda, December, 2016.

could concentrate on the task at hand if we (the anti-seismic building) kept asking them this and that. So, if that was the case, I thought it would be better to stick someone into the central control room who could report back in a timely fashion to our questions."[20]

Masuda said, "There were things we didn't do well in responding to the crisis, but dispatching a worker who knew how to operate the reactor made interaction with the control room a success. I'd like to see this adopted at all nuclear power plants in the future."[21]

Even in logistics, the Fukushima Daini Nuclear Power Plant took its own measures, not heeding the manual-like exchange between the emergency response teams at the power plant and Tokyo head office. For example, there was a mistake when head office was asked for 4,000 tons of water for cooling the reactor, but 4,000 liters of drinking water were delivered. The drinking water could only be transported to Miharu Town in Fukushima Prefecture, far from the nuclear power plant site. At the time, the Fukushima Daini Nuclear Emergency Response Team remembered that it used to draw water from the Kido River flowing next to the nuclear power plant, and started to restore the pipeline there. When restoring the line by a power supply car, there was a possibility that external refueling activities for the power supply car would not be possible due to the impact of the building explosion at Fukushima Daiichi Nuclear Power Plant, and there was a risk that the water supply would be delayed. As a result, Daini used the prohibited strategy of borrowing electricity from Tohoku Electric Power's power lines. Masuda remembers, "I know Tokyo head office was working hard, but the situation at Daiichi was getting worse, and the situation at Daini was not getting across accurately. So, it was up to us to do it. Using Tohoku Electric Power's electricity was an idea tantamount to stealing, but the person in charge of distribution arranged it for me in just two days. I only have gratitude for Tohoku Electric Power for letting us use their electricity in those circumstances."[22]

Onagawa Nuclear Power Plant: doing away with the videoconference

The Onagawa Nuclear Power Plant was also just a hair's breadth away from a serious accident. Located in Miyagi Prefecture, where a tsunami caused severe damage in the Meiji Sanriku Earthquake (1896) and the Chilean Earthquake (1960), tsunami awareness was higher than at both the nuclear power plants in Fukushima. The distance from the sea's surface became far, and the altitude of the reactor building at the Onagawa Nuclear Power plant was as high as 14.8m (about 10m at the Fukushima Daiichi Nuclear Power Plant), barely avoiding a huge volume of seawater pouring into the site. However, the tsunami damage around the nuclear power plant was serious, and the group that was supposed to take over the shift at the main control room on the day of the earthquake could not get to work, and it took 20 hours until Unit 1 was put into a cold shutdown at 1 am on the 12th. The operators dealt with the crisis unrelieved. During this time, a fire broke out in the Unit 1 turbine building, but the local fire brigade could not be dispatched, so the in-house fire brigade extinguished the fire. After the tsunami hit, neighboring residents who had lost their places of refuge had to be evacuated, so the plant decided to accept residents by opening the gymnasium as an evacuation center during the crisis.

Tohoku Electric Power Co., Inc. also ordered a helicopter stationed at Sendai Airport and owned by an affiliate to take off just before the tsunami hit, preventing it from flooding. This helicopter was used to transport people and materials, including a pregnant women from the Onagawa Plant. Their high level of tsunami preparedness was only highlighted by the fact that a SDF helicopter stationed at Sendai Airport that was meant to be a so-called "first responder" in the event of an emergency was flooded at the airport and could no longer be used.

[20] Ibid.
[21] Ibid.
[22] Ibid.

What should be noted in the response by Onagawa Nuclear Power Plant is its raising doubts about the nature of videoconferencing, which had been considered effective for information sharing.

At the discretion of the emergency response team within the nuclear power plant, the video conferencing system was not turned on. Since communicating with counterparts on a daily basis is the most important aspect of communication in response to an accident, they gave priority to communicating via telephone over a security line. They also note that they refrained from connecting to head office because they were aware that, as a harmful attribute of video conferencing, having senior executives participating in crisis response communication might confuse discussion and debate, which, in turn, might lead to the wrong response priorities.[23]

According to the interview record conducted by the Government Accident Investigation Committee, Director Yoshida often complained about the constant inquiries and directives from the Tokyo head office, who were unable to accurately grasp the situation via the video conference system. Until the situation exceeded the capacity of the site, the Onagawa Nuclear Power Plant's crisis response involving the conservative use of communication via a security line helped to prevent confusion.

3. A review of logistics systems

The Fukushima Daiichi Nuclear Power Plant accident, which amounted to a logistical defeat, forced a revision not only of on-site but off-site support systems. After the accident, a regulatory shakeup took place with the Nuclear Safety and Safety Agency and the Nuclear Safety Commission being dismantled, and a highly independent Nuclear Regulation Authority established as an external agency of the Ministry of the Environment. The government's crisis management system was also revamped.

In the new post-accident crisis response system, the Nuclear Regulation Authority, together with the Nuclear Regulation Authority Secretariat, will concentrate on response support (on-site response) at the power plant where an accident occurs. On the other hand, because the Cabinet Office will coordinate with government as a whole including the relevant ministries and agencies, and carry out disaster response outside the nuclear power plant sites (offsite response) such as the evacuation of residents, a new secretariat heading by a minister for nuclear disaster prevention and a full-time policy director was established comprising some 50 full-time staff.

Up until the Fukushima Daiichi Nuclear Power Plant accident, an approach was emphasized of setting the target area for an Emergency Planning Zone (EPZ) at a radius of 8 to 10 km from a nuclear power plant. Following the accident, the need arose to draw up evacuation plans for considerably more municipalities and resident populations as the Urgent Protective Action Planning Zone (UPZ) was changed to a radius of 30 km from the nuclear power plant. Consequently, the policy director of the Cabinet Office, who is in charge of nuclear disaster preparedness, provides support for disaster prevention planning through discussions with each local government taking into account the characteristics of the nuclear power plants in their respective regions (number of reactor locations, geographical features, population distribution, years of operation, etc.).[24]

Additionally, mimicking the days of the Nuclear Safety and Security Agency, the secretary general of the Nuclear Emergency Response Headquarters, which is set up when an accident actually occurs,

[23] Visit to Onagawa Nuclear Power Plant (by author), November, 2015.
[24] Regarding the nuclear disaster prevention system after the Fukushima Daiichi Nuclear Power Plant, see chapter 1 on "Safety Regulations" written by Akihide Kugo.

was initially to be the secretary general of the Nuclear Regulation Authority, but was changed to the policy director of the Cabinet Office. Regarding this process, Tetsuya Yamamoto, who served as the policy director of the Cabinet Office (in charge of nuclear disaster management) at the time of the Fukushima Daiichi Nuclear Power Plant accident response, pointed out, "It's difficult for the Nuclear Regulation Authority and the Nuclear Regulatory Agency Secretariat to handle all the disaster prevention measures. There are various tasks that have to be performed not only on-site but also off-site. Even taking into consideration the power relationships in Kasumigaseki, it won't be easy for a single regulator like the Nuclear Regulation Authority and the Nuclear Regulatory Agency to coordinate comprehensively."[25] On-site response is a specialized field that requires knowledge of reactor characteristics and nuclear engineering at each power plant, while off-site response such as resident evacuation requires coordination with many ministries. Establishing a policy director in the Cabinet Office to newly assume the task of secretary general of the Nuclear Disaster Headquarters was aimed at speeding up coordination between ministries and agencies as well as strengthening the government's crisis response system so that it can be put into action immediately.

Support for the formulation of regional disaster management plans by the policy director has also shown some progress after the Fukushima Daiichi nuclear power plant accident. Yamamoto commented, "Before the accident, most local government disaster prevention plans were just copies of a template distributed by the government as reference material.[26] Regarding Fukushima Prefecture, the disaster prevention plans for the towns of Okuma and Futaba (where Fukushima Daiichi Nuclear Power Plant is located) were mere shams." Currently, based on the lessons learned from the Fukushima Daiichi Nuclear Power Plant accident, the scope of the evacuation plan has been expanded to a 30km area. Evacuation plans for relevant local governments, including securing evacuation destinations and preparing evacuation means for residents within 30 km, have been formulated for each region with a nuclear power plant. Specifically, the number of residents living within 30 km, especially the number of people needing special attention, is attained, securing transportation means such as welfare vehicles according to the condition of people requiring attention. For the general public, the basic plan is to evacuate via private vehicles, but the required number of evacuation vehicles such as buses is prepared in advance for those who do not have their own vehicle. As for evacuation destinations, facilities suitable for people requiring special attention and facilities for the general public are prepared outside the 30km area.[27] Regarding the evacuation of residents and the supply of goods, he explained, "the local bus association, truck association, and other local governments surrounding the nuclear power plant have individually signed agreements and are preparing a system of cooperation in an emergency."[28] In order to improve the future effectiveness of the agreement, he noted enthusiastically that "they will continue to ensure that the contents of the agreement are understood and constantly revised by having each of these industry groups participate in the comprehensive nuclear disaster preparedness drill conducted by the government to deepen their understanding of emergency response and to identify issues."[29]

There is no doubt that moves to improve information sharing and logistics systems in an emergency are active both within business and the government. However, looking at overseas efforts and trends following the Fukushima Daiichi nuclear accident may provide new suggestions on the actions Japan should take.

[25] Interview with Tetsuya Yamamoto, November 22, 2019.
[26] Ibid.
[27] Ibid.
[28] Ibid.
[29] Ibid.

4. "Worst Scenario": safety and security

Another issue to be considered is that the division of roles between the operators' voluntary emergency response units and relevant ministries, security authorities and the military (SDF) is not yet clearly defined in Japan. It is quite possible that in a nuclear accident, the condition will progress to a level beyond the control of the operator. When such a situation occurs, it is essential to determine in advance who will stop the accident from advancing. A "worst scenario" was, in fact, secretly created within the government over the Fukushima Daiichi Nuclear Power Plant accident. With the acquisition of this confidential material and the inclusion of its full text in the report, the Private Accident investigation became widely known.

The worst scenario was commissioned by Dr. Shunsuke Kondo, (then) chairman of the Atomic Energy Commission, while Naoto Kan's Cabinet was responding to the accident. Saying, "this expression [worst case] is not desirable since anticipating the worst case in a nuclear accident leads to another kind of worst case. Contingency scenario is more suitable"[30], Chairman Kondo made the title "Drawing up a contingency scenario for Fukushima Nuclear Power Plant". It consisted of fifteen PowerPoint slides, the date of submission to Cabinet being "March 25, 2011", two weeks after the accident took place.

The scenario was composed of six chapters including "assumed new event" and "emergency countermeasure range", and it is assumed that there was a possibility of a steam explosion due to core damage and that the concrete floor of the spent fuel pool would drop out. It warned that a chain of accidents would be triggered once a serious event occurred at a given unit, and pointed out if the spent fuel concrete dropped off and a large amount of radiation was emitted, all workers would have to be evacuated and regarding the range of evacuation range, "there was the possibility of requesting compulsory displacement in a radius of 170 km or more (from the Fukushima Daiichi Nuclear Power Plant) and voluntary relocation would have to be recognised in a radius of 250 km if the annual dose greatly exceeded the natural radiation level." In other words, it assumed that people would hardly be able to live in eastern Japan.

How should we deal with such a serious accident? In contrast to Japan, which at present has no provision for when the operators' capabilities are exceeded, other countries have two-stage provisions for cases of unexpected situations.

Bearing in mind the speed of development and the difficulty of convergence for nuclear accidents, FARN, which consists of nuclear power workers, is in charge of responding within 72 hours after the disaster, and if there is no prospect of accident convergence by that time, it is clearly decided that the response is to be taken over by Groupe INTRA, a company specializing in operating unmanned equipment, and the French Defense Forces.

Groupe INTRA is a special organization set up following the 1986 Chernobyl nuclear accident by the French nuclear power industry, Cogema, a company whose main business is uranium mining, and the then Commission for Atomic Energy (Commissariat à l'énergie atomique: CEA), which was involved in developing nuclear power for both military or commercial purposes, (now the French Alternative Energies and Atomic Energy Commission). It is a unit consisting mainly of remotely operated heavy machinery (excavators, bulldozers, etc.), disaster support robots, and drones, and it has striven for more than 30 years since its establishment to train operating staff, improve equipment performance, and develop new equipment. Originally, this unit was also supposed to be deployed on-site within 24 hours, and although since 2015 a division in roles has been created with FARN, should the scale of

[30] Interview with Shunsuke Kondô, November, 2016.

the accident be judged to be extensive, it is capable of being deployed immediately. Koichi Shiraishi, director of the Nuclear Emergency Situation Support Center in Mihama-cho, Fukui Prefecture, acknowledges their sophisticated disaster response, saying, "We have a lot to learn, having just started, and we have visited Groupe INTRA many times for training."[31]

There is also a large difference between Japan and other countries in preparations regarding the dose limit for workers handling accidents. Regarding the radiation exposure of workers involved in emergency work in the event of an accident, the International Commission on Radiological Protection (ICRP) gave countries 500mSv (millisievert) or 1000mSv as a "reference level" in 2007. It was recommended that these figures be used as dose limitation values, and in the case of lifesaving activities, "no dose limitation" was recommended. Based on these ICRP recommendations of 2007, Haruki Madarame, (then) chairman of the Nuclear Safety Commission, advised the Cabinet to "raise the worker exposure limit from 100 mSv to 500 mSv" during the Fukushima Daiichi Nuclear Power Plant accident[32]. However, government officials commented that raising the value to 500mSv might lower worker morale, eventually halving it to 250mSv. This number, which did not comply directly with the recommendations of international organizations and had ambiguous grounds, has been carried over as the dose limit for workers even after the Fukushima Daiichi Nuclear Power Plant accident. There has been little discussion in Japan about raising the dose or removing the dose limit for volunteers.

Prefacing his remarks with "the United States has stipulated that there is no dose limitation for volunteers", Goshi Hosono, former special advisor to the Prime Minister at the time of the accident, says "If we don't institutionalize as a preliminary preparation that there's no limit in the case of volunteers, we'll be in trouble if a serious accident happens again."[33] He is pointing to the fact that government, businesses, and the people are less resolved to using nuclear power than other countries. Alternatively, Japan may be becoming infused with a new safety myth that "there will be no more nuclear accidents that require the abolition of dose restrictions".

In fact, the specially raised dose limit of 250 mSv for accident response was abruptly abolished in December 2011 when the government deemed that the reactor had reached a stable cold shutdown. Part of the Ionizing Radiation Hazard Prevention Regulations was revised in preparation for a nuclear emergency making 250 mSv the upper limit, which was only enforced in April 2016, five years after the accident. Although the Ministry of the Environment's Unified Basic Data on Health Effects Due to Radiation (2015 Edition), which explains the revision of the regulation, shows the difference between the ICRP recommendation and Japan's upper limit in a table, the reason why Japan does not directly introduce the ICRP recommendation is not provided.

It is not just the government that secretly created a "worst scenario". One was also drawn up by the Self-Defense Forces. Within TEPCO, just as with the aforementioned "contingency scenario" drawn up by Chairman Kondo, it is said that they considered Fukushima Daichi personnel filling and shielding the spent fuel with slurry as it was possible that the spent fuel pool might break and water drain out, exposing the fuel and scattering a large amount of radiation. The fact that these scenarios and the process of drawing them up were not shared is also one factor in the lack of debate in Japan regarding how the SDF should be involved in a worst case scenario and the division of roles with electric power companies.

In the current Japanese situation, joint training between the SDF and electric power companies was

[31] Interview with Koichi Shiraishi, November, 2019.
[32] Interview with Haruki Madarame, March, 2016.
[33] Interview with Goshi Hosono, December 19, 2019.

finally implemented eight years after the Fukushima accident. Since cooperation with the Self-Defense Forces is indispensable for transporting relief supplies to a nuclear power plant by air or sea routes, the Nuclear Emergency Assistance Center proposed to the Cabinet Office the "implementation of nuclear disaster prevention drills including cooperation with the Self-Defense Forces". In the nuclear disaster preparedness training held by the government in November 2019, transportation of equipment and heavy equipment to the nuclear power plant was carried out by the SDF-owned transport helicopter Chinook CH47 and the transport ship *Shimokita*. Japanese nuclear power plants use seawater for cooling reactors, so they are all along the seaboard, and several places, such as the Onagawa Nuclear Power Plant (Miyagi Prefecture) located on the cliffs, assert "we should be looking seriously into transporting equipment and materials by sea" (Director Shiraishi).

By conducting joint training with the Self-Defense Forces, it is possible to learn small details. For example, when loading big heavy equipment into a large truck at the support center, the weight of the heavy equipment lowered the bumper, which caught on the slope leading to *Shimokita*, wasting time[34]. Accumulating such small lessons allows us to avoid situation where the standard of power supply cars was incompatible, complicating power recovery at the time of the Fukushima Daiichi Nuclear Power Plant accident.

Given these circumstances, government, business and support centers are proactive in clarifying the division of roles between the Self-Defense Forces, the fire department, and the police regarding accident response, Director Shiraishi saying, "we at the emergency support center have requested the Cabinet Office that disaster prevention drills include cooperation with the SDF in the menu every year."[35]

However, since training takes place once a year, it is difficult to improve crisis response capabilities through that alone. Yamato noted, "One way would be incorporating the simulation exercises the Self-Defense Forces routinely carry out and nuclear disaster prevention." If cooperation was deepened between each organization through training and simulated exercises, and frank discussion on preparations for the worst were held between operators, who respond to the accident, the related ministries, security authorities, the Self-Defense Forces, and even the U.S. Forces stationed in Japan, safety (safe operation of facilities) and security (security of facilities against external attack), which Japan is poor at, could be linked, thereby strengthening the safety of facilities. Casto claims that security awareness must be constantly updated in order to prepare for new threats such as cyber attacks. "[The loss of power, the loss of emergency diesel generators] that covers the last war, which was Fukushima, but what's the next war? And that's the imagination thing. I think the failure of imagination is one of your lessons learnt. So, what's the next big thing? Our judgement is black sky. Because of hacking and all that."[36]

5. Emergency response capabilities and logistics capabilities: France FARN and the Mihama Emergency Support Center

FRAN: the French approach

In order to improve accident response capabilities at a disaster site and ensure the supply of materials and equipment to the site, it is essential that electric power companies first take an overview of the Fukushima Daiichi Nuclear Power Plant accident and in the process of learning the lessons, continue self-help efforts. This section introduces the efforts started by France, a nuclear power country where

[34] Interview with Koichi Shiraishi, November, 2019.
[35] Interview with Koichi Shiraishi, November, 2019.
[36] Interview with Charles Casto, August 26, 2019.

the ratio of nuclear power in the power source mix exceeds 70%, from the lessons learned from the Fukushima Daiichi nuclear accident and the post-accident efforts of Japan at the time of the accident. It covers FARN and the Mihama Nuclear Emergency Support Center that have already been partially covered.

France established FARN as part of strengthening the initial response of electric power companies and it has been active since December 2015. Originally, the creation of a unit was proposed by France Electricity (Électricité de France: EDF) in 2011 as part of self-help efforts on the part of operators. Subsequently, three-way discussions were frequently held with the French Nuclear Safety Agency (Autorité de Sûreté Nucléaire: ASN), the regulatory body for nuclear power, and the French Institute for Radiation Protection and Nuclear Safety (Institut de Radioprotection et de Sûreté Nucléaire: IRSN), made up of nuclear experts, the decision being taken to make it a regulatory requirement in the newly revised safety standards following the Fukushima accident. ASN has a policy of developing new regulatory standards in three stages, and has set the following schedule to strengthen the safety of nuclear facilities.

- Phase 1 (Strengthening safety standards in nuclear facilities, 2011-2015): Reinforce facilities in accordance with their respective characteristics (years of operation, geographical factors, population distribution in the vicinity, etc.), put in place power supply vehicles, fire engines, maintenance of reservoir, etc.
- Phase 2 (Reinforcement of backup system, 2015-2020): In the event of an emergency at a nuclear facility, provide the necessary equipment within 24 hours and establish a system that can quickly bring the accident to a conclusion.
- Phase 3 (Residual risk measures unresolved in the previous phases, from 2020): Response to new threats to nuclear facilities such as cyber attacks and terrorism.

As one of the highlights of beginning Phase 2, FARN was established in December 2015 with headquarters in Paris, four local branch offices and a staff of 270[37].

With the exception of staff members with licenses for helicopters and large heavy equipment as well as a few branch managers who applied from the army, FARN is mainly comprised of engineers who previously worked for a long time at EDF and normally work at nuclear power plants while taking part in training. ASN's Dominique Martineau emphasizes, “We set up a Paris headquarters and four regional headquarters given the geography of the French territory and the distribution of nuclear facilities. We can put equipment and materials into any power station within 12 hours of an accident and be operational within 24 hours. The organization is under the operator’s control, and there aren’t any collisions between the organizations like the problem of command authority between the police and the fire department that you sometimes see in a normal disaster.”[38] As will be described later, there is, however, a mechanism for collaborating with the French Defense Forces in a nuclear emergency.

[37] Follow-up seminar at the Autorité de Sûreté Nucléaire, November, 2017. Paris.
[38] Ibid.

Photo 1: Large FARN vehicle (French Electric Power: EDF)

What kind of facilities does FARN have and what is the scale of its bases? Let us look at an overview of FARN's Paluel Regional Headquarters (Northern France) as an example.

The headquarters are on a site the area of 62,354 m2, with a building of 997 m2. The building alone cost more than 4 million euros (about 480 million yen). Main equipment includes a generator, a bulldozer/lifter attachment, a cooling water pump, a helicopter-landing pad as well as 10 generators of 100kW class as well as an emergency diesel generator. Transportation is not only by deploying large vehicles and helicopters but also by ships for flood damage[39]. A total of 70 people are divided into five 14-man teams, members coming from the five nuclear power plants located in northern France, and they are provided trained in areas such as debris removal in the event of a disaster and strive to improve capabilities in operating heavy equipment and large vehicles.

At the time of actual deploy, members gather at this FARN regional headquarters within one hour and don protective equipment such as Tyvek suits. The necessary equipment and materials are dispatched to the site within 2 hours and all equipment is brought to the power station within 12 hours. It is the job of the military police to provide an escort to the accident site at the power plant. If helicopter dispatch is required in order to be operational within the time limit specified above, helicopters from EDF subsidiaries or military helicopters will be used, but they will be under the control of the French Defense Forces.

Grégory Buzogany served as head of the Paluel Regional Headquarters for three years until 2018. After serving as a captain of a French Navy nuclear submarine for 15 years, he learned of FARN's founding concept, raised his hand for recruitment, and was involved in the organization from the start. "The important thing in crisis management is that, in the absence of a scenario, decisions are made by preparing multiple answers and conducting a case-by-case response. In particular, there can be many scenarios for how nuclear disaster progresses. I thought it was indispensable for French Armed Forces graduates, who are trained based on such multiple scenarios, to participate in FARN." Furthermore, standardization and equalization of equipment and training at the Paris headquarters and the four regional headquarters are essential for a swift response to an accident. For this reason, the general managers of the five bases meet every Wednesday at the Paris headquarters to promote

[39] Japan Atomic Industrial Forum, 2014.

standardization of equipment at each FARN base according to the two types of plants EDF has (900 MW class and 1300 MW)[40]. This standardization of equipment and training is based on experiences at the Fukushima Daiichi Nuclear Power Plant accident when it took time to restore the power supply because the specifications of the power supply vehicles that arrived at the scene were not compatible.

Logistics tend to be interpreted as a backup system, but as we defined in this chapter's introduction, self-sufficiency and local procurement are also important factors for improving logistics capabilities. Not only EDF, but also those involved in the regulatory body are aware of the importance of training the nuclear power plant personnel and improving their ability to operate the equipment and materials necessary for accident response. French nuclear power parties take the fact very seriously that because subcontractors were in charge of operating fire engines and heavy equipment during the Fukushima Daiichi nuclear accident, TEPCO could not demand work under a high dose that was not covered by their contracts[41].

The Nuclear Emergency Support Center (Mihama, Fukui Prefecture) approach

There is also an organization in Japan established as part of the self-help efforts of the electric power companies. This is the Nuclear Emergency Support Center based in the town of Mihama in Fukui Prefecture, where Kansai Electric Power has a nuclear power plant. It consists of 21 members mostly seconded from the Japan Nuclear Power Company, a nuclear power company specializing in nuclear power plants funded by Japan's nine Japanese electric power companies, excluding Okinawa Electric Power, which does not have nuclear power generation. It has a total of 2 tons of equipment necessary for a disaster including a total of 8 small and medium-sized robots, 3 large and small shovel cars, 2 drones for dose measurement and on-site filming, protective clothing, masks, dosimeters and batteries, and emergency food. It has a total of 10 trucks, including large trucks for transporting heavy equipment, and electric power company staff who do not have a large-vehicle license cannot be seconded as staff to the Emergency Support Center even if they so wish.

Photo 2: Unmanned heavy equipment training at the Nuclear Emergency Support Center (photographed by the author, November 2019)

Even although the necessary equipment and materials were delivered close to the site of the power plant at the time of the Fukushima Daiichi Nuclear Power Plant accident, there were many incidences where drivers refused to transport it because the high radiation dose and debris made it physically

[40] Ibid.
[41] Interview with Philippe Jamet, May, 2019.

impossible to move it from there to the power plant. Based on regret about this, electric power company staff now obtain large-vehicle driver's licenses to prepare for an emergency. Furthermore, in order to ensure the transportation of materials and equipment to the disaster site, the Center said, "We only employ staff who have pledged to perform their duties up to the dose limit of 250 mSv applicable in emergencies, and have that written into their contracts." (Director Shiraishi)[42]. In addition, in order to secure three or more transportation routes for each nuclear power plant by simulating transportation routes to the site, they are working to secure access in an emergency by visiting multiple nuclear power plants with a large truck owned by the Center. Compared to before the Fukushima Daiichi Nuclear Power Plant accident, it seems that the awareness and system of delivering materials and equipment to the nuclear power plant no matter what has been strengthened, but compared to the case overseas, there are still issues that need to be itemized further as later described.

There is no point in conducting training for just the small number of Center staff, and unless there is an increase at each nuclear power plant in staff familiarity with the operation of robots and heavy equipment, it will not serve any use in the event of an accident. Accordingly, some 100 employees from each company's nuclear power plant visit for training each year. In the two days of initial training, they learn the basic operation of equipment such as heavy equipment and robots, and in a further two days of consolidation training, they perform highly difficult operations such as working in total darkness assuming the loss of all power. This is still not enough, however, so the Center prepares applied training such as operations on a debris-filled site. Nevertheless, Director Shiraishi confesses that there is a difference in intensity between the electric power companies when participating in applied training. Chubu Electric Power's Hamaoka Nuclear Power Plant, which is located in an area where Tokai and Nankai Trough earthquakes are predicted, is enthusiastic, proposing its own menu for applied training, and regularly dispatching staff to the Emergency Support Center.[43]

Points to learn from overseas efforts

Comparing France's FARN and Japan's Nuclear Emergency Support Center, which were given as examples of strengthening emergency response capabilities and practical logistics capabilities in the event of an accident, differences can be seen in the views of the regulatory body and its relationship with the electric power companies, which provide important suggestions when thinking about crisis management.

As you can see at a glance, FARN in France has a five-headquarters system, whereas Japan has only one nuclear emergency support center in Mihama, Fukui Prefecture. The Hokkaido Tomari Nuclear Power Plant, which is the farthest location from Fukui Prefecture, would take 31 hours at the quickest to replenish supplies. In the Fukushima Daiichi Nuclear Power Plant accident, a hydrogen explosion occurred in the Unit 1 building about 24 hours after the tsunami hit. Once a reactor is out of control, the accident progresses faster than you can imagine. Director Shiraishi admits to this weak point, "At the time of establishment, it was planned to have three sites in Japan, but we are initially working to improve the effectiveness of Mihama's Support Center and then increase the number of bases." FARN assigns a nuclear facility to the jurisdiction of each of the five bases under the ironclad rule of "arrival on site within 12 hours".

This difference comes from the outlook of the regulatory bodies in the two countries. Out of regret for the Fukushima Daiichi Nuclear Power Plant accident, Japan obliges each nuclear power plant to "prepare equipment that can withstand seven days during an accident, including emergency power supplies and heavy machinery", making this one of its regulatory requirements. The Nuclear

[42] Inspection of the Nuclear Emergency Support Center. Japan, November, 2019.
[43] Interview with Koichi Shiraishi, November, 2019.

Regulation Authority clearly stated in an official document that "the primary responsibility for an accident should be the operator's responsibility", and it can be said that this idea has been thoroughly implemented. France and the United States are concerned about terrorism and are wary of different natural disasters (mainly tornadoes) than Japan, and they fear that if heavy equipment and equipment were concentrated at a nuclear power plant, they could be misused by terrorists or wiped out by tornadoes, so the tendency is to distribute deployment bases outside nuclear power plants.

Since the types of natural disasters that need to be guarded for and the possibility of terrorism differ from country to country, it is not possible to unambiguously determine which country's regulatory body has the right mindset. However, the Japanese-style risk of concentrating disaster prevention equipment at nuclear power plants should be taken into consideration. Based on this point, Director Shiraishi suggests they should consider methods like, "In the event of an emergency at Tomari Nuclear Power Plant, for example, in addition to the equipment that the nuclear power plant itself has, it could be dealt with through an inter-operator agreement with Tohoku Electric Power Co., which is geographically closer."

Many business operator agreements have been concluded among other electric power companies as part of strengthening disaster prevention systems. For example, four electric power companies including Kansai Electric Power signed a mutual cooperation agreement in the event of a disaster in August 2018 with the Maizuru District Headquarters of the Maritime Self-Defense Force. According to the press release distributed by KEPCO, it assumes mainly sharing of personnel, goods and transportation means during crisis response, citing that effectiveness will be improved through training.[44] Similar to the Nuclear Emergency Support Center, agreements between operators limit the "completion of duties up to the dose limit of 250 mSv applicable in emergencies", and assume that nuclear power plant staff acting as disaster prevention personnel will respond. However, questions still remain as to whether this standard can really be applied in supporting facilities at another operator, and might not disaster prevention staff refuse to transport goods or work on-site because "I don't want to put my life on the line dealing with another operator's nuclear accident". Issues such as whether workers can be dispatched to a different nuclear power plant to the one they belong to and what to do if a business order is rejected are being discussed overseas, but they are not easily overcome. For example, the FARN headquarters are based on a system of five 14-man teams for each nuclear power plant because they fully understand the difficulty of accommodating personnel in the event of a nuclear disaster, and it will be difficult to establish a backup system for the supply of goods even in Japan unless the above issues are faced.

Self-help efforts and regulatory requirements

The second difference is that FARN is a regulatory requirement, while the Emergency Support Center is not. In other words, it is not obligatory for NRA staff to monitor and check the effectiveness of training and centers. In France, FARN training is also a regulatory requirement, and ASN checks the training and, if it deemed that there is no capability of reaching each nuclear power plant within 12 hours, it instructs EDF to improve. If the improvement measures are deemed to be insufficient, the nuclear power plant under the jurisdiction of the local office may be suspended.

In 2006, France separated its regulatory body from the Nuclear Energy Agency (Ministry of Economy) in accordance with the Act on Ensuring Independence and Transparency Regarding Nuclear Safety Regulations. As for current regulations, ASN, which is in charge of inspection work, is advised by IRSN, which comprises a group of experts, and gives priority to "discussing better regulation through public dialogue between the three organizations including EDF" (ASN). In fact, FARN itself was initially part of the self-help efforts of businesses, but became a regulatory

[44] KEPCO Press release, 2018.

requirement through discussion by the three parties.

Regarding the voluntary training of nuclear power companies, the importance of "rigorously checking and discussing with business operators" is being recognized by Japan's regulatory bodies. Yamamoto emphasizes, "In the disaster prevention drills conducted by operators, the training results are reported by all of the operators and discussed with each electric power company on points for improvement."[45] Today, ten years on from the earthquake, it is becoming increasingly important for operators and regulatory bodies to hold public discussions in order to further strengthen nuclear safety.

6. Issues involved with a "Japanese version of FEMA"

Following the Fukushima Daiichi nuclear accident, it has often been suggested regarding the clarification of the division of roles for each organization that is indispensable in dealing with contingencies and strengthening on-site and off-site cooperation, that the U.S. Federal Emergency Management Agency (FEMA) approach be introduced to Japan. The Private Accident Investigation proposes, "In the case of a severe nuclear accident, the responsibility of the state and the role of the corresponding execution unit should be clearly defined in the legal system. We should aim to create in the future a full-fledged execution unit for severe disasters and accidents comparable to the U.S. Federal Emergency Management Agency (FEMA)."[46]

The Fukushima nuclear accident was a compound disaster comprising natural disaster and nuclear accident, which greatly exceeded the response capabilities of the operator and local government. In addition, the national response also spanned many ministries and agencies, so coordination was time-consuming and prompt measures could not be implemented. Contriteness from this saw the opinion put forward that "a ministry specialized in disaster response should be established using the U.S. FEMA as a model" not only by disaster experts but also by the Diet[47].

Yasuo Sato, a former Tokyo Fire Department Police Department chief, asserted, "I think we should probably create an organization along the lines of FEMA under the prime minster that can establish a quick response task force that can be deployed nationwide, train for large-scale disasters, bring disaster related information together in an emergency and coordinate all the first responders. Currently, each municipality is supposed to collect disaster information, but the more an area is hit by a disaster, the greater the damage. We need to ready some other forces for the Prime Minister, not just the SDF. There's no central government agency with proper staff at present that can support disaster prevention measures, and no government agency that can comprehensively plan disaster countermeasures and control production units". [48] In addition to the Self-Defense Forces, he emphasized the need to maintain at the government level the creation of disaster response units that can be directly commanded by the Prime Minister.

However, not a few of the "build a Japanese FEMA" arguments are based on inaccurate understanding of FEMA's organizational structure and the nature of U.S. and Japanese government administration. Not only is it a misconception that FEMA is in charge of all ministries and agencies involved in disaster response, but the command of disaster response in the United States is legally authorized by local government, FEMA's main institutional duty being coordination and advise. On the other hand, FEMA sceptics often voice the opinion that "it doesn't fit the vertically

[45] Interview with Tetsuya Yamamoto, November 22, 2019.
[46] Independent Investigation Commission on the Fukushima Daiichi Nuclear Accident, 2012.)
[47] House of Representatives, Japan, 2014.
[48] Interview with Yasuo Satô, October 8, 2019.

compartmentalized organization of Japan's government", but this counterargument is also not convincing. The adverse effects of a vertically divided administration are not unique to Japan, but are also common in the United States and Europe. In particular, any organization whose mission is survival and the preservation of life, such as national defense, security, and emergency response, tends to become a vertically divided administration if only because of its "familial" organizational culture. Discussions and organizational reforms have been undertaken by all countries in order to overcome this and achieve prompt response.

Therefore, even if an organization such as FEMA was established without giving due consideration to Japan's governance system, it is unlikely that disaster response would be dramatically improved. Rather, highlighting how FEMA clarifies the jurisdiction of disaster response work, and knowing exactly how the federal government, the states, and local governments strengthen cooperation would be a first step in extracting lessons for Japan.

FEMA outline

FEMA is a disaster response organization founded in 1979, coming under the jurisdiction of the Department of Homeland Security, which was established in November of the year following the terrorist attacks of September 2001. In order to deal with ever-changing threats, emphasis is placed on natural disasters, attempts to improve response capabilities for terrorist attacks, and changes have been made in its authority and personnel.

One of FEMA's characteristics is that the law stipulates that the FEMA Commissioner shall act as the president's representative in all emergency situations. In addition, for disaster response across multiple departments, emergency support functions (ESF) are classified into 15 categories that are carried out by principal departments (P), support ministries (S), and coordinating bodies (C) (see Figure 1)[49].

	USDA	Forestry	DOD	Military Engineers	DOE	DHSS	DHS	Cybersecurity Communications Agency	FEMA	Coast Guard	FEMA Fire Dept	DOI	National Park Service	Office of Alcohol, Tobacco, Firearms & Explosives Control	DOT	EPA	GPA	Red Cross
Transportation	S		S		S		S					S			CP		S	
Telecommunications	S		S				S	CP	P			S					S	
Civil engineering	S		S	CP	S	S	S					S			S	S	S	
Fire fighting		CP	S							S	CS	S				S		
Information/Planning									CP									
Victim response	S		S	S		S	S		CP			S			S		S	PS
Logistics	S		S	S	S	S			CP			S			S		CP	S
Health & hygiene	S		S		S	CP	S					S			S	S	S	S
Search & rescue	S		PS			S	S		CP	P		S	P		S			
Oil & poisons	S		S		S	S	S			P		S			S	CP	S	
Agriculture & nature	CP		S		S	S	S					P			S	S	S	S
Energy	S		S		CP		S					S			S	S		
Public safety			S				S					S		CP				
Shift to NDFR																		
External							C		P									

Figure 1: The main areas of ESF & division of governmental roles in the U.S. (compiled by the author with reference to *The possibilities and the Points for the Construction of the 'Japanese FEMA': Recommendations on Disaster Response for the National Government and Local Governments*)

At first glance, it is clear that it is unrealistic to consolidate all of the work into one organization as there are many major areas of emergency response alone.

FEMA specializes in six of the 15 major tasks: communications, information/planning, disaster victim response, logistics, search and rescue, and public relations, which are especially important in the initial stage. The remaining nine tasks are carried out after coordination with departments and agencies. If coordination between departments and agencies proves difficult for these nine tasks, the FEMA Administrator directs the final coordination.

[49] Sashida et al., 2014, pp. 9–12.

However, even if the FEMA Administrator directs all disasters, departments with specialized knowledge take the lead in responding to highly specialized cases such as nuclear/radioactive accidents, cyber accidents, terrorism and pandemics, FEMA being responsible for the evacuation of residents and logistics.[50]

There are two points to keep in mind when studying U.S. crisis management and FEMA functions. One is that the top (mayor) of the basic municipality affected by the disaster centrally manages the disaster response. State government employees and federal FEMA support units are under the command of the mayor, so the initial response will be greatly affected if government offices or disaster response bases in the basic municipality sustain damage as was the case in the Great East Japan Earthquake. The United States is aware of this, and in fact, there was fierce debate among experts concerning the fact that in the 2005 Hurricane Katrina disaster, both the New Orleans City Hall and the alternative base were destroyed by storm surges making an initial response impossible.[51]

The other point is that FEMA is a competent organization with working units for the aforementioned six specialized tasks. It is a huge government office with more than 7,600 full-time employees, having personnel with qualifications and licenses required for communications, civil engineering, and emergency response. The number of part-time staff mobilized during a disaster exceeds 10,000. It has ten regional bases in the United States, and has a system in place to immediately support an affected local government. A common practice in the United States, the delegation of task authority in the event of a disaster has been decided in advance by law or regulation, and the person in charge of local bases can make a prompt decision on the spot without permission over loading the equipment necessary for initial operations and the number of people to mobilize, for example. During normal times, employees are dispatched from local bases to state and basic municipalities for education and training. Employment in the United States takes the form of hiring by job type, and since experts with specialized knowledge are assigned to disaster response departments at the basic municipalities, the effectiveness of training is likely to increase. It conducts training and concludes disaster agreements in cooperation with local companies and NPOs.[52]

Possibility of a 'Japanese FEMA'

What should Japan learn from understanding the current status of FEMA and the clarification of jurisdictions over disaster response in the United States?

Measures have been implemented in Japan also to improve the effectiveness of crisis management following the Great East Japan Earthquake of 2011. Regarding nuclear accidents, the Nuclear Regulation Authority has jurisdiction over the on-site response, and the Cabinet Office is responsible for off-site response such as resident evacuation. The Cabinet Office, which reports directly to the Cabinet and is independent of other ministries and agencies in charge of specific fields and industries, is characterized by its ability to exert power as a coordinating body when cooperation between ministries and agencies is required. In addition, the Cabinet Office discusses the allocation of tasks under each jurisdiction, and stipulates the division of tasks under the jurisdiction of each ministry in the event of a nuclear disaster, as in the United States.[53]

However, the Cabinet Office does not specialize in matters of initial response that are particularly important in disaster response, nor does it have a working unit. In Japan, each ministry and prefecture

[50] FEMA Website: http://www.fema.gov/
[51] Comfort et al., 2010, pp.42–51.
[52] Mutai et al., 2013.
[53] Cabinet Office, Government of Japan, 2014.

has jurisdiction over actual working units, and they are dispatched at the instruction and request of the Prime Minister, the minister in charge, and the prefectural governor. The Ministry of Defense has jurisdiction over the Self-Defense Force, and each municipality and prefecture is in charge of fire fighting and police. Examples of actual work units specialized in more specialist fields are the Ministry of Land, Infrastructure, Transport and Tourism's TEC-FORCE (Emergency Disaster Response Dispatch Unit), which handles the restoration of national roads, and the Ministry of Health, Labor and Welfare's DMAT (Disaster Medical Assistance Team), which provides emergency and medical care.

TEC-FORCE was founded in April 2008. It comprises 12,654 members nationwide, mainly technical staff at the Ministry of Land, Infrastructure, Transport and Tourism and its regional development bureaus, which are the Ministry's regional outposts. In addition to damage investigation and restoration of national roads in the event of a disaster, ten regional development bureaus throughout the country dispatch members to the emergency response headquarters of disaster-affected local governments to provide advice. Since its establishment, it has dispatched a total of more than 100,000 members in response to 106 disasters including the 2011 Great East Japan Earthquake and the heavy rains of July 2018.[54]

DMAT is defined as a "a medical team trained in mobility capable of working in the event of a disaster" and consists of 9,000 doctors, nurses and work coordinators (medical and non-nurse medical staff and clerical staff) nationwide. "Having mobility" means having the ability to operate within approximately 48 hours at the scene of a large-scale disaster or accident involving multiple injured persons. It was launched in April 2005 after it was pointed out that there were 500 cases where lives could have been saved if emergency medical services had been available at the time of the Great Hanshin-Awaji Earthquake in 1995.[55]

Following the Great Hanshin-Awaji Earthquake, there were many cases where organizations were reorganized with the aim of strengthening response in the event of a widespread disaster. The fire department, dubbed a "first responder" for disaster response along with the Self-Defense Force, newly established an Emergency Fire Support Corps, and the police established a Wide Area Emergency Relief Corps.[56]

As far as nuclear disaster prevention is concerned, it is rare at present for all task forces including the police, fire department and the Self-Defense Force to participate in the comprehensive disaster prevention drill organized by the government once a year. As pointed out earlier, the SDF officially began to participate in nuclear disaster preparedness training only from 2019. Irrespective of whether working units excluding security organizations and the SDF such as TEC-FORCE and DMAT are to be integrated in FEMA-like fashion or not, it is clear that training should be enhanced to improve cooperation.

It is also necessary to examine FEMA's efforts in analyzing disaster response and revising important items in tune with the times, both in terms of success and failure.

It is difficult to discriminate between on-site and off-site responses regarding the topic broached by this chapter of "supplying materials to a nuclear power plant that has had an accident". In fact, if

[54] Ministry of Land, Infrastructure, Transport and Tourism Homepage: http://www.mlit.go.jp/river/bousai/pch-tec/index.html (In Japanese.)
[55] Japan Disaster Medical Assistance Team Homepage: http://www.dmat.jp/ (In Japanese.)
[56] For organizational reforms of the police and fire department, see chapter 4 on first responders written by Kôichi Isobe.

cooperation agreements between operators are not adequate, the SDF, police, and fire fighters will have to be responsible for supplying materials. Even in the case of the Fukushima Daiichi Nuclear Power Plant accident, power supply vehicles and fire engines could not be supplied just by exchanging information between operators, and the SDF and fire department brought them in. Self-Defense Force personnel, police, and fire department personnel all participated also in the task of on-site water discharge. Following the accident, progress has been made in clarifying the division of roles with the Nuclear Regulation Authority being assigned on-site and the Cabinet Office off-site, but who is responsible for tasks that fall somewhere in between on-site and off-site such as providing materials to nuclear facilities? This is a point that can be learned from the U.S. case, which has identified issues from experience and disaster training, and has clarified the division of roles of each department centering around FEMA.

On the other hand, it should be noted that there are cases where the lessons learned from disasters have been oversimplified, and are thought to have had an impact on later emergency response. In 2005, when the failure in the initial response to Hurricane Katrina wreaked terrible damage in New Orleans, it was pointed out that after the 2001 terrorist attacks, personnel at the Department of Homeland Security, which is in charge of FEMA, had an over tendency to assign experts on terrorism and had become unfamiliar with natural disaster responses[57]. What should be gleaned as a lesson from disasters is always a difficult task not just for Japan. In 2020, a lack of infectious disease control became clear as the new corona virus spread around the world. The lessons from this are also a difficult issue.

Comparing Japan's present situation with that in other countries, a more serious issue than the compartmentalization of administrative tasks in the central ministries is that, except for some local governments, the number of staff with specialized knowledge who have learned resilience and crisis management at graduate school, is small and the ability to prepare and respond to disasters is inadequate. If this point is overlooked, it is doubtful how effective disaster response will be even if central government administrative tasks are clarified. In the United States, the local government has the authority to control disasters, and the FEMA support team is under the command of the mayor. As with the United States, Germany has also transferred control of emergency response except for war to basic municipalities[58]. In France, which is said to be more strongly centralistic among the democracies, basic action is conducted by the basic municipality, and depending on the level of disaster, it has adopted a mechanism in which commanding power ascends to the prefecture, the region (France divides the whole country into 13 regions), or the state.[59]

In Japan's legal system for crisis management, it is customary for the national government to have overall command with "directive authority" and "total regulatory authority" when responding to disasters even though under the Basic Act on Disaster Management authority is distributed among both national and local governments. Even when dealing with the novel coronavirus, there was a scene in which the governor and the mayor, who were both trying to respond to the local situation, conflicted with the national government regarding the interpretation of the law (the Act on Special Measures for Pandemic Influenza and New Infectious Diseases Preparedness and Response). The national government also provides guidance to prefectures and local governments in preparing disaster prevention plans, and the nuclear disaster prevention plans have been drawn up in a process where the state, which has command of disaster prevention but no knowledge of the actual situation in local areas, sends a template to local governments that know the local areas well but have little expertise in disaster prevention. It has been pointed out that this composition has not changed

[57] Sashida et al., 2014.
[58] Ministry of Land, Infrastructure, Transport and Tourism, 2012.
[59] Cabinet Office, Government of Japan, 2014.

significantly since the Fukushima Daiichi nuclear accident. Regarding the regional disaster prevention plan (nuclear disaster prevention measures) newly formulated after the accident, Muneyuki Shindo, Professor Emeritus of Chiba University, commented ironically, "The composition is almost identical regardless of which municipal plan you look at."[60]

This difference with the U.S. and Europe can be attributed to the fact that the U.S. and Europe basically hire professionals, whereas Japan practices general hiring, which derives from the tendency to transfer employees regularly every two to three years to handle a broad range of jobs and build up a certain amount of expertise[61]. This will be difficult to change overnight because human resource systems are deeply connected not only to workstyles but also to the very nature of society.

Against such a backdrop, the government has concluded after due deliberation that there is no need to review the establishment of an organization along the lines of FEMA. Under the current administration's stance, immediately after a disaster, members of the emergency assembly team from the relevant ministries and agencies will immediately gather under the supervision of the Cabinet's crisis management to take initial action, and with the establishment of a Government Response Headquarters, the Cabinet Office Disaster Prevention (in the case of nuclear disaster, the Cabinet Office Nuclear Disaster Prevention) will take the initiative. Their view is that it is realistic to accumulate training and make steady improvements under the current system.

Idealizing overseas cases should be avoided whether for a corporate organization or a ministerial organization.

When preparing for the worst, differences in the environment surrounding nuclear energy between Europe and Japan must be considered, especially the difference in the impact of the 1986 Chernobyl accident. The countries of Continental Europe, which were directly affected by the accident through the arrival of radioactive material, improved their emergency response systems considerably after the accident, witness the creation of the French Groupe INTRA. What Japan has to learn from Groupe INTRA is not so much improving the domestic production and operation capabilities of disaster support robots, but more clarifying roles concerning how to prevent the spread of an accident and who will prevent the spread of an accident if a reactor goes out of control. It should not be forgotten that in the Fukushima Daiichi Nuclear Power Plant accident, if just one more piece of bad luck had occurred, a catastrophe where Metropolitan Tokyo was no longer be liveable would have taken place.

Additionally, the Fukushima Daiichi Nuclear Power Plant accident was a complex disaster in which earthquakes, tsunami and reactor abnormalities overlapped, and in the process of responding to the nuclear disaster, which required specialist knowledge, and the natural disaster, which required mobility, the division of roles among the ministries and agencies became confused. As a lesson to be learned from this, the Private Accident Investigation recommended that "we should aim at establishing a full-scale execution unit for severe disasters and accidents comparable to FEMA", but without improving the disaster response capabilities of local governments and redefining the division of roles between central government agencies, businesses and local governments, it is unlikely that disaster response capabilities can be expected to improve.

7. Summary

In this chapter, we compared efforts in Japan and overseas following the Fukushima Daiichi Nuclear

[60] Shindô, 2017, p.153.
[61] Sashida et al., 2014.

Power Plant accident in terms of logistics, that is, how to quickly supply the necessary materials and equipment to the disaster site in order to respond to a nuclear accident. Each country has reviewed its nuclear safety regulations, and electric power companies have also established voluntary emergency response units. FARN in France and the Nuclear Emergency Assistance Center in Japan are part of this, and compared to the time of the Fukushima accident, preparedness for emergencies, especially logistics capabilities, has been strengthened.

However, in order for such voluntary response units to improve their effectiveness, excessive subdivision and manualization of tasks in the nuclear industry must be avoided. In the Fukushima Daiichi Nuclear Power Plant accident, such excessive manualization hindered the response to "a situation that exceeded expectations", and due to a failure in information sharing, it was not possible to transport materials and equipment efficiently. Electric power companies are confident that they have improved their ability to respond to emergencies by reorganizing and revamping training methods, but there are still many points that Japan should learn in comparison with overseas efforts.

First, regulatory bodies and electric power companies need to discuss in a transparent setting with a view to strengthening safety regulations. FARN was initially part of the self-help efforts of electric power companies, but it became a regulatory requirement as a result of public discussions with regulatory agencies and experts.

Furthermore, in order to improve response capabilities in emergencies, it is also necessary to envision "unexpected scenarios" and clarify the division of roles for the business operator and related ministries. After the Fukushima Daiichi nuclear power plant accident, the Nuclear Regulatory Agency was placed in charge of on-site response, and the Cabinet Office in charge of off-site response, but this is not enough. In the case of a compound accident, since the response will cover many ministries and agencies, the division of roles must constantly be discussed through training and simulation exercises.

Lastly, it was revealed during our examination of "Building a Japanese FEMA" that, except for some local governments, there are few staff who have gained disaster prevention knowledge at graduate school. Even if the state directs the disaster response, the presence or absence of expertise in the local government at the disaster site has a great effect on the response.

Ten years have passed since the Fukushima Daiichi Nuclear Power Plant accident, but there are still matters to be weighed in improving emergency response and logistics.

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