The Fukushima Nuclear Accident and Crisis Management

— Lessons for Japan-U.S. Alliance Cooperation —

September, 2012

The Sasakawa Peace Foundation

Foreword

This report is the culmination of a research project titled ”Assessment: Japan-US Response to the Fukushima Crisis,” which the Sasakawa Peace Foundation launched in July 2011.

The accident at the Fukushima Daiichi Nuclear Power Plant that resulted from the Great East Japan Earthquake of March 11, 2011, involved the dispersion and spread of radioactive materials, and thus from both the political and economic perspectives, the accident became not only an issue for Japan itself but also an issue requiring international crisis management. Because nuclear plants can become the target of nuclear terrorism, problems related to such facilities are directly connected to security issues. However, the policymaking of the Japanese government and Japan-US coordination in response to the Fukushima crisis was not implemented smoothly.

This research project was premised upon the belief that it is extremely important for the future of the Japan-US relationship to draw lessons from the recent crisis and use that to deepen bilateral cooperation. The objective of this project was thus to review and analyze the lessons that can be drawn from US and Japanese responses to the accident at the Fukushima Daiichi Nuclear Power Plant, and on the basis of these assessments, to contribute to enhancing the Japan-US alliance's nuclear crisis management capabilities, including its ability to respond to nuclear terrorism. At the same time, the project sought to offer proposals that would contribute to enhancing the capacity of the crisis management system in the Asia Pacific region in the future.

At the core of the project was a study group comprised of the five security and nuclear power experts listed below. The group met more than 10 times, and through those meetings as well as through trips to the United States and numerous interviews with relevant actors in the United States and Japan, they reviewed, assessed, and analyzed each country's prior assumptions, preparations, and responses, as well as their policymaking mechanisms.

In carrying out this project, the research team received the unsparing cooperation and advice of many practitioners and researchers in both Japan and the United States. This was based on the shared sincere hope that the lessons of the Great East Japan Earthquake, which took so many lives, and of the subsequent accident at the Fukushima Daiichi Nuclear Power Plant, would not be wasted. We would like to take this opportunity to express our deep gratitude for their kindness and cooperation. At the same time, we would like to offer our heartfelt condolences to all those who lost loved ones, and to those victims who are continuing to face significant hardships as a result of the Great East Japan Earthquake.

The Sasakawa Peace Foundation

Project Members

Nobumasa AKIYAMA, Acting Project Team Chair; Professor, Graduate School of Law, Hitotsubashi University *(Introduction, Chapter 6, and Afterword)*

Heigo SATO, Professor, Institute of World Studies, Takushoku University *(Introduction, Chapter3, and Afterword)*

Kaoru NAITO, President, Nuclear Material Control Center *(Chapter 4)*

Yosuke NAOI, Deputy Director, Integrated Support Center for Nuclear Nonproliferation and Nuclear Security, Japan Atomic Energy Agency *(Chapter 5)*

Tadahiro KATSUTA, Associate Professor, School of Law, Meiji University *(Chapter 1 and 2)*

Note: This project was a self-initiated research project conducted by the Sasakawa Peace Foundation's Japan-US Exchange Program. The contents of this report, however, are the opinion of the study group members and do not reflect the opinions of the Sasakawa Peace Foundation, nor do they reflect the opinions of the experts who kindly participated in interviews or meetings during the course of the project.

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Frequently Used Abbreviations

BWR	boiling water reactor
CTBTO	Comprehensive Test Ban Treaty Organization
DPJ	Democratic Party of Japan
ERC	Emergency Response Center (METI)
IAEA	International Atomic Energy Agency
IC	isolation condenser
JAEA	Japan Atomic Energy Agency
INES	International Nuclear and Radiological Event Scale
MAFF	Ministry of Agriculture, Forestry and Fisheries
METI	Ministry of Economy, Trade and Industry
MEXT	Ministry of Education, Culture, Sports, Science & Technology
MHLW	Ministry of Health, Labour and Welfare
MOFA	Ministry of Foreign Affairs
NGSI	Next Generation Safeguards Initiative
NISA	Nuclear and Industrial Safety Agency
NRC	(US) Nuclear Regulatory Commission
NSC	(Japan) Nuclear Safety Commission
NSWG	Japan-US Nuclear Security Working Group
RCIC	reactor core isolation cooling system
SDF	Self-Defense Forces
SPEEDI	System for Prediction of Environmental Emergency Dose Information
TEPCO	Tokyo Electric Power Company
WINS	World Institute for Nuclear Security

Introduction

The immediate cause of the March 2011 accident at the Fukushima nuclear power plant was the melting of the reactor cores and the hydrogen explosions that occurred after the tsunami knocked out all of the plant's electrical supply. In response to this major accident, all relevant actors including the Tokyo Electric Power Co. (TEPCO) and the government authorities have devoted their full energies to cooling the nuclear reactor, receiving cooperation from the United States and France in the process, and currently the situation is calming down. However, there is still a great deal to be done before the reactors can be decommissioned, and with many obstacles still to overcome, the outcome remains unpredictable.

Nuclear power generation is a system in which electricity is generated using the enormous energy created through the nuclear fission of uranium fuel. The enormous energy from nuclear fission was first utilized practically for the atomic bombs in 1945. Then, technology was first used for generating electricity in 1951 in an experimental breeder reactor (EBR-1). The world's first functioning nuclear power plant was the Obninsk power plant, which began operating in 1954 in what was then the Soviet Union.

Subsequently, nuclear power plants were commissioned in England in 1956 and in the United States in 1957. In Japan, the first commercial nuclear reactor went online in 1966 at the Tokai Power Station. In part influenced by the first oil crisis that struck the international community in 1974, the introduction of nuclear power proceeded at a rapid pace from the mid-1970s, as industrialized nations became increasingly concerned about the instability of fossil fuel supplies, but from the mid-1980s on, the growth of nuclear energy seemed to stagnate. Recently, however, with the rapid economic growth in newly emerging nations, there has been a noticeable upturn in the construction of nuclear power plants.

During this time, there have been three major accidents at nuclear power plants worldwide. The first occurred in the United States in March 1979 at the Three Mile Island nuclear power plant. The incident occurred when the reactor's main feedwater pumps, valves, and other equipment failed, and the operators mistakenly shut down the emergency core cooling device. That led to a loss of water in the core container, thereby damaging the fuel. However, because the plant's system for containing the release of radioactive materials was operational, only a minimal amount of radioactivity was released and there was no significant impact on the surrounding region. The proximate cause of this accident was said to be the operators' lack of knowledge, training, and regulations, and after reflecting deeply on this incident, the United States implemented broad-ranging reforms.

The second accident was Chernobyl. It occurred in April 1986, at a time when the reactor had been shut down and a test was being implemented to determine whether backup generators would be operational in the case of an external power failure. The plant was operating at low power levels over an extended period of time, which was prohibited, and when the tests began, almost all of the control rods had been extracted. They then attempted to reinsert the control rods all at once (probably because the power output spiked), which resulted in a nuclear burst that ignited the graphite moderator, melting the core and dispersing radioactive materials. Because there was no containment vessel for this reactor (Unit 4), the radioactive materials were not contained in this case and were released into the surrounding area. This was a major accident that affected not only Russia but the broader European region. Although design flaws also played a role, here again the proximate cause was a fundamental deficiency among the reactor operators in terms of knowledge, regulations, training, and other factors, and in that sense this accident was also a man-made disaster.[1]

The third accident was the Fukushima nuclear plant accident that occurred in March 2011. In this case, the proximate cause was the power failure at the reactor caused by a natural disaster—the earthquake

[1].The reactor was designed with a positive void coefficient (i.e., if boiling occurs for some reason, the power output rises dramatically, which further accelerates boiling, thereby accelerating the output—or in other words, it creates a vicious cycle and leading to a power burst), which is prohibited in Western reactors.

and tsunami—and thus it was fundamentally different in nature than the accidents at Three Mile Island in the United States or at Chernobyl in Russia, which were caused by errors committed by the operating personnel. However, the Fukushima Nuclear Accident Independent Investigation Commission (The National Diet of Japan) determined that "despite numerous opportunities to come up with countermeasures, successive generations of regulatory authorities and TEPCO's management resorted to delay tactics." The commission therefore concluded that the accident "cannot be regarded as a natural disaster. It was a profoundly manmade disaster."

In other words, the indirect causes of the Fukushima accident can be assumed to be an accumulation of offsite mismanagement in terms of disaster prevention and mitigation. However, the relationship in terms of the accident's cause and effect has yet to be determined, and many of the wide-ranging issues that the accident raised both within Japan and abroad will require greater efforts to resolve. Detailed analysis and study is required on the indirect causes of this accident to determine where precisely the deficiencies in crisis management reside.

Needless to say, the accident at the Fukushima Daiichi power plant has raised serious questions not only for Japan but for the entire international community about safety management at nuclear power plants and about nuclear security. In Japan, it has had a major impact on industry and energy, but also on Japan's society and lifestyle as the people have been forced to change their fundamental conception of safety management for nuclear power. The issues are far-reaching and many have yet to be resolved, but the key issues include (1) the response to nuclear accidents and safety management; (2) the revision of energy policy; (3) the handling of radioactive contamination and reparation issues; (4) concerns related to electrical power production and supply (PPS); (5) the restructuring of nuclear power safety management (the launch of a new Nuclear Regulation Authority and nuclear regulation agency in September 2012); (6) onsite nuclear power safety measures, and the strengthening of nuclear security; (7) the question of maintaining nuclear power–related technology and personnel and the question of nuclear exports; and so on. Each of these issues in turn contains many subsidiary or related issues, but we will avoid going into detail here.

Most of these issues need to be resolved first within Japan, but international cooperation will be required on many issues as well. Naturally, however, in order for Japan to pursue international cooperation, it must first show that it has sufficient nuclear safety management and crisis management systems in place to lead other countries. It is unlikely that it will be able to win the trust of other countries if it attempts to undertake international cooperation without first taking these steps. In other words, if Japan is going to maintain its nuclear power program, then it will need to take drastic measures to shore up its safety management.

Of course, ensuring the safety of nuclear power requires that safety management at nuclear plants be combined with nuclear security measures. Nuclear security refers to comprehensive measures to ensure the safety of nuclear-power facilities and nuclear materials against illegal or malicious acts. The Fukushima accident was of course not a nuclear security–related accident. It was not a terrorist attack on the nuclear plant nor an accident that occurred as a result of the theft of nuclear materials. However, there were certain factors behind the accident at Fukushima that might have been prevented had greater consideration been paid to nuclear security in advance. The accident has also created a new problem by exposing a vulnerability—i.e., that major disasters can be caused by power failures not only at the reactors themselves, but also at the surrounding critical facilities. It is thus clear that Japan must pursue a combination of measures to ensure both nuclear security and nuclear power safety management. Since the accident, the Japanese government has been strengthening its initiatives to enhance nuclear security. The current status of such initiatives should be outlined and more in-depth discussions should also be held on their future direction.

Meanwhile, as of January 2012 there were 427 nuclear reactors in operation in about 30 countries around the world, as well as 169 reactors that are either under construction or in the planning stages.[2] Of those, a total of 111 are in Asia: 50 in Japan (not including Units 1–4 at Fukushima Daiichi), 21 in

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[2]. "Generating Capacity of Nuclear Power Plants in the World," Japan Atomic Industrial Forum website, http://www.jaif.or.jp/ja/nuclear_world/overseas/f0103.html.

South Korea, 20 in India, 14 in China, and 6 in Taiwan. There are also plans for new construction in the region, as China plans to build additional 48–80 reactors by 2020, South Korea will add 3–6, and India is planning on building 20–26. Vietnam is planning on introducing nuclear power plants as well, with 13 reactors scheduled to be constructed by 2030. As a result, the number of nuclear power plants in Asia is expected to nearly triple by the year 2035.

The reason that the number of countries wanting to adopt nuclear power is so high despite the risks of a nuclear accident is that nuclear power enables countries to gain an enormous supply of electricity from a small quantity of uranium fuel. The advantage of possessing a high-density energy with a very large effect in terms of fuel reserves is becoming attractive to countries that are seeking economic growth and economic development. It also has a number of other advantages: the suppliers of natural uranium (the raw material needed for nuclear power) are politically stable countries such as Australia and Canada, making it a highly stable fuel supply; the low level of CO_2 emissions is good for the environment; and the price is relatively low compared to other sources of energy. Emerging nations are thus becoming increasingly interested in adopting nuclear power not only for economic reasons, but also from the perspective of energy security and environmental protection.

However, nuclear power also brings problems such as the risk of nuclear accidents and the treatment and disposal of radioactive waste, and it entails many issues on both the safety management and security fronts.

Many problems exist, above all the fact that some developing countries that already possess nuclear power plants do not have a sufficient level of technology or nuclear-related engineers to meet the requirements of their planned new construction and expansion of nuclear power plants, the personnel and responsibilities for operations management and crisis management are unclear, and it is possible that they will be reluctant to share information or accept assistance from other countries when an accident does occur.

In any event, the crises that one can foresee occurring in the future in the operation of nuclear power plants include the loss of power or cooling systems (including by subversive acts), illegal actions in the administration of nuclear facilities and nuclear materials or illegal actions against the means of transport of nuclear materials (disruption, illegal photographs, etc.), failures in crisis management (including the protection system), information sharing, and mistakes or internal threats in terms of information manipulation. Those countries that possess nuclear power capabilities have an enormous responsibility to address these problems. Serious consideration must be given to ensure that these types of accidents never happen again in Japan or in the international community. The International Atomic Energy Agency (IAEA) is making various efforts to that end, South Korea hosted a nuclear security summit in March 2012, and the Japanese government will hold an international conference at the end of this year on nuclear safety management, all of which contribute to the necessary efforts.

Looking back on the handling of the accident at the Fukushima nuclear power plant, the close way in which the United States and Japan cooperated is striking, and it is no exaggeration to say that it was thanks to the Japan-US alliance that the damage caused by the Fukushima accident was kept to a minimum. The close exchange of information and mutual cooperation between the two countries produced many lessons, and one could say that it has created a foundation for future Japan-US cooperation on issues related to nuclear safety management and nuclear security.

Over the past half-century, the Japan-US alliance has consistently contributed to the peace and stability not only of the United States and Japan, but also of the Asia Pacific region as a whole. This alliance relationship extends beyond the fields of security, diplomacy, and defense, to such fields as economics and finance, and the trustworthiness of the alliance has enabled the relationship to develop through mutual effort to a point where we can pursue cooperation in crisis management and response as the most trusted of allies. In the handling of the Fukushima incident as well, although there were some mutual misunderstandings seen in the initial management of information, in the end Japan-US cooperation produced results and the issues were resolved.

This project examined and analyzed the American and Japanese responses to the Fukushima nuclear plant accident and the lessons to be drawn from those experiences. The objective was to draw on those lessons to help strengthen the capacity of the Japan-US alliance to deal with nuclear crises, including nuclear safety management and nuclear terrorism, and improve the capacity of the world's nuclear management and crisis management systems.

In particular, with respect to the accident at Fukushima, all Japanese institutions—the government, the electric utilities, the Self-Defense Forces, the police, the firefighters, local governments, and others—made a tremendous effort to handle the situation, but as a result, many questions arose with regard to the way in which the Japanese side responded. Above all, if we look at this as a crisis management situation, then clearly there are many issues that must be resolved in order to promote measures that cover both (1) nuclear safety management (i.e., measures to prevent nuclear accidents), and (2) nuclear security (i.e., measures to protect nuclear power plants and nuclear fuel). These include problems with the policymaking process and mechanisms for measures to prevent certain situations from arising, the guidelines for responding to situations, the guidelines on damage limitation, crisis management, and so on.

In this context, US cooperation based on the Japan-US alliance played an extremely important role in helping to localize and control the situation surrounding the nuclear accident, and the main reason the United States was able to contribute in the area of crisis management was the fact that the alliance-based cooperative framework functioned so effectively. However, when one looks carefully at the situation, as already emphasized above, it must be frankly recognized that there were many areas such as information sharing, communications, and mutual understanding where the cooperative efforts were not necessarily without flaws. Moreover, given the nuclear safety management and nuclear security vulnerabilities that became evident as a result of this accident, it is clear that improvements are not only needed within Japan; regulations at the global level must be stronger and more effective as well. In that context, Japan and the United States should cooperate to promote stronger regulations and to carry out capacity building for those regulatory agencies and plant operators in each country that are tasked with safety management and nuclear security. In order to more effectively share the lessons learned from the Fukushima accident with the international community, the question is how Japan-US collaboration can be applied not just in Japan's own initiatives, but in universal rule-making. Also, in terms of improving the effectiveness of nuclear security, given that both Japan and the United States are carrying out cutting-edge technological research, they should carry out joint research to build the technological foundation for lowering the risk of nuclear terrorism and other security threats.

By examining in detail both those areas in which Japan-US cooperation functioned smoothly and those in which it did not, this project has attempted to provide important hints for improving cooperation in the future. Another primary objective was to gain knowledge on the methods and key points for promoting future Japan-US collaboration on preventing and handling nuclear disasters, and on strengthening nuclear security, including the protection of nuclear reactors and nuclear fuel. Accordingly, in carrying out this project we directly interviewed many of the practitioners involved in responding to the accident and in Japan-US collaborative efforts, and through exchanges of opinions between Japanese and American experts, we explored the lessons learned from the accident and areas for improvement. We believe that this process has resulted in a highly efficient and practical set of project findings.

The government, Diet, and Independent Investigation Commission on the Fukushima Nuclear Accident are among those who have launched investigations into the Fukushima Daiichi accident, and their reports are being made public. Much of the content of this report is based on those sources of information. For that reason, as these diverse investigations bring to light new facts and data, it may be necessary to revise certain portions of this report. However, it is imperative that thorough examinations of this accident continue to be conducted by Japanese society as a whole, and it is important that Japan continue to seek ways in which the lessons from the Fukushima accident can be shared with the world. This report represents one attempt to play that role, using the framework of "crisis management and Japan-US cooperation" as a way to convey those lessons.

Chapter 1: The Accident at the Fukushima Daiichi Nuclear Power Plant

The earthquake that struck Japan on March 11, 2011, caused a tsunami that resulted in the meltdown of three nuclear reactors. It was one of the three worst nuclear reactor accidents in history, following in the path of Three Mile Island in the United States and Russia's Chernobyl.[3] This chapter will examine how the accident occurred and what responses were undertaken, and it will consider the issues that arose at the time as well as the issues that remain to be addressed in the future.

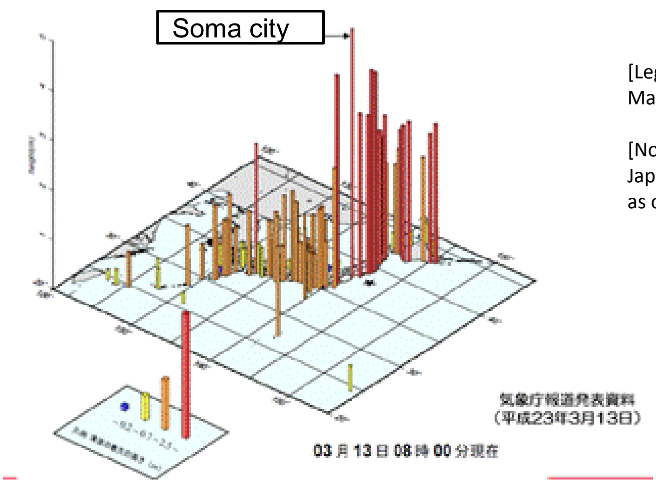
1.1 An overview of the accident at the Fukushima Daiichi Nuclear Power Plant

(1) Earthquake and tsunami

At 2:46 p.m. on March 11, 2011, a magnitude 9.0 earthquake struck Japan—the largest in recorded history to strike the country. The Great East Japan Earthquake produced a large-scale tsunami that covered 561 km^2 of land, leaving approximately 25,000 dead or missing (as of February 2012[4]). As shown in figure 1-1, an extremely high tsunami reached the coastlines of Miyagi Prefecture and Fukushima Prefecture.

TEPCO's Fukushima Daiichi Nuclear Power Plant was situated 178 km from the epicenter of the quake. Figure 1-2 shows the position of the plant relative to the epicenter, while the following photo shows the conditions at the Fukushima Daiichi Plant prior to the disaster.

Figure 1-1. The height and location of the tsunami's impact



[Legend]
Maximum wave height (m)

[Note]
Japan Meteorological Agency (JMA) report, as of March 13, 2011, 08:00.

Source: TEPCO, "Tohoku-chiho Taiheiyo-oki Jishin ni okeru jishindo oyobi tsunami ni tsuite" [On the seismic motion and tsunami of the Off the Pacific Coast of Tohoku Earthquake], August 11, 2011, http://www.pref.niigata.lg.jp/HTML_Article/334/751/110811_26-1,0.pdf.

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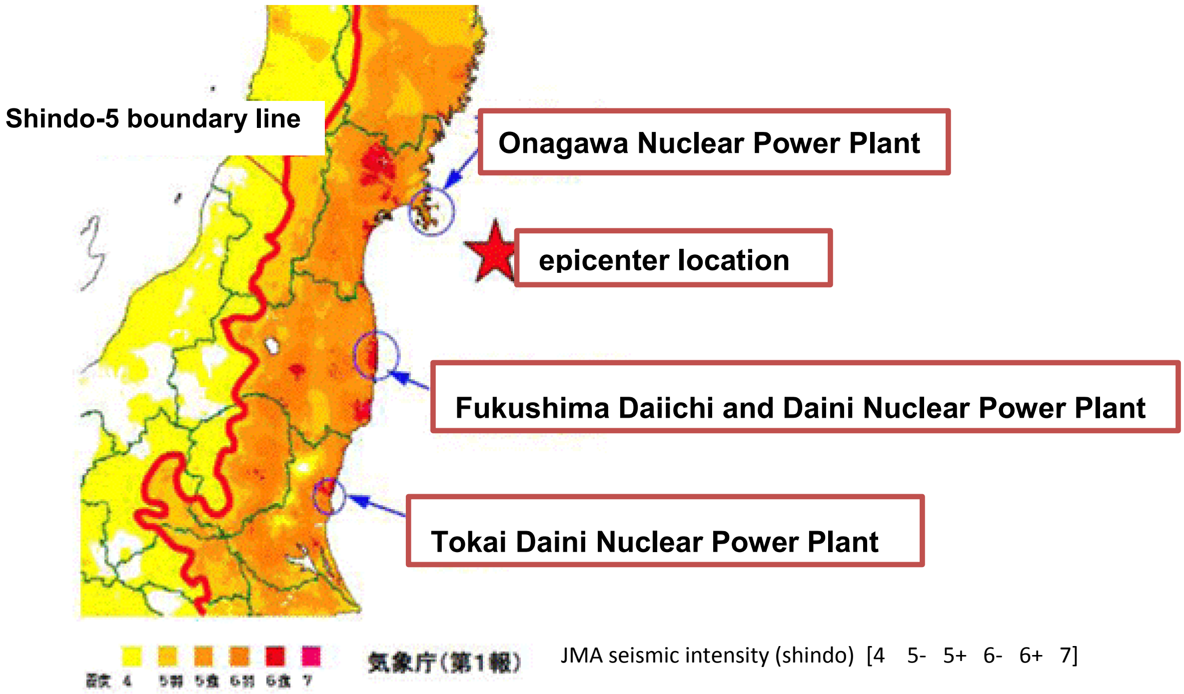
3. The former accident occurred on March 29, 1979, at Unit 2 of the Three Mile Island nuclear power plant. The upper portion of the reactor core was exposed, damaging the fuel. The radiation exposure of residents within an 80-km radius was an average of 0.01 mSv. The latter case occurred on April 26, 1986, at the Chernobyl nuclear power plant's Unit 4. Of the 135,000 residents within a 30-km radius of the plant, 16,000 people received external exposure. A total of 31 deaths were reported at the site and 203 were hospitalized with acute radiation exposure. The effects of internal radiation exposure are still being studied. See Shigehiro An, ed., *Genshiryoku jiten* [Dictionary of nuclear science and technology] (Tokyo: Nikkan Kogyo Shinbunsha, 1995).

4. Emergency Headquarters for Disaster Response, "Heisei 23-nen (2011) Tohoku-chiho Taiheiyo-oki Jishin (Higashi Nihon Shinsai) ni tsuite" [On the 2011 Off the Pacific Coast of Tohoku Earthquake], February 7, 2012 (5:00 p.m.), http://www.kantei.go.jp/saigai/pdf/201202071700jisin.pdf.

Figure 1-2. Locations of the epicenter and nearby nuclear power plants



Source: NISA, "Tokyo Denryoku Kabushiki Kaisha Fukushima Daiichi Genshiryoku Hatsudensho jiko no gijutsuteki chiken ni tsuite chukan torimatome" [Interim report on the technical knowledge gained from the accident at the TEPCO Fukushima Daiichi Nuclear Power Plant], February 2012.

The Fukushima Daiichi Nuclear Power Plant prior to the accident

Photo: TEPCO website.

The Fukushima Daiichi Plant is comprised of six boiling water reactors (BWRs; total installed power-generating capacity of 4.696 million kilowatts), but at the time of the earthquake, only Units 1–3 were operating; Units 4–6 had been shut down for routine inspections. Moreover, because Unit 4 was in the process of large-scale construction, all of the fuel from the reactor pressure vessel had been transferred to the spent fuel pool. Table 1-1 shows the conditions at that time, but one notable feature is that they were using an old model of reactor, the Mark I.

Table 1-1. Status of nuclear fuel management at the time of the accident (as of March 11, 2011)

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Date of commission	1971.3.26	1974.7.18	1976.3.27	1978.10.12	1978.4.18	1979.10.24
Electric output [1,000 kW]	460	784	784	784	784	1,100
Thermal output [1,000 kW]	1,380	2,381	2,381	2,381	2,381	3,293
Reactor type	BWR-3	BWR-4	BWR-4	BWR-4	BWR-4	BWR-5
Containment type	Mark I	Mark I	Mark I	Mark I	Mark I	Mark II
No. of fuel assemblies	400	548	548[2)]	—[3)]	548	764
Amount of uranium (t)	69	94	94	94	94	132
No. of spent fuel assemblies in spent fuel pool	292	587	514	1,331	946	876
No. of new fuel assemblies in spent fuel pool	100	28	52	204	48	64
Pool capacity (m^3)[1)]	1,020	1,425	1,425	1,425	1,425	1,497
Operating conditions	Operating	Operating	Operating	Outage due to regular inspection	Outage due to regular inspection	Outage due to regular inspection

[1)] In addition to this, 6,375 fuel assemblies were being stored in the spent fuel common pool (capacity=6,840) and 408 were being stored in dry casks (capacity=408).
[2)] Unit 3 includes 32 MOX fuel assemblies.
[3)] All fuel assemblies had been transferred to the pool for the purpose of core shroud replacement.

Source: The data for this table was drawn from NISA and Japan Nuclear Energy Safety Organization, "The 2011 Off the Pacific Coast of Tohoku Pacific Earthquake and the Seismic Damage to the NPPs," April 4, 2011, http://www.nisa.meti.go.jp/english/files/en20110406-1-1.pdf; TEPCO website, www.tepco.co.jp, etc.

(2) Timeline of the accident

This section explains the incident in the order the events occurred.[5]

① Loss of power

Power could no longer be received from any of the six lines that comprised the electrical supply system to the plant (one of which was already out due to construction). This was because the earthquake caused an embankment to collapse that in turn brought down the steel electrical towers, and because there was damage to the electrical circuit breakers and disconnecting switches.

[5]. Please refer to Appendix 1 for further details on the timeline.

However, the emergency diesel generators were activated, providing electricity within the plant. Also, the emergency cooling systems—the emergency isolation condensers (ICs) and the reactor core isolation cooling (RCIC) system—launched automatically and cooled the reactor.

② *Loss of AC power*

The tsunami struck approximately 40 minutes after the earthquake. In Units 1–5, the diesel generators and AC power supply equipment[6] were inundated and damaged by the water, making them unusable, and as a result the water injection and cooling equipment that are driven by those power sources were rendered unusable as well.

③ *Loss of the ultimate heat sink*

In addition, the tsunami inundated and damaged the cooling seawater pump in all of the reactors, leading to a loss of function of the residual heat removal system and the component cooling water system. That meant the loss of the ultimate heat sink because the residual heat within the reactors and the heat generated through the use of equipment could not be released into seawater.

④ *Total loss of power*

In Units 1, 2, and 4, the advent of the tsunami led to a total loss of function of the DC power sources and the central control room instrumentation, which made it impossible for plant operators to monitor conditions in the plant, operate motorized valves, and so on. In Unit 3, where DC power functions remained, eventually the batteries ran out, and Units 1–4 were faced with a total loss of power, lacking both AC and DC power sources for an extended period of time.

⑤ *Core meltdown*

The shutdown of the core cooling system caused the water level in the nuclear reactor to drop, and the exposure of the core eventually led to a core meltdown. In Unit 1, water injections had stopped for approximately 14 hours, while in Units 2 and 3, injections had stopped for approximately 6 hours. According to reports by the Government of Japan[7] and by TEPCO,[8] damage to the core began approximately 3 hours after the earthquake struck in Unit 1, and approximately 40 hours after the earthquake in Units 2 and 3.[9] Figure 1-3 shows the results of a simulation of conditions in each reactor based on subsequent analysis.

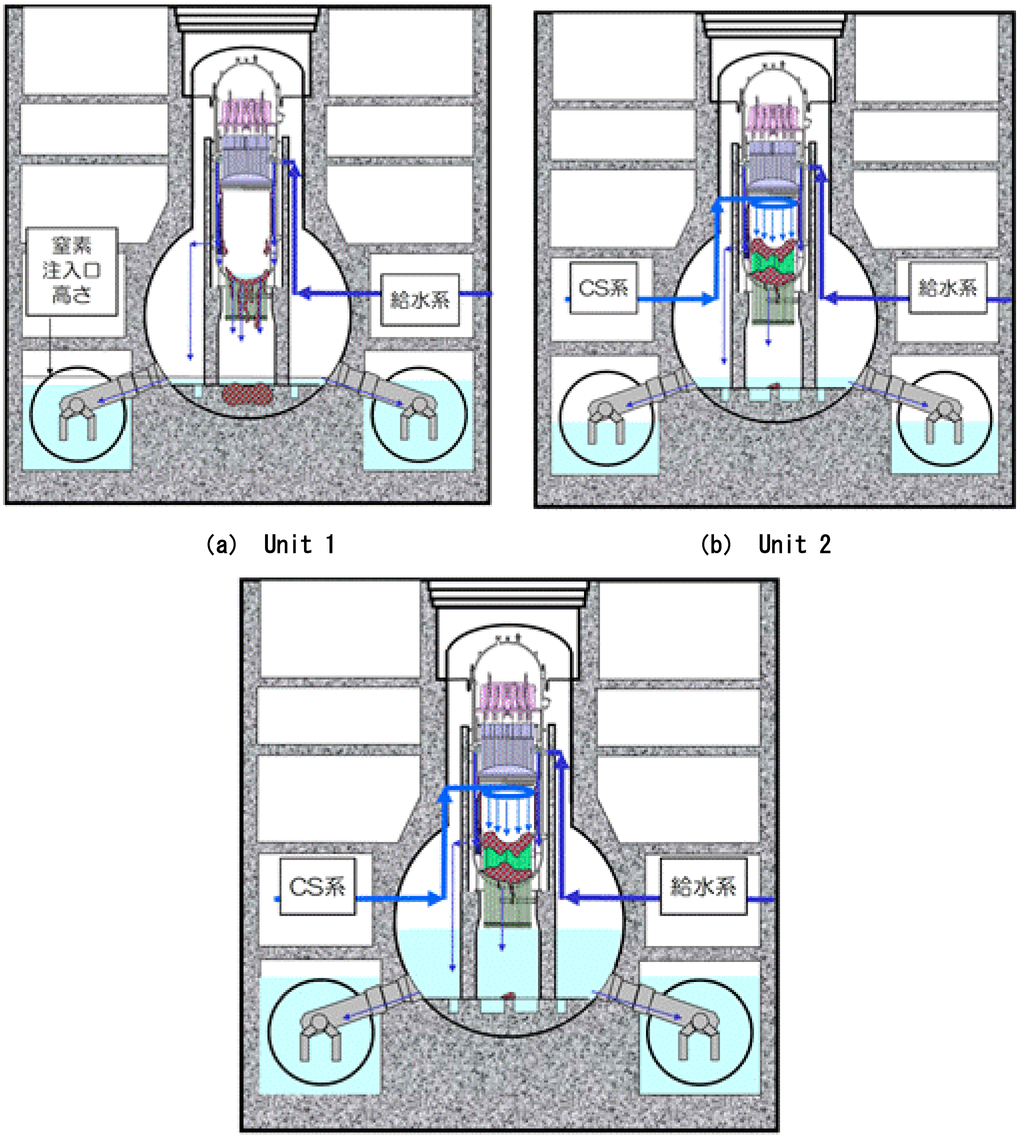
[6]. AC power supply refers to metal-clad type switchgears (M/C), power centers (P/C), etc.

[7]. Nuclear Emergency Response Headquarters, "Genshiryoku anzen ni kansuru IAEA kakuryo kaigi ni taisuru Nihon-koku seifu no hokokusho—Tokyo Denryoku Fukushima Genshiryoku Hatsudensho no jiko ni tsuite" [Report of the Government of Japan to the IAEA Ministerial Conference on nuclear safety—On the accident at the TEPCO Fukushima Nuclear Power Plant], June 2011, http://www.kantei.go.jp/jp/topics/2011/iaea_houkokusho.html.

[8]. TEPCO, "Fukushima Daiichi Genshiryoku Hatsudensho 1-goki no roshin jotai ni tsuite" [On the status of the reactor core in Fukushima Daiichi Nuclear Power Plant Unit 1], May 15, 2011, http://www.tepco.co.jp/cc/press/betu11_j/images/110515k.pdf; and TEPCO, "Fukushima Daiichi Genshiryoku Hatsudensho 2-goki/3-goki no roshin jotai ni tsuite" [On the status of the reactor cores in Fukushima Daiichi Nuclear Power Plant Unit 2 and Unit 3], May 23, 2011, http://www.tepco.co.jp/cc/press/betu11_j/images/110524b.pdf.

[9]. In Unit 1, the reactor core was exposed approximately 3 hours after the earthquake struck, damage to the core began after about 4 hours, and after about 15 hours, the nuclear reactor pressure vessel sustained damage. In Unit 2, the core exposure began approximately 40 hours after the earthquake struck, and the damage to the reactor core began after about 42 hours (analysis showed that the reactor pressure vessel was not damaged). In Unit 3, core exposure began roughly 40 hours after the earthquake, core damage began after 42 hours, and damage to the reactor pressure vessel occurred after about 66 hours.

Figure 1-3. Estimation of conditions in reactor cores



(a) Unit 1 (b) Unit 2

(c) Unit 3

Source: TEPCO, "Fukushima Daiichi Genshiryoku Hatsudensho 1~3-goki no roshin jotai ni tsuite" [On the status of the reactor core in Fukushima Daiichi Nuclear Power Plant Units 1~3], November 30, 2011, http://www.tepco.co.jp/nu/fukushima-np/images/handouts_111130_09-j.pdf.

⑥ Hydrogen explosions

During the core meltdown process, the zirconium in the fuel cladding reacted with the water, producing a large quantity of hydrogen. This hydrogen, combined with the volatile radioactive materials, leaked out of the containment vessels and into the reactor buildings, resulting in hydrogen explosions in the reactor buildings of Units 1, 3, and 4. For example, calculations show that as much as 1,000 kg of hydrogen was produced in Unit 1.[10] At the time, explosions were heard in the vicinity of Unit 2, but there is a high probability that

[10]. However, NISA acknowledged at a press conference on April 8, 2011, that this type of hydrogen explosion had not been investigated prior to that time.

Unit 2 did not experience a hydrogen explosion.[11] The photo below offers a bird's-eye view of the plant on March 20, 2012, following the hydrogen explosions.

Aftermath of the hydrogen explosions

Note: In this photo taken on March 20, Units 1–4 are shown from right to left, with turbine buildings in the foreground. The sea is in front of the turbine buildings.

Photo: AP Photo/AIR PHOTO SERVICE, http://photos.oregonlive.com/photo-essay/2011/03/fukushima_dai-ichi_aerials.html.

⑦ Environmental Contamination

Fuel was ultimately released into the surrounding environment. Subsequent studies discovered that contamination of the atmosphere, ocean waters, and soil had occurred.[12] If we use the estimates reported by the Nuclear Safety Commission or the Nuclear and Industrial Safety Agency (NISA)[13] of radioactive materials discharged, then only 2 percent of the iodine-131 (^{131}I) and 1 percent of the cesium-137 (^{137}Cs) in the reactors was released into the environment. On April 12, the NISA issued a provisional rating of

[11]. The reason for this is that as a result of the hydrogen explosion in Unit 1, the Unit 2 blowout panel had by chance been released, and it is believed that as a result, hydrogen was released outside the building. Also, in terms of the Unit 4 explosion, it is believed to have been caused by the influx of hydrogen from Unit 3. See NISA, "Tokyo Denryoku Kabushiki Kaisha Fukushima Daiichi Genshiryoku Hatsudensho jiko no gijutsuteki chiken ni tsuite chukan torimatome."

[12]. TEPCO finally began releasing atmospheric sampling results on March 22, 2011. Within the grounds of the Daiichi plant, tests showed volatile ^{131}I, ^{132}I, and ^{133}I, particulate ^{134}Cs, ^{137}Cs, and other nuclides. See TEPCO, "The Result of the Nuclide Analysis of Radioactive Materials in the Air at the Site of Fukushima Daiichi Nuclear Power Station," March 22, 2011, http://www.tepco.co.jp/en/press/corp-com/release/betu11_e/images/110322e4.pdf. An analysis was also conducted of seawater surrounding the discharge canal. See TEPCO, "The Result of Seawater Nuclide Analysis," March 22, 2011, http://www.tepco.co.jp/en/press/corp-com/release/11032208-e.html. On the sea floor 3 km off the coast, ^{131}I, ^{134}I, and ^{137}I were discovered. See TEPCO, "The Results of Nuclide Analyses of Radioactive Materials in the Ocean Soil off the Coast of Fukushima Daiichi Nuclear Power Station," May 3, 2011, http://www.tepco.co.jp/en/press/corp-com/release/11050305-e.html. In the soil within the Fukushima Daiichi site, ^{238}Pu, ^{239}Pu, and ^{240}Pu were found. See TEPCO, "Detection of Radioactive Material in the Soil in Fukushima Daiichi Nuclear Power Station," March 28, 2011, http://www.tepco.co.jp/en/press/corp-com/release/11032812-e.html. In addition, ^{234}U, ^{235}U, and ^{238}U were also found the following month. TEPCO, "Detection of Radioactive Material in the Soil in Fukushima Daiichi Nuclear Power Station (4th release)," April 22, 2011, http://www.tepco.co.jp/en/press/corp-com/release/11042210-e.html. On April 12, 2011, MEXT announced that ^{89}Sr and ^{90}Sr were found in soil and vegetation samples. See MEXT, "Fukushima Dai-1 Genshiryoku Hatsudensho no jiko ni kakawaru rikudo oyobi shokubutsu no houshasei sutoronchiumu bunseki kekka" [Results of the analysis for radioactive strontium in soil and vegetation related to the Fukushima Daiichi accident], http://radioactivity.mext.go.jp/ja/contents/4000/3707/view.html

[13]. According to the Nuclear Safety Commission's assessment, the amount of ^{131}I released into the air from Fukushima Daiichi was 1.5 x 10^{17} Bq, while the amount of ^{137}Cs was 1.2 x 10^{16} Bq; NISA's calculations showed that 1.3 x 10^{17} Bq of ^{131}I was released and 6.1 x 10^{15} Bq of ^{137}Cs. Also, NISA calculated that at the time the reactor shut down, the quantity of radioactive nuclides was 6.1 x 10^{18} Bq of ^{131}I and 7.1 x 10^{17} Bq of ^{137}Cs. If we use those figures, then we can determine that the amount of these two nuclides released into the environment from within the reactors was roughly 2 percent and less than 1 percent respectively.

the accident as a level 7 (major accident) on the International Nuclear and Radiological Event Scale (INES).[14]

(3) The spent fuel pool and other conditions at the plant, and the exposure of workers to radiation

Similar to the reactors, the condition of the spent fuel pools was serious. In particular, the greatest amount of spent fuel was stored in Unit 4 (see table 1), and moreover, because there was a large quantity of new fuel, there was a rapid rise in temperature.[15] According to the NISA, the water level in Unit 4 dropped precipitously, but it is believed that the length of time required before the fuel was exposed was extended because, by chance, water flowed back into the reactor well from the pool. Figure 1-4 shows the rise in temperature in the fuel pools of Units 1–6[16], but in fact Unit 5 and Unit 6 as well as the common pool were facing the danger that as their coolant temperature rose closer to 100°C it would evaporate and expose the fuel. Moreover, because the top portions of the reactor buildings of Units 1, 3, and 4 had exploded, all of their pools were now exposed to the air.

Additionally, unlike other nuclear power plants (with the exception of the Tokai Daiichi Nuclear Power Plant), the Fukushima Daiichi Nuclear Power Plant is equipped with dry casks to store spent fuel. That facility also sustained damage from the earthquake, but the conditions did not become critical.

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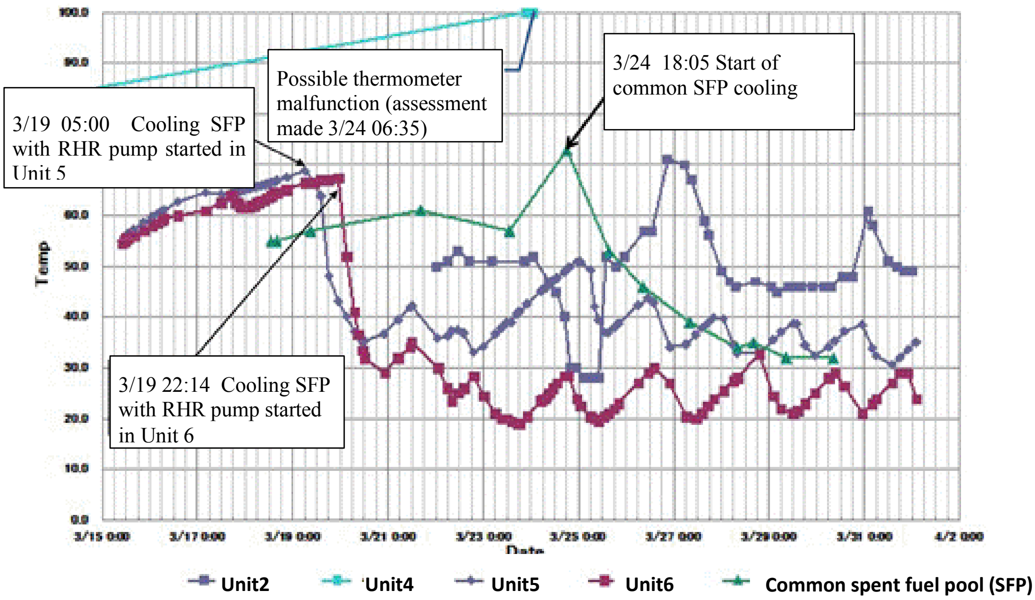
14. METI, "Tohoku Chiho Taiheiyo-oki Jishin ni yoru Fukushima Daiichi Genshiryoku Hatsudensho no jiko, toraburu ni taisuru INES no tekiyo ni tsuite" [On the application of the INES to the accident/trouble at the Fukushima Daiichi plant as a result of the Off the Pacific Coast of Tohoku Earthquake], April 12, 2011, http://www.meti.go.jp/press/2011/04/20110412001/20110412001.html.

15. The water level above the fuel rack was 4 m or more at its lowest point in Unit 1 (on May 20), at least 5.5 m in Unit 2 (on March 31), and 5 m or more in Unit 3 (around March 15), but in Unit 4 alone, it was roughly 1.5 m (around April 20), posing a real danger that the fuel would be exposed. TEPCO, "Fukushima Daiichi Genshiryoku Hatsudensho Tohoku Chiho Taiheiyo-oki Jishin ni tomonau genshiro shisetsu e no eikyo ni tsuite" [The impact of the Off the Pacific Coast of Tohoku Earthquake on the nuclear reactor facilities at Fukushima Daiichi Nuclear Power Plant], September 9, 2011, http://www.tepco.co.jp/cc/press/betu11_j/images/110909m.pdf.

16. NISA and Japan Nuclear Energy Safety Organization, "2011-nen Tohoku Chiho Taiheiyo-oki Jishin to genshiryoku hatsudensho ni taisuru jishin no higai" [The 2011 Off the Pacific Coast of Tohoku Earthquake and the earthquake damage to the nuclear power plant], April 4, 2011, http://www.nisa.meti.go.jp/oshirase/2011/files/230411-1-1.pdf.

Figure 1-4. Temperature shifts in each pool



Source: NISA and Japan Nuclear Energy Safety Organization, "2011-nen Tohoku Chiho Taiheiyo-oki Jishin to genshiryoku hatsudensho ni taisuru jishin no higai" [The 2011 Off the Pacific Coast of Tohoku Earthquake and the earthquake damage to the nuclear power plant], April 4, 2011, http://www.nisa.meti.go.jp/oshirase/2011/files/230411-1-1.pdf.

Although the March 11 disaster did not produce the same results at other nuclear power plants (see fig. 1-2) that it did at Fukushima Daiichi, they were just one step away from experiencing similarly dire conditions.[17]

Large numbers of TEPCO employees, staff from affiliated companies, as well as Self-Defense Force personnel and others were tasked with restoring the site. On March 14, the Ministry of Health, Labour and Welfare raised the allowable radiation exposure limit for emergency workers from 100 millisieverts (mSv) to 250 mSv.[18] As of September 2011, six employees had exceeded the 250 mSv limit. A total of 103 people had been exposed to more than 100 mSv, primarily during the month of March.[19] Subsequently, TEPCO has repeatedly been asked to rectify its worker exposure to radiation, work environment, and so on (excessive radiation exposure of female workers, failure to adequately provide radiation monitoring equipment for workers, etc.).[20] Table 1-2 shows the cumulative dose of radiation exposure of workers as of August 2011.[21] Of the approximately 16,200 workers involved, roughly 3,200 are TEPCO employees and 13,000 are from cooperating companies.

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17. The Fukushima Daini Nuclear Power Plant and Onagawa Nuclear Power Plant both had a single external power line remaining (Fukushima Daini: total 4 lines; Onagawa: total 5 lines), so they did not lose their AC generators and it was thus possible to maintain reactor cooling. Also, although the Tokai Daini plant did lose all three of its lines, it was able to use an emergency diesel generator, so it did not lose its AC power.

18. Ministry of Health, Labour and Welfare (MHLW), "Heisei- 23-nen Tohoku Chiho Taiseiyo-oki Jishin ni kiin shite shojita jitai ni taio suru tame no denri hoshasen shogai boshi kisoku no tokurei ni kansuru shorei no shiko ni tsuite" [On the enforcement of the special ministerial ordinance for special provisions of the 'regulation concerning prevention of radiation hazards due to ionizing radiation' to respond to the situation caused by the 2011 Tohoku Pacific Ocean Earthquake], March 15, 2011, http://www.mhlw.go.jp/stf/houdou/2r9852000001gkcc-att/2r9852000001gkf6.pdf.

19. Nuclear Emergency Response Headquarters, "Additional Report," II-414, http://www.iaea.org/newscenter/focus/fukushima/japan-report2/chapter-2-4.pdf .

20. MHLW, "Jishin hasseigo no keika" [Progression following the earthquake], http://www.mhlw.go.jp/shinsai_jouhou/keii.html; and Nuclear Emergency Response Headquarters, "Additional Report," II-415, http://www.iaea.org/newscenter/focus/fukushima/japan-report2/chapter-2-4.pdf.

21. Ground SDF troops dispatched on March 12–13, immediately after the accident, were exposed to radiation during the on-site efforts to inject water, with one person receiving a dose of 80.7 mSv and 8 others exposed to doses of 30 mSv. *Yomiuri Shimbun*, June 18, 2011.

Table 1-2. Radiation exposure of workers due to the accident at the Fukushima Daiichi Nuclear Power Plant (cumulative dose)

Dose (mSv)	External exposure March~July			External exposure March~July + internal exposure through May		
	TEPCO employees	Employees at affiliated co.'s	Total	TEPCO employees	Employees at affiliated co.'s	Total
> 250	0	0	0	6	0	6
201~250	0	0	0	1	2	3
151~200	6	3	9	12	2	14
101~150	27	9	36	90	25	115
51~100	174	166	340	257	252	509
21~50	410	1,038	1,448	562	1,225	1,787
11~20	608	1,587	2,195	528	1,697	2,225
<10	1,979	10,172	12,151	1,748	9,772	11,520
Total (no. of people exposed)	3,204	12,975	16,179	3,204	12,975	16,179
Maximum dose (mSv)	182.33	199.42	199.42	672.27	238.42	672.27
Average dose (mSv)	13.30	6.90	8.20	19.60	8.10	10.40

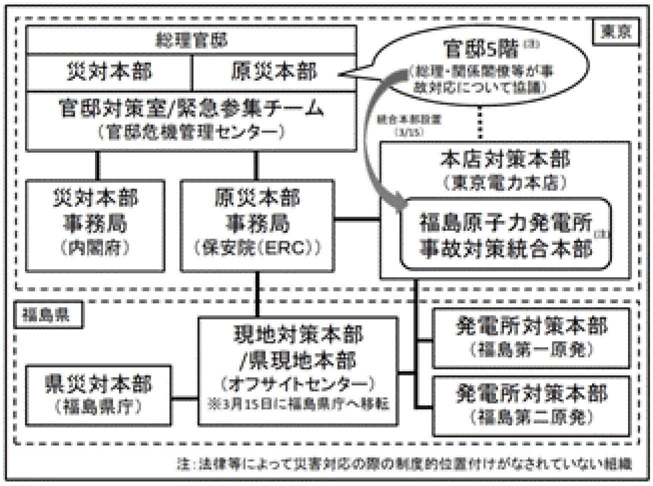
Source: Nuclear Emergency Response Headquarters, "Additional Report," II-4, http://www.iaea.org/newscenter/focus/fukushima/japan-report2/chapter-2-4.pdf.

1.2 The government response and evacuation of residents: offsite conditions

(1) Government response

An organizational schematic of the disaster response is provided in Figure1-5.

Figure 1-5. Organizational schematic of the response to the accidents at the Fukushima Daiichi and Daini Nuclear Power Plants



[Tokyo]		Kantei 5th Floor [Tokyo] (Deliberations on response to accident among PM, relevant Cabinet ministers, etc.)
Kantei (Prime Minister's Official Residence)		
Emergency HQ for Disaster Response	Nuclear Emergency Response HQ	
Cabinet Response Office/ Emergency Meeting Team (Cabinet Emergency Control Center)		
Emergency HQ for Disaster Response Secretariat (Cabinet Office)	Nuclear Emergency Response HQ Secretariat (NISA-ERC)	TEPCO Emergency Response HQ (TEPCO Head Office)
		Government-TEPCO Integrated Response Office* established (3/15)
[Fukushima Prefecture]	Local Nuclear Emergency Response HQs (NERHQ)/Prefectural Local NERHQ) (Off-Site Center)	Plant Response HQ (Fukushima Daiich Nuclear Power Plant)
Prefectural Emergency Response HQ (Fukushima Prefectural Office)	※Relocated on 3/15 to Fukushima Prefectural Office	Plant Response HQ (Fukushima Daini Nuclear Power Plant)
* Note: This organization has no position in the disaster response system under the current law.		

Source: Investigation Committee on the Accident at the Fukushima Nuclear Power Station of Tokyo Electric Power Company [hereafter, TEPCO Investigation Committee], *Interim Report*, December 26, 2011, http://icanps.go.jp/eng/interim-report.html.

① Headquarters for Emergency Disaster Response

Immediately after the earthquake struck on March 11, 2011, at 2:46 p.m., the Ministry of Economy, Trade and Industry (METI) established a Headquarters for Emergency Disaster Response and began gathering information on the reactors in the effected region.

② Cabinet Response Office, Emergency Headquarters for Disaster Response

At 2:50 p.m., the Prime Minister's Official Residence, known as the Kantei, also set up a Cabinet Response Office to respond to the earthquake, and the members of an Emergency Meeting Team—bureau directors from each relevant ministry—gathered in the Cabinet Emergency Control Center located under the Kantei. At 3:14 p.m., the government set up an Emergency Headquarters for Disaster Response, headed by Prime Minister Naoto Kan, which was located in the Kantei, the secretariat for the headquarters was set up in the Cabinet Office.

③ Off-Site Center

At 3:42 p.m., when the Fukushima Daiichi Nuclear Power Plant lost all AC power, the director of the TEPCO plant notified the NISA via TEPCO headquarters that an incident as stipulated in Article 10, Clause 1 of the Act on Special Measures Concerning Nuclear Emergency Preparedness (hereafter, Nuclear Emergency Preparedness Act) had occurred.[22] The NISA in turn contacted the Kantei and others, following which METI established the Nuclear Disaster Alert Headquarters and the On-Site Nuclear Disaster Alert Headquarters within the METI Emergency Response Center (ERC) and the Off-Site Center respectively.

④ Cabinet Response Office

At 4:36 p.m., having received notification from the NISA, the deputy chief cabinet secretary for crisis management established an Emergency Response Office to address the situation at the nuclear plant. The Emergency Meeting Team that had already gathered to respond to the earthquake was expanded to handle the nuclear disaster as well.

⑤ Emergency Technical Advisory Body

At 3:59 p.m., the Nuclear Safety Commission of Japan established an Emergency Technical Advisory Body.

⑥ Nuclear Emergency Response Headquarters and Local Nuclear Emergency Response Headquarters

At 4:36 p.m., TEPCO notified the NISA of the possibility that it would not be able to inject water at the Fukushima Daiichi plant's Units 1 and 2 using the emergency core cooling device. The NISA determined that an incident stipulated in Article 15 of the Nuclear Emergency Preparedness Act had occurred. At 7:03 p.m., the government issued a declaration of a nuclear emergency, as required under Article 15, following which it established the Nuclear Emergency Response Headquarters in the Kantei, headed by the prime minister; the Local Nuclear Emergency Response Headquarters headed by the minister of economy, trade and industry, which was set up in the Off-Site Center; and the

[22]. Article 10 of the Act on Special Measures Concerning Nuclear Emergency Preparedness lays out the obligation of nuclear emergency preparedness managers with regard to notifications and other matters:
Article 10 (1) When a nuclear emergency preparedness manager has been notified that a radiation dose above the limit specified by a Cabinet Order has been detected, pursuant to the provisions of a Cabinet Order, near the border of an area where the nuclear site is located or has discovered such fact for him/herself, he/she shall, pursuant to the provisions of an ordinance of the competent ministry and the nuclear operator emergency action plan, immediately notify the competent minister, the competent prefectural governor, the competent mayor of a municipality and the related neighboring prefectural governors (in the case of the occurrence of an event pertaining to transport outside the nuclear site, the competent minister, and a prefectural governor and the mayor of a municipality who have jurisdiction over the place where said event has occurred) to that effect. In this case, the competent prefectural governor and the related neighboring prefectural governors shall notify the mayors of related surrounding municipalities to that effect.
(2) A prefectural governor or the mayor of a municipality who has received a notification pursuant to the provisions of the first sentence of the preceding paragraph may, pursuant to the provisions of a Cabinet Order, request the competent minister to dispatch expert officials for the purpose of understanding the situation. In this case, the competent minister shall dispatch officials who are found to be qualified. See http://www.nisa.meti.go.jp/english/resources/legislativeframework/files/EmergencyPreparedness.pdf.

secretariat of the Nuclear Emergency Response Headquarters in the ERC. At 7:45 p.m., the chief cabinet secretary issued the declaration of a nuclear emergency at a press conference.

⑦ Fifth Floor of the Kantei

On the fifth floor of the Kantei (hereafter, the Fifth Floor), where the prime minister's office is located, the prime minister, relevant cabinet ministers, the chair of the Nuclear Safety Commission, the vice director-general of the NISA, and executives from TEPCO all gathered to begin discussions on how to respond to the accident.

Since the accident, investigative committees have been initiated in the cabinet and the Diet, and they have also been examining the actions taken by the government at the time of the accident. The cabinet's investigative committee for this accident was established in May 2011,[23] and it submitted an interim report in December 2011 and a final report on July 23, 2012.[24] In addition to the administration's committee, the Diet also launched its own investigative committee in December of the same year, and it published its report on July 5, 2012.[25] Moreover, an independent, private-sector investigative committee[26] also presented its report on the accident in February 2012.[27]

As is described in detail in these reports, a number of issues have already come to light in terms of the government's response.[28] The first is the problem of cooperation with the relevant institutions.

① The function of the Kantei

Decisions related to the disaster response were made primarily on the Fifth Floor, which is not prescribed under the law, and there was a lack of communication with other key actors. For example, the Emergency Meeting Team was not aware of the details of the discussions held among those on the Fifth Floor. Furthermore, the group at the Kantei created confusion in terms of the actual disaster response. For example, the Fifth Floor issued the evacuation orders, but that role was supposed to have been played by the Off-Site Center. The directive was issued at a time when the ministry that oversees the System for Prediction of Environmental Emergency Dose Information (SPEEDI) had no data on which to base a decision regarding the scope of the evacuation.

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23. According to the Cabinet decision of May 24, 2011, the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company was established "with the aim of making policy proposals on measures to prevent further spread of the damage caused by the accident and a recurrence of similar accidents in the future, by conducting a multifaceted investigation in an open and neutral manner that is accountable to the Japanese public to determine the causes of the accident at the Fukushima Dai-ichi and Dai-ni Nuclear Power Stations," http://icanps.go.jp/eng/2011/07/05/0524CabinetDicision.pdf.

24. TEPCO Investigation Committee, *Interim Report*.

25. The Diet Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) was established not only to "elucidate the background and causes of the accident" but also to "make proposals concerning policies and measures to prevent future accidents," NAIIC website, http://www.naiic.jp/en/.

26. This refers to the Independent Investigation Commission on the Fukushima Nuclear Accident, established by the Rebuild Japan Initiative Foundation. See http://rebuildjpn.org/en.

27. *Report of the Independent Investigation Commission on the Fukushima Nuclear Accident*, February 28, 2012 [English version to be released in summer 2012], http://rebuildjpn.org/en/project.

28. TEPCO Investigation Committee, *Interim Report*.

② The NISA's passive approach

The NISA officials who assembled at METI's ERC did not think to use the teleconferencing system employed by TEPCO, nor did it dispatch its staff members to TEPCO.

③ TEPCO's uncooperative stance and organizational inadequacies

At the time of the incident, there were scattered indications that TEPCO's organization was closed off and uncooperative, but there has been little information offering a clear analysis of the situation. In December 2011, TEPCO released a report[29] on its interim evaluation of the Fukushima nuclear disaster, and it spoke of the extreme working conditions at the site when the accident occurred, but the report drew criticism for being defensive in tone and lacking in details on many points.[30] Moreover, there have been some reports and indications that TEPCO may have tried to implement a "total withdrawal" and evacuate all of its workers from the power plant on March 15. Although TEPCO denies this claim,[31] some believe that it is undeniably possible that such an attempt was made.[32]

④ Failure of the Off-Site Center to function adequately

The Off-Site Centers are facilities that serve as bases for responding to emergencies, and when a nuclear accident does occur, they are to play the central role for emergency response measures and are thus situated close to the scene of the accident. The designated Off-Site Center in this case was located 5 km from the Fukushima plant. The earthquake damage to the transportation infrastructure and other factors posed impediments to assembling the center's personnel, and the center had to be evacuated because of the paralysis of the IT infrastructure; the shortages of food, water, and fuel; and the lack of air purifying filters to block out radioactive materials. Moreover, out of all the essential personnel from surrounding local governments who were supposed to gather in the case of an emergency, only one person actually arrived at the center.

(2) Evacuation of residents/evacuation zone

The conditions surrounding the evacuation of residents is described below:[33]

① Evacuation within a 2 km radius of the plant

At 8:50 p.m. on March 11, the governor of Fukushima Prefecture ordered an evacuation of residents and others within a 2 km radius of the Fukushima Daiichi Nuclear Power Plant for the towns of Okuma and Futaba.

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29. TEPCO, "Release of the Interim Report of Fukushima Nuclear Accidents Investigation Committee," December 2, 2011, http://www.tepco.co.jp/en/press/corp-com/release/11120205-e.html.
30. "Yure wa soteinai, tsunami wa soteigai—Toden ga chukan hokokusho" [The tremors were expected but the tsunami was not, says TEPCO interim report], *Asahi Shimbun*, December 2, 2011, http://www.asahi.com/national/update/1202/TKY201112020569.html.
31. TEPCO, "Tokyo Denryoku kara no oshirase" [Notice from TEPCO], March 1, 2012, http://www.tepco.co.jp/nu/fukushima-np/info/index-j.html.
32. Rebuild Japan Initiative Foundation website, http://rebuildjpn.org/en.
33. Nuclear Emergency Response Headquarters, "Genshiryoku anzen ni kansuru IAEA kakuryo kaigi ni taisuru Nihon-koku seifu no hokokusho" (June 2011), V-5.

② Evacuation within a 3 km radius; take refuge indoors within a 10 km radius

At 9:23 p.m. on the same day, the head of the Nuclear Emergency Response Headquarters (namely, the prime minister) issued orders to the heads of relevant local organizations under the Nuclear Emergency Preparedness Act: eviction of residents within a 3 km radius of the Fukushima Daiichi plant for the purpose of evacuation; those within a 10 km radius were to take refuge indoors. The Unit 1 reactor could not be cooled at that time, and this order was considered a precautionary measure in case the situation persisted.

③ Evacuation within a 10 km radius

At 5:44 a.m. on March 12, the head of the Nuclear Emergency Response Headquarters ordered the evacuation of all those residing within a 10 km radius, who had previously been taking refuge indoors. According to the report to the IAEA, the reason for this order was the rising pressure within the reactor's pressure vessel.

④ Evacuation within a 20 km radius

At 6:25 p.m. that day, the head of the Nuclear Emergency Response Headquarters issued the order to heads of relevant local governments to evict for the purpose of evacuation all residents within a 20 km radius. This decision was considered an emergency measure in light of the explosion at Unit 1.

⑤ Take refuge indoors between a 20 km and 30 km radius

Subsequently, in light of the hydrogen explosions at Unit 1 on March 12 and Unit 3 on March 14, and the explosion-like event, the fire in the fuel pool, and other conditions at Unit 2 on March 15, the order was conveyed to local government officials on March 15 at 11:00a.m. that residents within a radius between 20 and 30 km from the plant should take refuge indoors.

In addition, on March 12, at 5:22 a.m., orders were given to evacuate everyone within a 3 km radius of the Fukushima Daini Nuclear Power Plant as well, and to take refuge indoors within a 10 km radius of that plant. At 5:39 p.m., following the explosion at Fukushima Daiichi's Unit 1, residents within a 10 km radius were ordered to evacuate.

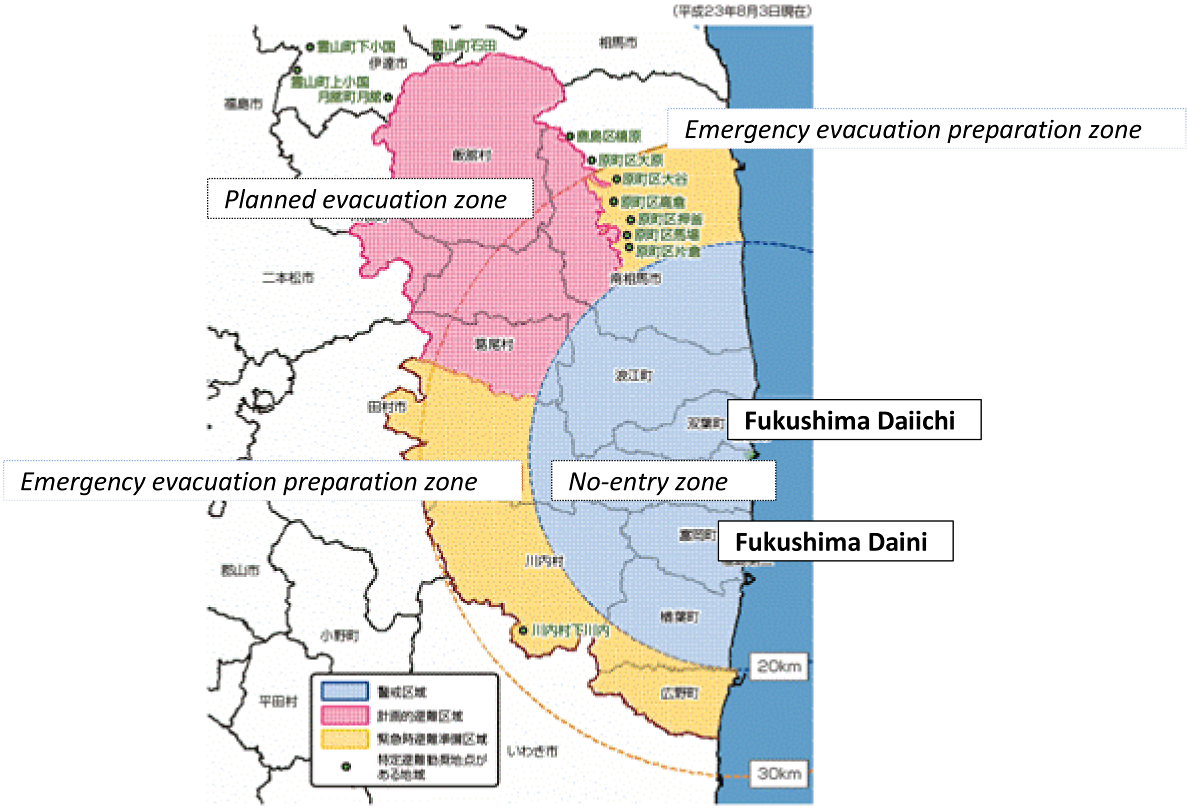
As of January 2012, the total number of Fukushima Prefecture evacuees was approximately 158,000 residents (approx. 97,000 moved to different locations within the prefecture while approx. 62,000 moved to locations outside the prefecture).[34]

On April 21, the head of the Nuclear Emergency Response Headquarters designated the area within a 20 km radius of Fukushima Daiichi to be a "no-entry zone," prohibiting entry into the area as a rule. Subsequently, temporary re-entry policies were announced and a new "planned evacuation zone," "emergency evacuation preparation zone," and "specific spots recommended for evacuation" were established (see fig. 1-6).[35]

[34]. Cabinet Office, "Genshiryoku hisaisha e no torikumi ni tsuite" [Regarding efforts for the victims of the nuclear power plant accident], February 2012, http://www.enecho.meti.go.jp/info/committee/kihonmondai/10th/10-7.pdf.

[35]. Starting on May 10, 2011, residents were temporarily permitted to enter the area, and the first round of visits was completed on September 9, 2011. Areas in which the total accumulated dose of radiation was feared to reach 20 mSv within a year after the event were designated as "planned evacuation zones" (population within those zones: approx. 10,000; the 5 relevant municipalities completed evacuation in early July 2011). Also, the area within a 20–30 km radius was designated as an "emergency evacuation preparation zone," in which residents were to remain indoors or evacuate in the case of an emergency once the indoor evacuation order had been lifted (population: approx. 58,500; affected 5 municipalities). "Specific spots recommended for evacuation" were also established for pregnant women and children in specific locations where the accumulated dose of radiation was predicted to exceed 20 mSv in the year following the accident, and these were designated on a household basis with consideration given to the community (227 sites; 245 households; 3 local governments affected). (Information as of August 3, 2011.) This effort, which began on June 16, was intended to alert residents living in the affected locations, and to support and encourage their evacuation.

Figure 1-6. No-entry zone, planned evacuation zone, emergency evacuation preparation zone, and areas with specific spots recommended for evacuation



Source: METI, *White Paper on International Economy and Trade 2011*, October 2011, http://www.meti.go.jp/english/report/data/gWT2011fe.html.

Moreover, from March 12, Fukushima Prefecture began conducting screenings (evaluations to detect radioactive contamination and to determine the necessity of decontamination). More than 200,000 people—over 10 percent of the prefecture’s total population—underwent these screenings. Of these, doses of 13,000–100,000 counts per minute (cpm) were detected on 901 people, while 102 people registered readings of 100,000 cpm or more.

The key issues are outlined below.

① Issues related to evacuation orders

Many problems arose in terms of providing clear definitions and appropriately implementing the evacuation zones, and the complicated nature of the zones led to confusion among residents. The town of Namie in Fukushima Prefecture was not able to obtain accurate information and, lacking that information, evacuated to a location where the radiation levels were high.[36] The town of Okuma did not receive information when the event had occurred.[37] One would think that if data from SPEEDI and elsewhere on the

36. “Shogen/ kosenryochi to shirazu hinan/ Fukushima-Namie enganbu jumin 8,000-nin” [Testimony/8,000 residents of coastal areas of Namie, Fukushima, unwittingly evacuate to high-radiation-level site], *Kahoku Shimpo*, November 9, 2011, http://www.kahoku.co.jp/spe/spe_sys1071/20111109_01.htm.

37. Nuclear Safety Commission (NSC) Working Group of the Expert Meeting on Disaster Prevention at Nuclear Facilities to Consider Disaster Prevention Guidelines [hereafter, NSC Disaster Prevention WG] (13th Meeting), Reference Materials 1, “Fukushima-ken Okuma-machi jittai chosa hokoku” [Survey report on status of Okuma, Fukushima Prefecture], February 14, 2012, http://www.nsc.go.jp/senmon/shidai/bousin/bousin2012_13/ssiryo1.pdf.

atmospheric radiation dispersion forecasts had been made known preventively, it could have been appropriately applied as one reference source for decisions on evacuations, and residents would not have evacuated in the same direction in which the radiation was being dispersed. In addition, on March 31, the IAEA directed the residents of the village of Iidate (approx. 40 km northwest of Fukushima Daiichi), which was not in the designated evacuation zone, should be advised to evacuate. The Government of Japan, however, simply stated that they would investigate and did not immediately respond.[38]

② Issues with the screenings and testing for radiation exposure

Prior to this event, Fukushima Prefecture had used a screening level in which 40 Bq/cm^2 was considered to be the equivalent of 13,000 cpm. When the accident occurred, the head of the Local Nuclear Emergency Response Headquarters indicated that it corresponded to 6,000 cpm. Because of the need for the small number of staff to respond quickly, however, the prefecture raised that to 10,000 cpm on its own initiative. Subsequently the Nuclear Safety Commission suggested that 13,000 cpm would be appropriate, but the prefecture did not change it.[39] In addition, due to concerns about the risks of side effects and the shortage of medical personnel, the administration of stable iodine tablets was delayed[40] and testing for internal radiation exposure was done in August, after the iodine tablets, which have short half-life, were out of people's bodies.[41]

1.3 The inadequacies of the response to the accident

This section presents several of the causes of the accident.

(1) Were accident prevention measures sufficient?

① Automatic shutdown

According to TEPCO, the shaking of the earthquake triggered the automatic insertion of the control rods into the three reactors that were in operation, Units 1–3, thereby stopping nuclear fission normally. If that had failed, it would have led to a runaway nuclear reaction as occurred in the 1989 accident at the Chernobyl nuclear plant in the former Soviet Union, but given the current conditions, it is believed that such a situation was averted in the Fukushima accident.

② Earthquake countermeasures and impact

The seismic motion detected within the Fukushima Daiichi nuclear plant was below the maximum response acceleration value of the design basis earthquake ground motion (Ss), but in areas of Units 2, 3, and 5, the Ss did exceed the maximum value.[42] Although there is undeniably a chance that the earthquake damaged the reactors, according to TEPCO, that chance is small. (The final report of the government's investigation committee on the Fukushima accident denies the possibility that damage occurred that caused a loss of the containment function.)

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38. "Iidatemura ni hinan kankoku wo = IAEA" [IAEA recommends evacuation of Iidatemura], Jiji Press, March 31, 2011.
39. TEPCO Investigation Committee, *Interim Report*.
40. NSC Disaster Prevention WG (13th Meeting), WG13-3, "Antei yosozai no yoboteki fukuyo ni kansuru teigen kosshi (an)" [Outline of recommendations on the preventive use of stabilized iodine tablets (draft)], February 14, 2012, http://www.nsc.go.jp/senmon/shidai/bousin/bousin2012_13/siryo3.pdf.
41. NSC Disaster Prevention WG (13th Meeting), Reference Materials 1.
42. NISA, "Tokyo Denryoku Kabushiki Kaisha Fukushima Daiichi Genshiryoku Hatsudensho jiko no gijutsuteki chiken ni tsuite chukan torimatome" [Interim report on the technical knowledge gained from the accident at the TEPCO Fukushima Daiichi Nuclear Power Plant], February 2012.]

③ Tsunami countermeasures and impact

The first wave of the tsunami reached the Fukushima Daiichi plant at 3:27 p.m.—41 minutes after the earthquake struck—and at 3:35 p.m., a major wave hit. In the plant's building permit, the design basis tsunami height was 3.1 m, but in an evaluation (2002) based on the Japan Society of Civil Engineers' "Tsunami Assessment Method for Nuclear Power Plants in Japan," the maximum height was said to be 5.7 m. However, the actual run-up height of the tsunami reached 14–15.5 m, and the inadequacy of the tsunami countermeasures has been indicated.[43]

④ Problems concerning Mark I

Roughly one week after the accident occurred, General Electric published a Japanese-language version of a report on the Mark I reactor's containment vessel.[44] Because concerns had been growing about the Mark I model not only in Japan but also in the United States, the report offered a number of defenses of the technology.

However, according to a study by the Japan Nuclear Energy Safety Organization (JNES),[45] when they examined various types of BWRs including the one used at Fukushima Daiichi and analyzed the development and source terms (the quantity and type of radioactive materials released) of the major accident sequences in the case of an earthquake, significant differences were apparent depending on the type of containment vessel used. In particular, it noted that in the case of the BWR-4 Mark I model of containment vessel (the model used in Units 2–5 of Fukushima Daiichi), because the floor of the substructure of the reactor's pressure vessel is at the same height as the floor of the containment vessel, debris that falls after the pressure vessel is damaged is spread on the floor of the containment vessel, and in some cases that may lead to a partial melt-through. Further research is needed on this issue.

⑤ The lack of severe accident countermeasures

In January 2012, the NISA began deliberations to regulate the measures to be taken in response to severe accidents, which had until then been carried out by the power company employees.[46] However, according to reports, in 2010 a document was compiled that noted the fear that regulations would raise questions about the safety of existing nuclear plants and that would lead to administrative litigation.[47] According to another report, documents uncovered through the Freedom of Information Act showed that although there had been efforts to reexamine and revise the disaster prevention guidelines for responding to nuclear accidents in order to align them with international standards, the NISA opposed that effort, saying that it would "cause confusion in society," and thus those reforms could not be implemented.[48] If these reports are true, then it is undeniably possible that one factor that exacerbated the accident was the delay in severe accident response planning.

[43]. Ibid.

[44]. Nuclear Energy Institute, "Maaku I gata genshiro kakuno yoki ni kansuru hokokusho" [Report on the Mark I model containment vessel], March 19, 2011, http://www.ge.com/jp/docs/1307504328207_NEI_Report.pdf.

[45]. Japan Nuclear Energy Safety Organization, "Heisei-21-nendo—Jishinji reberu 2PSA no kaiseki (BWR)" [FY2009 analysis of level 2PSA during earthquakes (BWR)], October 2010, http://www.jnes.go.jp/content/000017303.pdf.

[46]. NISA, "'Hatsudenyo keisuigata genshiro shisetsu ni okeru shibia akushidento taisaku kisei no kihonteki kangaekata ni kakawaru iken choshukai' no setchi ni tsuite" [Regarding the establishment of a 'hearing to gather opinions on the basic thinking regarding the regulation of countermeasures against severe accidents in light-water nuclear reactor facilities used for power generation'], February 15, 2012, http://www.meti.go.jp/press/2011/02/20120215002/20120215002.html.

[47]. Kyodo News, "Kizon genpatsu eno soshou kenen suru bunsho kakoku jiko taisaku de hoanin," March 26, 2012.

[48]. "Hoanin genpatsu bousai shishin kaiteini teikou 06nen 'konran wo jakki,'" *Asahi Shimbun*, March15, 2011.

(2) Were accident mitigation efforts sufficient?

This section presents several issues related to the response to the accident.

① Core cooling failure

Units 1–3 lost the reactor cooling functions, which run on an AC generator, but reactor cooling functions that do not use AC generators are also in place for that very purpose. That includes the emergency isolation condenser (IC) in Unit 1. But the valve on the IC is an electromagnetic valve that requires electricity, and the control panel that displays the status of the valve also requires electricity. Moreover, there was inadequate knowledge and training done on the Unit 1 IC. There were also deficiencies with relation to Unit 3, as seen for example in the manual shutdown done without adequate preparation.

② "Ventilation" and leakage of the radioactivity

Whether the special measure known as venting was implemented according to plans, and if not, whether the cause was technical or systemic, is a question that requires further investigation and improvement in the future. In addition, the causal relationship between the vent operations and the hydrogen explosions must be examined further. Also, it seems that measures to prevent a hydrogen explosion did not correspond at all.

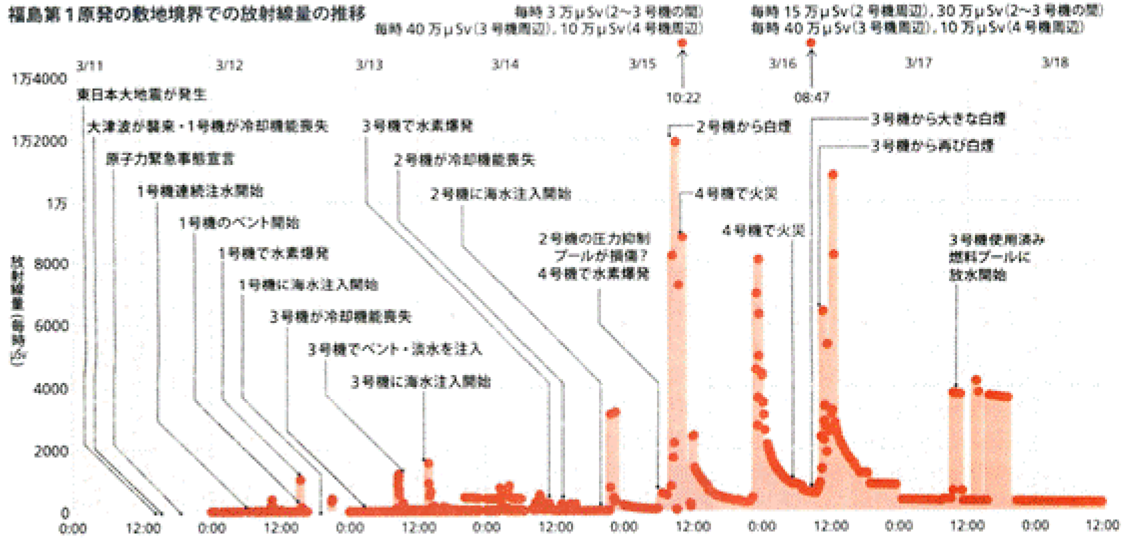
It has also been indicated that radioactive materials may already have been leaking from the top flange of the reactor core prior to the event.[49] Although an investigation has been rendered difficult in light of the earthquake, tsunami, and hydrogen explosion, this possible pre-existing leak must be examined.

③ Inadequate mitigation plans for multiple disasters

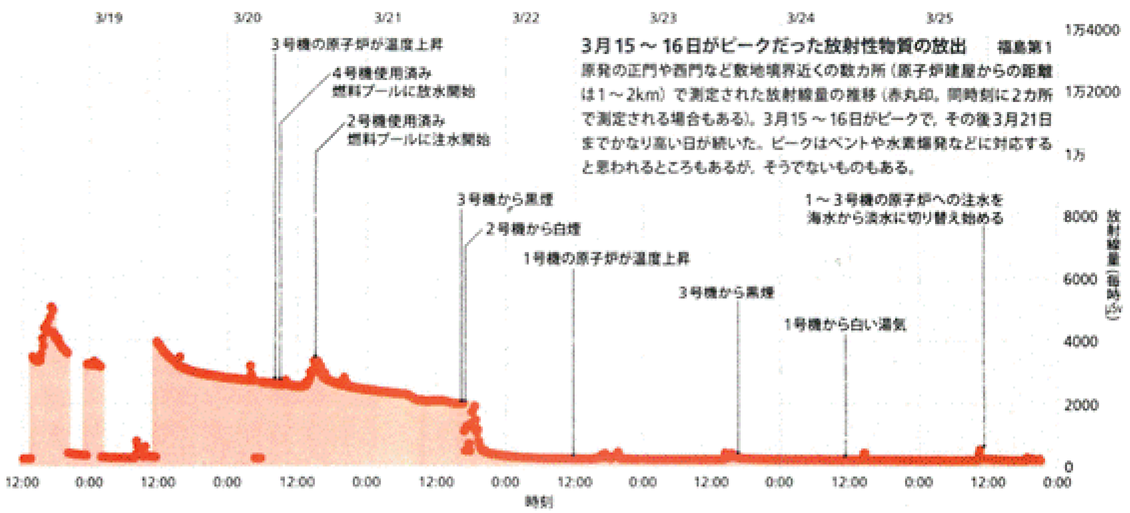
The need to address multiple disasters presented an enormous challenge, as efforts to recover from the earthquake had to be carried out simultaneously with measures to mitigate the impact of the nuclear accident. Figure 1-7 shows the changes in radiation doses within the site borders over time and the status of the disaster response at that time, and conditions emerged where the mitigation efforts were delayed by conditions at the adjoining reactors, such as when the efforts to restore power were suspended due to the hydrogen explosions.

[49]. NISA, "Tokyo Denryoku Kabushiki Kaisha Fukushima Daiichi Genshiryoku Hatsudensho jiko no gijutsuteki chiken ni tsuite chukan torimatome."

Figure 1-7. Changes in radiation levels within the boundaries of the Fukushima Daiichi Nuclear Power Plant site



(a) March 11 to March 18



(b) March 19 to March 25

Source: *Bessatsu Nikkei Saiensu genpatsu to shinsai* [Special edition of Nikkei Science: Nuclear power and disasters] (Tokyo: Nikkei Science, 2012), 94–95.

④ *Inadequate response by the government and others*

On May 12, TEPCO acknowledged that a reactor meltdown had occurred. However, roughly one year later it was discovered that the possibility that such an event had occurred had been indicated on March 11, the day of the accident, according to a summary of discussions held that day that was later disclosed by the Nuclear Emergency Response Headquarters.[50,51] It was also established that at the time of the accident the government had hypothesized a worst-case scenario in which evacuations would be

[50]. NISA, "Genshiryoku Saigai Taisaku Honbu nado no giji naiyo no kiroku no seibi" [Organization of the records of the proceedings of the Nuclear Emergency Response Headquarters and others], March 9, 2012, http://www.meti.go.jp/press/2011/03/20120309002/20120309002.pdf.

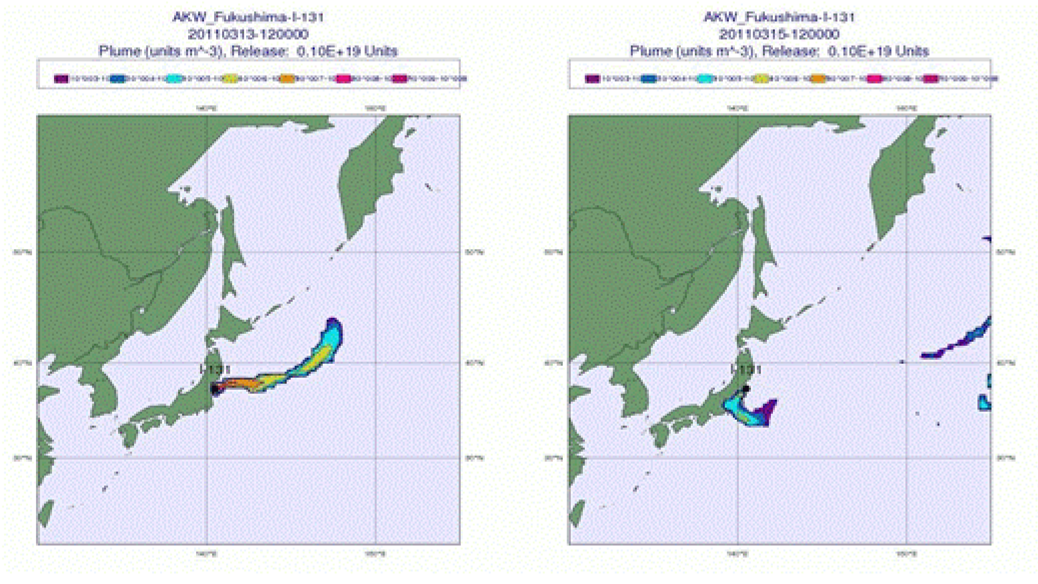
[51]. Kantei, "Dai-1-kai Genshiryoku Saigai Taisaku Honbu Kaigi giji gaiyo" [Summary of the proceedings of the 1st meeting of the Nuclear Emergency Response Headquarters], http://www.kantei.go.jp/jp/singi/genshiryoku/pdf/gensai_gaiyo_01.pdf.

implemented within a 250 km radius.[52] Given the anxiety and distrust these actions engendered among the Japanese people, consideration must be given to the question of the timing and level of detail with which information should be disclosed in the future.

Whether or not the application of SPPEDI went as planned and whether that was sufficient or not is another area that needs to be examined. The Nuclear Safety Technology Center, which operates SPEEDI, began releasing forecasts of the diffusion of radioactive materials (plume forecasts) immediately following the earthquake, but nobody noticed those reports and Fukushima Prefecture decided that the data was outdated and thus did not officially announce it. On April 25, 2011, the Nuclear Safety Commission finally announced the results of the total forecasts to date[53] (up until that point, they had only made two official announcements, on March 23 and April 11), but the commission's reason for the delay in the announcement was that "it took time to coordinate between the Ministry of Education (MEXT) and the Nuclear Safety Commission on such issues as how the forecasts would be applied, published, and so on."[54]

Overseas, detailed information was being provided promptly to the general public (for example, see fig. 1-8),[55] but because the relevant authorities failed to adequately explain the differences in how the forecasting systems were being applied within Japan and abroad, it led to a great deal of distrust and confusion among the public.

Figure 1-8. Forecasts of diffusion of radioactive materials as of March 13 and March 15



Source: ZAMG, "Kernschmelze im Japanischen Kernkraftwerk, Ausbreitung von möglicher Radioaktivität," (Update: March 13, 2011), http://www.zamg.ac.at/aktuell/index.php?seite=21&artikel=ZAMG_2011-03-13GMT09:20.

[52]. This became clear in an interview following a cabinet meeting, and it was hypothesized that the fuel in Unit 4 would melt. "Heikei 250-kiro-kennai wo hinan taisho—seifu no 'saiaku shinario'" [Government's 'worst-case scenario'—evacuation of a 250 km radius], *Asahi Shimbun*, January 6, 2012, http://www.asahi.com/politics/update/0106/TKY201201060501.html.

[53]. Nuclear Safety Commission, "SPEEDI no keisan kekka ni tsuite" [Regarding the forecast results of the System for Prediction of Environmental Emergency Dose Information (SPEEDI)], http://www.nisa.meti.go.jp/earthquake/speedi/speedi_index.html.

[54]. "Hoshasei busshitsu no kosan yosoku, kongo wa kohyo—Genshiryoku Anzen-I" [Nuclear Safety Commission says dispersion forecasts for radioactive materials will be made public in future], *Asahi Shimbun*, April 25, 2011.

[55]. However, study is needed on whether foreign countries would have been able to do the same if the incident had been in their own country.

Chapter 2: The Societal Impact of the Nuclear Accident

The accident at the Fukushima Daiichi Nuclear Power Plant was not something that could be resolved by restoring the plant internally. Because of the accident, radioactive materials were released into the environment, making the damage long-term and complex and creating chaos in society. This chapter presents the societal impact of and response to the accident, raises questions about the current issues, and seeks to identify the fundamental problems.

2.1 Response to the contamination problem

(1) Contamination of food and water

Cases of contaminated vegetables and drinking water, as well as dairy products and meat were discovered one after another. On March 19, tests detected 1,190 becquerels (Bq) of iodine in fresh milk in Fukushima Prefecture.[56] On March 22, ^{131}I levels of 210 Bq/kg, were detected in tap water in Tokyo, which exceeds the provisional limit for ingestion by infants of 100 Bq/kg.[57] On April 4, ^{131}I levels of 4,080 Bq/kg were detected in young lancefish off the coast of Ibaraki Prefecture, exceeding the provisional limit of 2,000 Bq/kg.[58] From July 8 to 9, radioactive cesium in excess of the provisional limits set under the Food Sanitation Law was found in the meat of 11 cows that had been shipped from the emergency evacuation preparation zone.[59]

As of February 24, 2012—almost one year later—there had been 302 cases in Fukushima Prefecture of vegetables that exceeded the permissible levels, 203 of marine products, 18 of dairy products, 147 of meat, 2 of grains, etc., and contamination exceeding the government limits had also been detected in Tochigi Prefecture, Gunma Prefecture, Ibaraki Prefecture, Shizuoka Prefecture, Tokyo, and elsewhere.[60]

Prior to this accident, there had only been control indices for limiting ingestion, but there were no standards for the direct regulation of food and drink contaminated with radioactive materials. The Ministry of Health, Labour and Welfare was using the ingestion control indices as temporary limits, but on April 1, 2012, approximately one year later, new guidelines were set forth in the revised Food Sanitation Law.[61] Although stating that 'food products that meet the current provisional limits are generally considered to have no negative health impact and are assured to be safe," the limits were lowered to provide an even greater level of security and peace of mind. For example, the becquerels per kilogram limit for drinking water was reduced from 200 Bq to 100 Bq, for milk it was lowered from 200 Bq to

[56]. Ministry of Agriculture, Forestry and Fisheries (MAFF), "Chikusanbutsu-chu no hoshasei busshitsu no kensa kekka ni tsuite 3-gatsu-bun" [March results of inspections for radioactivity levels in livestock products], http://www.maff.go.jp/j/kanbo/joho/saigai/seisan_kensa/201103.html.

[57]. Bureau of Waterworks, Tokyo Metropolitan Government, "Suidosui no hoshano sokutei kekka ni tsuite~dai-17-ho" [17th report on radiation readings in tap water], March 23, 2011, http://www.waterworks.metro.tokyo.jp/press/h22/press110323-01.html.

[58]. Japan Fisheries Agency, "Suisanbutsu no hoshasei busshitsu no chosa kekka" [Results of inspections for radioactivity levels in marine products], February 24, 2012, http://www.jfa.maff.go.jp/j/sigen/housyaseibussitutyousakekka/other/120224_result_jp.xls.

[59]. MAFF, "Genshiryoku hatsudensho jiko wo fumaeta kachiku no shiyo kanri ni kakawaru gijutsu shido no saishuchi ni tsuite," http://www.maff.go.jp/j/press/seisan/c_sinko/110714.html. According to this press release, rice straw that was left in the paddies after the harvest was contaminated by radioactive fallout, and as a result the amount of cesium detected in the meat of cows that had ingested that straw was found to exceed the provisional limits.

[60]. MHLW, Department of Food Safety, Inspection and Safety Division, "Shokuhin-chu no hoshasei busshitsu kensa no kekka ni tsuite (gairyaku)" [Test results of radionuclides in foods (summary)], February 24, 2012, 10:00 p.m. release, http://www.mhlw.go.jp/stf/houdou/2r98520000023p4a-att/2r98520000023p91.pdf.

[61]. MHLW, Pharmaceutical & Food Safety Bureau, Department of Food Safety, "New Standard Limits for Radionuclides in Foods (provisional translation)," http://www.mhlw.go.jp/english/topics/2011eq/dl/new_standard.pdf.

50 Bq, and for vegetables, grains, and meat products it dropped from 500 Bq to 100 Bq. This has led to confusion among the public because there was insufficient debate on the scientific appropriateness of lowering those control values, and the change has resulted in a sudden increase in the number of food products that exceed the limits.

(2) Government policy on human radiation exposure

Fukushima Prefecture is conducting a Fukushima Healthcare Control Survey, which is intended to help the prefecture manage the health of its residents in the future.[62] A December 2011 report stated that out of 1,589 people, 62.8 percent had less that 1 millisievert (mSv) of exposure, 4 people had more than 10 mSv, and the largest reading was 14.5 mSv (1 person).[63] However, these results were no more than "estimates based on a record of actions taken by the patient provided on a medical questionnaire," and of the roughly 2 million people who were the focus of the survey, approximately 370,000 responses were received, making the response rate to date just 18 percent.

In terms of limiting radiation exposure in schools and on school grounds within Fukushima Prefecture, the Ministry of Education (MEXT) referred to the International Commission on Radiological Protection recommendation of 1–20 mSv per year as the reference level for post-emergency situations, setting 1 mSv or less per year as the general rule for the exposure that young students should receive in school, and setting a target of less than 1 μSv per hour for the ambient dose rate for schoolyards and playgrounds. Although the effect on children, or in other words radiation exposure and contamination at schools, has become a major issue, analysis is needed on whether or not those measures were adequate.[64,65]

In a survey of children conducted by the town of Namie in Fukushima Prefecture,[66] out of 1,190 respondents, roughly 36 percent stated that they feel anxiety about whether they will become sick as a result of the radiation. But even greater numbers responded to such statements as "I can no longer get together with my friends" (approx. 79 percent) or "I no longer have my own room" (approx. 42 percent). Not only are follow-up surveys needed on the impact of radiation exposure, but debate is also required on the broader social impact on future generations and on social responsibility.

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62. Fukushima Prefecture, "Fukushima kenko kanri chosa" [Fukushima healthcare control survey], http://wwwcms.pref.fukushima.jp/pcp_portal/PortalServlet?DISPLAY_ID=DIRECT&NEXT_DISPLAY_ID=U000004&CONTENTS_ID=24287.

63. The cumulative exposure of the 1,589 people was as follows: <1 mSv=998 people (62.8%); <5 mSv=1,547 (97.4%); <10 mSv=1,585 (99.7%); >10 mSv=4 people; max. of 14.5 mSv=1 person. Fukushima Prefecture Investigative Commission for the Healthcare Control Survey, "Fukushima-ken kenmin kenko kanri chosa 'kihon chosa (gaibu hibaku senryo no suikei), kojosen kensa'" [Fukushima Prefecture healthcare control survey 'Basic survey (estimate of external exposure) and thyroid gland examination'], December 13, 2011, http://www.pref.fukushima.jp/imu/kenkoukanri/231213gaiyo.pdf.

64. Following the accident, the government began making comparisons at a relatively early stage to the effect that it was roughly the same level as a CT scan, or the same level as you receive when travelling abroad. However, this did not take into consideration the difference between voluntarily being exposed to radiation and being exposed due to an accident, and since the amount of radioactivity had not been adequately indicated, this created more distrust. When (then) Chief Cabinet Secretary Yukio Edano used the phrase "There is no immediate health impact" at a press conference during the crisis, it generally raised the concern "Then what about the long-term impact?" At a press conference that began at 4 p.m. on March 25, 2011, Edano explained the comment that "there will be no physical impact" as meaning that "at that point in time, based on the various conditions, there was currently no chance of physical effects." For that reason, it is difficult to believe that he had given thought to issues such as low-dose radiation exposure or genetic effects. MSN Sankei News, "Hoshano-more—Edano chokan kaiken 'watakushi wa daijobu to hasshin shite inai'" [Radiation leak—Chief Cabinet Sec. Edano: I didn't say it was OK], March 25, 2011.

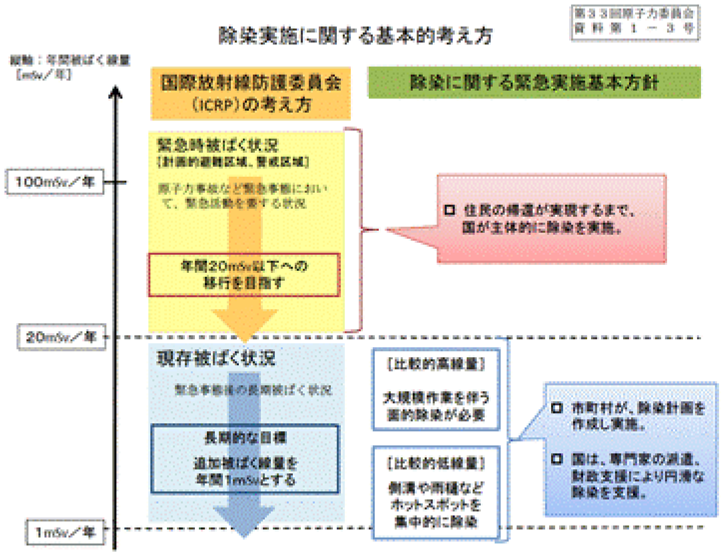
65. For example, in terms of the measurements on April 14, while they were determined based on the values measured 50 cm above the ground at preschools and elementary schools, at middle schools they measured 1 m above the ground, so even if the value was 3.9 μSv at 50 cm, it would not be restricted.

66. Municipal Government of Namie, Fukushima Prefecture, "Fukko ni kansuru kodomo-muke ankeeto shukei kekka (sokuho)" [Aggregate results of a survey of children regarding the recovery (bulletin)], February 20, 2012, http://www.town.namie.fukushima.jp/wp-content/uploads/2012/02/2-2.pdf.

(3) Decontamination efforts

The Minister for the Environment set the guidelines for the disposal of contaminated waste and soil, and decided on carrying out the observation and measurement of that process.[67] Substantial decontamination efforts were launched in January 2012[68] in order to bring the cumulative radiation exposure below 1 mSv in those municipalities indicated as priority areas for radioactive contamination testing[69] (see fig. 2-1).

Figure 2-1. Basic principles of decontamination



Source: Atomic Energy Commission (AEC), "Josen jisshi ni kansuru kihonteki kangaekata" [Basic principles of decontamination], 33rd AEC Regular Meeting, August 30, 2011, http://www.aec.go.jp/jicst/NC/iinkai/teirei/siryo2011/siryo33/siryo1-3.pdf.

A number of manuals were also presented to the general public on decontamination work.[70] Furthermore, measurements taken independently by citizens outside of Fukushima Prefecture detected hot spots where radiation levels were high. For example, on October 17, hourly levels of 3.99 μSv were detected at an elementary school in Tokyo's Adachi Ward, leading to

[67]. The government of Japan passed the "Act on Special Measures concerning the Handling of Environment Pollution by Radioactive Materials Discharged by NPS Associated with the Tohoku District-Off the Pacific Ocean Earthquake that Occurred on March 11, 2011 (Act on Special Measures Concerning Handling of Radioactive Pollution)," which was promulgated on August 30, 2011, and went into effect on January 1, 2012, http://law.e-gov.go.jp/htmldata/H23/H23HO110.html.

[68]. Following that, the plan is for contaminated materials to be stored for approximately three years in a temporary site, with each municipality or community ensuring its safekeeping; in the special decontamination areas (no-entry zone, planned evacuation zone), the Ministry of the Environment will work in cooperation with the municipalities to ensure its safekeeping, while in other areas, while the national government will be financially and technically responsible, the municipalities will ensure the safekeeping the materials. Subsequently, the contaminated materials will be brought to medium-range storage facilities. Ministry of Environment, "Josen kankei gaidorain, dai-ichi-ban" [Decontamination guidelines, version 1] (December 2011), http://www.env.go.jp/jishin/rmp/attach/josen-gl00_ver1.pdf.

[69]. This indicates areas that should be given priority in measurement surveys to test for environmental radioactive contamination as a result of the accident. The Minister of the Environment designates those areas (according to article 32, paragraph 1 of the law).

[70]. On July 29, 2011, the Japan Society of Radiation Safety Management issued a manual for the general audience on how to detect hot spots and on decontamination, http://www.jrsm.jp/shinsai/0728soil.pdf. Also, on November 22, 2011, the Cabinet Office's Team in Charge of Assisting the Lives of Disaster Victims released a "Decontamination Technology Catalog" that gave safety warnings and effects for decontamination of houses and roads, schools and parks, farmland, etc., http://www.meti.go.jp/earthquake/nuclear/pdf/20111122nisa.pdf. The Ministry of Environment is carrying out decontamination efforts with decontamination volunteers. See "Josen borantia no boshu jokyo nado ni tsuite" [On recruitment of volunteers for decontamination, etc.], Ministry of Environment website, http://josen-plaza.env.go.jp/josen-plaza/recruitment.html.

a shutdown of the school.[71] On October 21, in Kashiwa, Chiba Prefecture, approximately 450,000 Bq/kg (^{134}Cs and ^{137}Cs combined total) was detected.[72]

More than a year after the accident, on March 20, 2012, sediment in rainwater tanks at 18 city schools showed up to 16,800 Bq/kg, and because it exceeded the limits, even industrial waste management companies refused to take it.[73] Another issue that has arisen is the problem of not being able to dispose of highly concentrated cesium being detected in the sludge from water purification plants and sewage treatment plants.[74] Moreover, across a wide area that encompasses Fukushima Prefecture, Iwate Prefecture, and Miyagi Prefecture, the rubble left in the wake of the earthquake is still being cleared, but these efforts have run into difficulty as many local governments are concerned about accepting the debris for fear of radioactive contamination.

Through the enactment of special measures, preparations have come together to some degree for carrying out systematic decontamination. However, in terms of the Priority Areas for Radioactive Contamination Survey, it has been left up to the voluntary initiatives of each local government. Some local governments are hesitant to sign up out of fear that their reputations will be damaged by rumors, and some towns did not qualify based on a miniscule difference in radiation levels, so it would seem that further deliberation is needed on the appropriateness and flexibility of the system.

(4) Impact on industry and others

In terms of the trends in food product exports, a number of countries have barred the import of Japanese foods or demanded certification of radiation inspections,[75] and Japan has consequently responded to the need for certification of exports.[76] Also, on April 19, 2011, the EU recommended that all cargo ships from Japan undergo inspections for radiation.[77] According to JETRO,[78] October 2011 food exports were $332 million, down 26.4 percent from the same month the previous year, and showing a much greater gap from September, which had a decline of 3.9 percent over the previous year. It was the lowest level since the nuclear plant accident occurred in March. If one looks at the cumulative totals from March to October 2011, the largest impact was on exports headed to China, Hong Kong, and South Korea. Items such as marine products and prepared baby food showed a substantial drop. In South Korea, although minimal, there has been an increasing number of cases of radioactive materials being detected in marine products from Japan.[79] The accident has also had an

[71]. "Shogakko de maiji 3.99 maikuroshiiberuto—Tokyo, Adachi" [Readings of 3.99 mSv/hr at elementary schools in Tokyo and Adachi], *Asahi Shimbun*, online edition, October 17, 2011, http://www.asahi.com/special/10005/TKY201110170624.html.

[72]. The final report of the survey of locations within the city of Kashiwa where high dosages were detected in the air was announced by the Ministry of Environment on December 28, 2011, http://www.city.kashiwa.lg.jp/soshiki/030300/p010348.html.

[73]. "Gakko no usui shisetsu—kijuncho seshiumu" [Cesium levels above standards found in school rainwater tanks], *Asahi Shimbun*, March 30, 2012.

[74]. "Seshiumu osen: odei ga manpai, jichitai pinchi—gesui shoriba nado" [Cesium contamination: the sewage treatment plants, etc., are filled with sludge, putting local governments in a pinch], *Mainichi Shimbun*, August 13, 2011.

[75]. MAFF, "Genpatsu mondai no norinsui sangyo e no eikyo to taisaku" [The effect of the nuclear plant issue on the agriculture, forestry and fisheries industries and countermeasures], http://www.maff.go.jp/j/kanbo/kihyo02/fukkou/pdf/fukko2.pdf.

[76]. MAFF, "Tokyo Denryoku Fukushima Daiichi Genshiryoku Hatsudensho jiko ni kakawaru shogaikoku e no yushutsu ni kansuru shomeisho hakko ni tsuite" [In reference to the issuance of certificates for exports to foreign countries in response to the accident at the TEPCO Fukushima Daiichi Nuclear Power Plant], http://www.maff.go.jp/j/export/e_shoumei/shoumei.html.

[77]. JETRO, "EU, kabutsusen no hoshasen kensa wo kameikoku ni kankoku (EU)" [EU recommends that its member states inspect cargo vessels for radiation], http://www.jetro.go.jp/world/shinsai/20110419_03.html.

[78]. JETRO, Agriculture, Forestry, Fisheries, Food Department, "Nihon shokuhin yushutsu wa futatabi ohabagen, genpatsu jiko iko saitei no suijun ni" [Exports of Japanese food products drop drastically again—lowest level since the nuclear power plant accident], December 12, 2011, http://www.jetro.go.jp/world/shinsai/20111212_01.html.

[79]. "Hoshasei busshitsu no kenshutsurei zoka—Kankoku de Nihon sansuisanbutsu" [South Korea finds increase in radionuclides in Japanese fishery products], *Sankei Shimbun*, March 8, 2012, http://sankei.jp.msn.com/world/news/120308/kor12030814180000-n1.htm.

impact on exports of manufactured goods, an important industry for Japan. Radiation inspections are being conducted on electrical appliances and automobiles from Japan.[80]

The number of tourists visiting Japan from abroad has declined as well. According to the Japan National Tourism Organization, the Great East Japan Earthquake and Fukushima nuclear accident has resulted in a drop of 27.8 percent in the number of tourists from abroad in 2011 as compared to 2010, which had been a record high.[81]

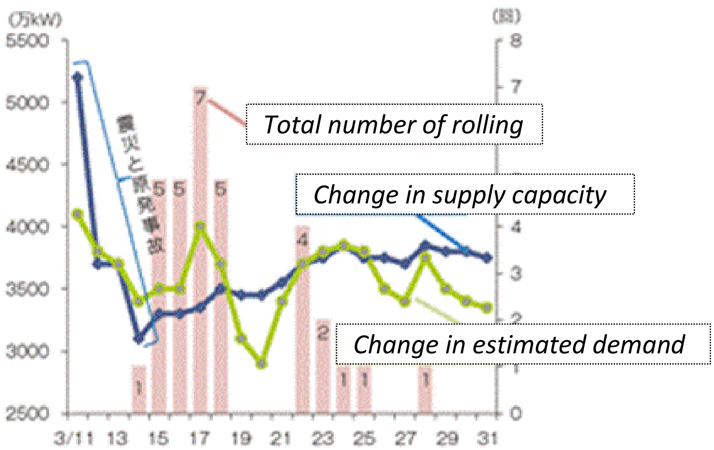
Although efforts have been conducted to counteract misinformation, the results are unclear. For example, there has been criticism that explanations only state that it is safe but do not provide any specific numbers.[82]

2.2 Impact on nuclear energy policy

(1) Impact on power supply stability

Because thermal power plants were also damaged, TEPCO's power supply dropped approximately 40 percent, from around 52 million kW to about 31 million kW. As a result, rolling blackouts were implemented in order to maintain the power supply-demand balance. Figure 2-2 shows the number of times such blackouts were carried out within TEPCO's service area. As can be seen here, from March 14 on, 32 outages were implemented over a total of 10 days.

Figure 2-2. Rolling blackouts implemented within TEPCO's service area



Source: METI, Agency for Natural Resources and Energy, *Enerugii hakusho 2011, daiichi-bu* [Energy white paper 2011, part 1], http://www.enecho.meti.go.jp/topics/hakusho/2011/1.pdf.

As summer began, the power supply capacity strengthened, increasing to as much as 53.8 million kW, and having called on large-volume business users to cut their consumption by 15 percent over the previous year and having called on the general public to conserve as well, in the end the supply exceeded expectations and there were no power outages. On the other hand, the inequity of the rolling blackouts became an issue as for example a hospital in Chiba

80. JETRO, "Genpatsu jiko ni tomonau Oshu ni okeru Nihonhatsu kaijo kabutsu (kogyohin) e no hoshasen kensa ni tsuite" [In reference to radiation testing in the EU of maritime cargo (manufactured goods) originating in Japan in connection with the nuclear accident], May 16, 2011 (partially revised June 16, October 5, October 19), http://www.jetro.go.jp/world/shinsai/manufacturing_inspection.html.

81. Japan National Tourism Organization, "Ho-nichi gaikyakusu, 27.8%-gen no 6,219,000-nin" [Foreign visitors to Japan down by 27.8% to 6,219,000], January 21, 2012, http://www.jnto.go.jp/jpn/downloads/12.0120_monthly.pdf.

82. "Kaigai de no hoshano fuhyo higai ga osamarazu, shinki yushutsu kaitaku muzukashiku" [As harmful rumors continue abroad about radioactivity, new exports are difficult], Reuters, May 31, 2011, http://jp.reuters.com/article/topNews/idJPJAPAN-21446020110531.

Prefecture was in the blackout area while the leisure and entertainment center next to it was not affected and was operating as usual.[83]

As of June 7, 2011, of Japan's 50 nuclear power plant reactors (not including Fukushima Daiichi's Units 1–4, which it had been decided would be decommissioned), 31 were shut down and 19 were operating.[84] The economic minister at the time declared that if the 13 nuclear power plant reactors that were scheduled to have completed their regular inspections were not restarted by the summer, then the power supply—including the supply for western Japan—would be severely constrained.[85] Figure 2-3 outlines the assumptions made at the time regarding what would happen if those reactors shut down at that time could not be restarted, and if in roughly one year all nuclear power plants were shut down. Although in May 2012, all 50 reactors were shut down, as of July 2012, Kansai Electric Power Company's Ohi Power Station Units 3 and 4 had been restarted.[86]

In July 2011, the government took heed of the stress tests being conducted in the EU in response to the Fukushima Daiichi accident and decided to conduct its own safety assessments. The preliminary evaluation was supposed to determine the feasibility of restarting those nuclear power plants that had been shut down for regularly scheduled inspections, but that work has run into difficulty. At the end of March 2012, each power company announced its FY2012 power supply plan, but in a highly unusual move, the 10-year supply plan was listed as "undecided."[87]

Based on the situation and the need to use thermal fuel, TEPCO claimed that the price of electricity would have to rise. The industrial sector reacted sharply to this, and the Japan Industrial and Medical Gases Association, for example, decided that its members would not accept TEPCO's electricity rate hikes aimed at businesses,[88] but ultimately it was decided that TEPCO would raise electricity fees from September 2012.

(2) Distrust of past nuclear energy administration and changes in nuclear energy policy

The recent accident has also increased the criticism leveled at the way in which nuclear power has been managed to date.

When an incident arose whereby Kyushu Electric Power Co. (Kyuden) pushed its workers to send e-mails in response to a government-sponsored TV program that aired on June 26 to explain the situation at Kyuden's Genkai Nuclear Power Plant to residents in the prefecture, it laid bare the mutual interdependence between the power companies, the Agency for Natural Resources and Energy, and NISA.[89] At the Japan Nuclear Energy Safety Organization as well,

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[83]. "Higashi Nihon Daishinsai: 'uchi wa mainichi teiden, tonari wa tsuiteru' . . . naze?" [Great East Japan Earthquake: 'Our house has blackouts everyday, next door the electricity is on'. . . Why?], *Mainichi Shimbun*, March 22, 2011, http://mainichi.jp/select/weathernews/news/20110322mog00m040009000c.html.

[84]. On May 6, 2011, then Prime Minister Kan also asked Chubu Electric Power Co. to shut down all reactors at its Hamaoka Nuclear Power Plant (http://www.kantei.go.jp/jp/kan/statement/201105/06kaiken.html). This was based on the prediction that there is an 87 percent probability of a magnitude 8 earthquake occurring within the next 30 years in the Tokai region of Japan, and when it did so, it received a ¥100 billion government loan. See "Chubuden ni kinyu shien 1000-oku-en=Toden wa 2400-oku-en hosho wo—Kaieda Kansansho" [Trade Minister Kaieda: ¥100 billion loan to Chubu Electric = TEPCO compensation to be ¥240 billion], Jiji Tsushin, June 24, 2011.

[85]. Trade Minister Banri Kaieda, "Tomen no enerugii jukyo taisaku ni tsuite (genshiryoku no anzen taisaku no jisshi to saikido)" [Short term policy on energy supply and demand (Implementation of nuclear power safety measures and reactivation)], June 22, 2011, http://www.npu.go.jp/policy/policy09/pdf/20110622/siryou7.pdf.

[86]. Ibid.

[87]. Based on the "FY2012 Electric Supply Plans" on each electric company's website.

[88]. Masahiro Toyoda, Chair, Japan Industrial and Medical Gases Association, letter to TEPCO presenting the association's response to TEPCO's letter of March 9 (in Japanese), March 29, 2012, http://www2.jimga.or.jp/dl/sangyo/all/bumon-news/20120329toukyoudenryokuhenoikenn.pdf.

[89]. According to a study, issues were discovered in seven cases from October 2005 to August 2008. See "Genshiryoku hatsuden ni kakawaru shinpojiumu nado ni tsuite no dai-sansha chosa iinkai saishu hokokusho" [Final report of a third-party investigative committee on

according to a newspaper report, problems have been discovered regarding the reliability of the agency's inspection work.[90] In addition, the actions of some scholars with close ties to the government are problematic, as cases have come to light one after another of these scholars having received donations from the relevant industries.[91] It is difficult to determine the intent or degree of impact these donations had on policy decisions, but it has been sufficient to create distrust among the Japanese people.

Because the Nuclear Safety Commission did not function well at the time of the accident, and because of the inadequacy of its response, it was decided to overhaul the country's nuclear safety regulations. In June 2012, the Act on the Formation of the Nuclear Regulation Authority was established, under which the NISA was separated out from METI, and the functions of the Nuclear Safety Commission and other agencies were consolidated in a "Nuclear Regulation Authority under the Ministry of Environment. [92] This Nuclear Regulation Authority is expected to be launched in September 2012 as an external bureau of the Ministry of Environment, and the secretariat will be the Nuclear Regulation Agency.

On May 17, 2011, the cabinet agreed on a "Guideline on Policy Promotion" and the Council on the Realization of the New Growth Strategy agreed to come up with an innovative energy and environmental strategy. Within the Council on the Realization of the New Growth Strategy, an Energy and Environment Council was created, and on July 29, 2011, it offered an "Interim Compilation of Discussion Points for the Formulation of 'Innovative Strategy for Energy and the Environment.'"[93] That report proposed three basic philosophies: best mix, energy systems, and national consensus. It indicated the necessity of reducing reliance on nuclear energy and achieving a distributed energy system, and of a national dialogue that goes beyond the simple pro-nuclear/anti-nuclear dichotomy. In terms of the future outlook, on March 28, 2012, METI laid out four options at the Fundamental Issues Subcommittee of the Advisory Committee for Natural Resources and Energy for reducing the country's reliance on nuclear power to between 0 and 35 percent by 2030.[94] In order to advance public debate, the government held meetings in 11 cities around the country to hear opinions on these options and received public comments as well. Based on those results, Japan's energy policy, including its policy on nuclear power, was expected to be announced sometime during the summer of 2012.

symposia, etc., related to nuclear power], September 30, 2011, METI website, http://www.meti.go.jp/press/2011/09/20110930007/20110930007-2.pdf.

90. Various problems were discovered, including the fact that an inspection manual, which is supposed to be drafted independently, was an exact duplicate of a manual created by the manufacturer. Third-Party Investigative Committee on Inspections and Other Work, "Hokokusho—shutaisei to dokuritsusei no aru kensa nado gyomu purosesu no kochiku no tame ni" [Report for the purpose of creating independent processes for inspections and other tasks], January 12, 2012, JNES website, http://www6.jnes.go.jp/pdf/20120112_last-report.pdf.

91. For example, 24 members of the Japan Nuclear Safety Commission were found to have received ¥85 million in "donations" over the past 5 years from nuclear energy manufacturers ("Genshiryoku gyokai ga anzen'i 24-nin ni kifu—kei 8500-man-en" [Nuclear power industry gives 24 Nuclear Safety Commission members donations totaling ¥85 million], *Asahi Shimbun*, January 1, 2012); three university professors who are committee members for the Framework for Nuclear Energy Policy, which sets the guiding principles for nuclear energy policy, received approximately ¥18 million over five years ("Genshiryokui 3-nin ni gyokai kara kifu—5-nen-kan de 1800-man-en" [Three Nuclear Safety Commission members received ¥18 million over 5 years in industry donations], *Asahi Shimbun*, February 6, 2012, http://www.asahi.com/national/update/0206/OSK201202050122.html; and it was also learned that between FY2008 and FY2011, the JAEA, which provides many committee members for the country's national safety inspections, received ¥250 million from 11 electric companies that have nuclear energy facilities, and from the industry's Federation of Electric Power Companies of Japan ("Genpatsu jigyosha kara tagaku kifu—genshiryoku kiko e 2.5-oku-en" [Large donations from nuclear operators— JAEA received ¥250 million], Kyodo Tsushin, April 2, 2012, http://www.47news.jp/CN/201204/CN2012040201001987.html.

92. Cabinet Secretariat, "Genshiryoku Kisei Iinkai setchi-ho ni tsuite" [On the Act on the Formation off the Nuclear Regulation Authority], http://www.cas.go.jp/jp/genpatsujiko/info/seiritsu.html.

93. See National Policy Unit (Cabinet Secretariat) website, http://www.npu.go.jp/policy/policy09/pdf/20110908/20110908_02_en.pdf.

94. The four options were (1) 0 percent; (2) 20–25 percent; (3) 35 percent; and (4) Not appropriate to indicate a number. "Enerugii mikkusu no sentakusuji ni kansuru seiri (an)" [Energy mix options (draft)], materials prepared for the 17th Meeting of the Fundamental Issues Subcommittee of the Advisory Committee for Natural Resources and Energy, section 3-1, Japan Agency for Natural Resources and Energy website, http://www.enecho.meti.go.jp/info/committee/kihonmondai/17th/17-3-1.pdf.

(3) Impact on nuclear energy policy abroad[95]

① United States

While the US government was quick to express its comprehensive assistance to Japan in the wake of the Great East Japan Earthquake, following the Fukushima Daiichi Nuclear Power Plant accident, on March 13, 2011, the US government expressed its continued support of nuclear power and stated that it foresaw no changes to its policy of support for nuclear power. In light of the accident, however, on March 17, it asked the National Regulatory Commission (NRC) to perform a comprehensive review of the safety of domestic nuclear plants. Meanwhile, on March 16, US citizens in Japan were advised to evacuate the area within a 50 mile (80 km) radius of the Fukushima Daiichi Nuclear Power Plant. Also, after the accident occurred, the United States dispatched 11 experts to assist and continued to cooperate with Japan. And on March 23, the NRC announced the establishment of a task force to review safety regulations at domestic nuclear power plants. The results were released in a report on July 12, which offered 12 recommendations.[96]

② EU

On March 15, French Prime Minister François Fillon immediately asserted that people should not condemn nuclear power because of this accident, and the following day President Nicolas Sarkozy also stressed the significance of nuclear energy. Also, the government announced a safety review on the assumption of an accident similar to that at Fukushima. In terms of regulatory organizations, the French Safety Authority (ASN) reported on the current status of the Fukushima accident and the impact of radioactive material on France. It also participated in drawing up the specifications for stress tests of nuclear power plants. The Institute for Radiological Protection and Nuclear Safety (IRSN) released the results on their website of a simulation of the dispersal of radioactive materials in the air and also transmitted information in Japanese.[97] However, in a public opinion survey (of 1,005 constituents), in what was unprecedented for France, 77 percent of respondents favored abandoning nuclear power,[98] and nuclear policy was expected to be a focal point in the 2012 election,[99] showing that it is an item of real concern among the French people. The winner of that election, President François Hollande, announced that his government would reduce the country's reliance on nuclear energy.

The Federal Republic of Germany on March 14, 2011, proposed a three-month suspension of plans to extend the life of nuclear reactors in that country, which had been decided the previous year.[100] On March 15, the central government reached an agreement with the minister-presidents of those German states in which older reactors are situated, call for the shutdown of seven reactors that had been online since 1980 (agreement had not been reached, however, with the operators of the power plants, and the decision was

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95. Office for Atomic Energy Policy, Cabinet Office, "Higashi Nihon Daishinsai iko no genshiryoku seisaku ni kansuru kokusai kodo" [International trends in nuclear energy policy since the Great East Japan Earthquake], from section 2-2 of the materials for the 14th Meeting of the AEC, May 10, 2011, http://www.aec.go.jp/jicst/NC/iinkai/teirei/siryo2011/siryo14/siryo2-2.pdf.

96. US Nuclear Regulatory Commission, "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," July 12, 2011, http://pbadupws.nrc.gov/docs/ML1125/ML112510271.pdf.

97. "Yoku aru shitsumon" [FAQ], IRSN website, http://www.irsn.fr/EN/news/Documents/irsn-QA-jp.pdf.

98. Kyodo News (Paris), June 6, 2011.

99. "Jiron koron: Kiki no naka no Furansu daitoryo senkyo" [French presidential election in the midst of the crisis], NHK editorial archives, February 14, 2012, http://www.nhk.or.jp/kaisetsu-blog/100/109375.html.

100. The administration of Gerhard Schroeder in 2002 set a course for the elimination of nuclear power, aiming for total shutdown of all plants by 2022. That course was changed by Angela Merkel in 2010, who adopted a policy that would extend the operating lifespan of nuclear plants by up to 14 years as renewable energy becomes more widely used.

therefore made by government order[101]). Then, on April 15, it was decided that all nuclear power plants would be shut down as quickly as possible.[102] In addition, the Germans established an Ethics Commission for a Safe Energy Supply, which is debating primarily the social aspects of nuclear safety and is compiling a report.[103] In terms of the regulatory agencies, the Federal Ministry for the Environment (BMU) and the Federal Office for Radiation Protection (BfS) have each been providing reports on the Fukushima accident on their websites since March 12. And on March 30, the Reactor Safety Commission (RSK) launched a safety review of Germany's nuclear power plants.

Major movements were also seen in Switzerland and Italy.[104] And on March 21, 2011, the EU held an extraordinary meeting of the EU Energy Council and determined that safety reviews, or in other words stress tests, should be conducted of nuclear plants within the European Union, and the entire process was completed by June 2012.[105]

③ Russia, Asia, and the IAEA

On March 15, 2011, Russian Prime Minister Vladimir Putin ordered checks of his country's nuclear power plants, while President Dmitry Medvedev indicated that nuclear power is an economical means of generating power. The director general of Rosatom State Nuclear Energy Corporation, Sergey Kirienko, stressed that Russian-made reactors have a dual safety system. On March 28, Rosatom and Rostekhnadzor (the Federal Service for Ecological, Technological and Nuclear Supervision) began inspections of the Russian nuclear reactor safety systems.[106]

In Asia, while there has been no change in China's nuclear power development since the Fukushima accident, it has suspended the approval process for the construction of new nuclear reactors in order to review its safety criteria, but in June 2012, the State Council approved a "safety plan," and it is said the new construction will be resumed.[107] South Korea has similarly made no changes in its nuclear energy policy, but there have been

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101. "1980-nen izen ni kado shita genpatsu 7-ki wo ichiji teishi e" [7 nuclear reactors in operation since before 1980 will be temporarily shut down], Reuters, March 16, 2011.

102. "Doitsu, genpatsu unten kikan wo tanshuku e—Fukushima jiko de hoshin tankan" [Germany changes policy as result of Fukushima accident, shortens lifespan of nuclear plants], *Asahi Shimbun*, April 16, 2011.

103. Ethics Commission for a Safe Energy Supply, "Germany's Energy Transition—A Collective Project for the Future," Berlin, May 30, 2011, http://www.bundesregierung.de/Content/DE/_Anlagen/2011/05/2011-05-30-abschlussbericht-ethikkommission_en.pdf?__blob=publicationFile.

104. In Switzerland, the Minister of the Federal Department of the Environment, Transport, Energy and Communications (UVEK) froze all consideration of new nuclear plants on March 14, 2011. In addition, after March 12, 2011, the Swiss Federal Nuclear Safety Inspectorate (ENSI) was reporting on the Fukushima accident, and in addition they began consideration of stricter safety standards and carried out stepped up safety inspections of existing reactors. On May 25, 2011, the Swiss Cabinet passed a resolution that they would eliminate nuclear power. ("Suisu, 2034-nen made ni 'datsu-genpatsu' wo kakugi kettei" [Swiss reach cabinet decision to eliminate nuclear energy by 2034], AFP, May 26, 2011, http://www.afpbb.com/article/politics/2802499/7265715?utm_source=afpbb&utm_medium=topics&utm_campaign=txt_topics.) The plan is to start with reactors that are approaching the end of their operating lifespan and decommission them one by one so that all reactors will have been shut down by 2034. In Italy, prior to the accident the government policy was to revive its nuclear power program, but on March 17, 2011, they announced that they would not carry out a policy choice that did not have the consent of the Italian people. On March 23, the cabinet agreed to a one-year moratorium on any steps to revise nuclear power. Even prior to a June 2011 referendum, the government had decided to extend the moratorium indefinitely, but in the end, after a 94 percent vote against a revival, the Italian government decided to eliminate nuclear power. (See "Genpatsu toketsu sansei wa 94%—Itaria kokumin tohyo, kaihyo owaru" [The Italian people cast and counted their votes—94% are in favor of moratorium on nuclear power], *Asahi Shimbun*, June 15, 2011, http://www.asahi.com/special/10005/TKY201106140106.html.)

105. EU MAG http://eumag.jp/behind/d0512/ .

106. In addition, April 18, 2011, marked the 25th anniversary of the accident at Chernobyl, and at a summit in Kiev, a fund was set up to build a new shield to seal Chernobyl's Unit 4, where an explosion had occurred. The existing sarcophagus is deteriorating, and will not hold for more than five more years. Also the European Bank for Reconstruction and Development has already raised 990 million euros ($1.43 billion) for the project, but another 740 million euros is still needed. (James Gomez and Daryna Karsnolutska, "Chernobyl, Still Leaking, Forces Ukraine to See $1 Billion," http://www.bloomberg.com/news/2011-04-17/chernobyl-leak-forces-ukraine-to-seek-1-billion-after-25-years.html.)

107. "Chugoku, Fukukensho nadoshinki genpatsu 4-kasho no kensetsu purojekuto saikai ka" [Is construction resuming on four new nuclear plants in China's Fujian Province and elsewhere?], *Asahi Shimbun,* July 23, 2012, http://www.asahi.com/business/news/xinhuajapan/AUT201207230098.html.

opposition movements, and in February 2012 an issue arose when operators at the Kori Nuclear Power Plant hid the fact that there had been a power outage in Unit 1 from regulators for more than a month.[108] India is also reviewing the safety of its existing reactors, but is moving forward with plans for new construction. Vietnam is also maintaining its planned introduction of nuclear power, while placing highest priority on safety.

At the 55th IAEA General Conference,[109] discussions were held on an action plan to bolster nuclear safety.[110] The draft plan indicated 12 "main actions" including safety assessments in light of the Fukushima accident, but according to reports, as a result of opposition to tighter regulations from those newly emerging countries that are seeking to increase their reliance on nuclear energy, the content of the final draft stressed independence and retreated from the first draft.[111] Moreover, in the IAEA's estimates of nuclear power up through 2050, which it publishes annually, the IAEA reviewed the future of nuclear power as a share of total electricity and included forecast figures that were significantly lower than those indicated from the previous year.[112]

2.3 Societal impact and issues in the wake of the disaster

Based on the facts we have learned to date, what are the causes behind the impact the accident has had on society, and what are the issues that must be considered in the future?

(1) Social impact of the radioactivity

① The spread of the impact and cost of damages

Within Japan, the Fukushima accident has had an impact on all spheres of national society, including agriculture, forestry, and fisheries; manufacturing; education; industry; tourism; politics; and energy policy. Although nuclear power is just one of a number of power generating systems, the accident proved to have an enormous impact.

Although the final total amount of damage from the nuclear accident is not yet known, the Japan Center for Economic Research, for example, has calculated that the cleanup from the accident may reach as high as ¥20 trillion.[113] The Management and Financial Investigative Committee on TEPCO calculated that the transient damage alone (loss of property value and damage caused by rumor or misinformation) is approximately ¥2.6 trillion, while the required amount of compensation (evacuation expenses, emotional

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108. "Genpatsu jiko inpei de 3-nin kokuhatsu—Kankoku, jumin wa hairo yokyu" [3 indicted in cover-up of nuclear accident—Korea, general public call for decommissioning of reactors], *Sankei Shimbun*, April 4, 2012, http://sankei.jp.msn.com/world/news/120404/kor12040423050004-n1.htm.
109. IAEA 55th General Conference, IAEA website, http://www.iaea.org/About/Policy/GC/GC55/.
110. Report by the Director General, "Draft IAEA Action Plan on Nuclear Safety—GOV/2011/59-GC(55)/14 (5 September 2011)," http://www.iaea.org/About/Policy/GC/GC55/Documents/gc55-14.pdf.
111. "Genpatsu kodo keikaku no jikkosei ni kenen = jimukyokucho, minaoshi ni genkyu—IAEA sokai" [Concerns about the effectiveness of the Nuclear Action Plan—director-general discusses a review at the IAEA general conference], *Asahi Shimbun*, September 21, 2011, http://www.asahi.com/international/jiji/JJT201109210076.html.
112. Looking at the IAEA's annual report on "Energy, Electricity and Nuclear Power Estimates for the Period up to 2050," in the 2010 edition, for example, the estimates of nuclear electrical generating capacity in 2050 was 590 GW (5.0% share) on the low end and 1,415 GW (11.9% share) on the high end. In the 2011 edition, the low end was 560 GW (2.7%) and the high end was 1,228 GW (6.0%)—roughly half the previous year's estimated share. See IAEA website, http://www-pub.iaea.org/mtcd/publications/pdf/iaea-rds-1-30_web.pdf; http://www-pub.iaea.org/MTCD/publications/PDF/RDS1_31.pdf.
113. Japan Center for Economic Research, "Kizon genpatsu tomareba, eikyo 10-nen tan'i ni—denryoku busoku, GDP wo gendai 2% oshisage mo" [Stoppage of existing nuclear power generation would have decades-long impact—electricity shortages and 2% decline in GDP], April 25, 2011, http://www.jcer.or.jp/policy/pdf/pe(iwata20110425).pdf.

damages, business losses, etc.) until the accident is resolved will exceed ¥1 trillion in just the first fiscal year.[114]

In addition, there has not been adequate consideration as to whether losses have been incurred by companies overseas due to rumor and misinformation and what measures should be take with regard to the impact abroad. If in the future Japan is considering the export of nuclear power plants or tries to improve the safety of global nuclear power, then it will be necessary to conduct a quantitative assessment based on the Fukushima accident and determine a method of compensation.

② *Timeframe for the impact to be resolved*

Within the accident site, the plan is for the reactor to be decommissioned in about 40 years, but given that there has never been a similar experience, it is difficult to know whether that is realistic or not. In addition, while there may be a rough timeframe for the conclusion of decontamination efforts outside the site, the management of radioactive materials such as cesium, which has a long half-life, is extremely difficult. In either case, decommissioning and decontamination does not imply that radioactive materials will disappear; it simply means that they are moved to a different location.

Approval is being given for citizens to carry out decontamination, but this is being done while many issues remain unresolved—the securing of trustworthy professionals with expert knowledge, the effectiveness of decontamination by citizens, the health management of such individuals, and the securing of interim storage sites. Meanwhile, some point to the economic impact of these large-scale decontamination efforts and to the potential for it to become another “white elephant” public works project.[115]

③ *Low-dosage radiation exposure*

One probable root cause behind the confusion over radiation exposure is the scientific knowledge about “low-dosage radiation exposure.” There are two major biological effects of being exposed to radiation. One is a definite impact where the impact is predictable and there is a threshold dosage, above which symptoms will appear. It is possible to say that there is a danger if workers and other are exposed to that level of radiation.

The second effect is a probable impact, whereby the effects are likely to be caused depending on the dose. The effect can only be expressed as a probability, or to put it conversely, it is also impossible to say that below a certain level of radiation there will be absolutely no effect. The question is whether there is a “threshold” for low-dosage radiation exposure, or in other words if one can clearly indicate whether or not there is any impact from low-dose radiation at a certain fixed level. The fact that radiation protection measures should be premised upon the assumption that no threshold exists is a point of international agreement according to organizations such as the International Commission on Radiological Protection. It has been left up to the general public to think about this level of exposure, and since the public was suddenly required to make a judgment about “a phenomenon that cannot be decisively concluded even scientifically,” the public’s impact was significant.

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[114]. Committee report dated October 3, 2011, http://www.cas.go.jp/jp/seisaku/keieizaimutyousa/dai10/siryou1.pdf.

[115]. “Japan Split on Hope for Vast Radiation Cleanup,” *New York Times*, December 6, 2011, http://www.nytimes.com/2011/12/07/world/asia/japans-huge-nuclear-cleanup-makes-returning-home-a-goal.html?pagewanted=all.

(2) Social impact caused by the lack of clear information

① Habitual concealment of information

In addition to the fact that advances in the IT infrastructure—the Internet and Twitter did not exist at the time of past major nuclear accidents—resulted in a great deal of unconfirmed information flying about, Japan's unique closed nature also exacerbated the resultant chaos. It has become clear that immediately following the accident, there was a great deal of information that was not made available to the public, such as the core meltdown, the SPEEDI forecasts of the radioactive plumes, the "worst-case scenario," and so on. When it came to "groundless rumors" on the Internet, the Ministry of Internal Affairs and Communications was hastily responding just a few weeks after the accident, directing IT business operators to "appropriately" address the problem, [116] but at the same time the government was not releasing important information that it had, thereby further spreading anxiety among the public. An article in the *New York Times* addressed the delay in publicizing the SPEEDI data and other information, pointing to the Japanese government as "operating in a culture that sought to avoid responsibility and, above all, criticism."[117]

② The many stakeholders

According to a September 2011 report by the Japan Atomic Energy Commission, following the accident at the Fukushima Daiichi Nuclear Power Plant, the commission received approximately 4,500 comments from the public, and of those, 98 percent were in favor of "abandoning nuclear power."[118] On the other hand, in November, Keidanren's "Second Proposal on Energy Policy"[119] stated once again that in the short term, "it is very important that (. . .) nuclear power plants are reinstated after regular check-ups, upon confirming their safety," and that in the medium to long term, "The government must make extensive efforts to restore public trust in nuclear power so that it may continually assume a given role." Moreover, it came to light that in order to ensure the continuation of nuclear power, the Federation of Electric Power Related Industry Workers Unions of Japan (the union representing workers at all of Japan's electric utilities and related companies) is carrying out systematic efforts to lobby the Democratic Party of Japan. The budget for these political activities is approximately ¥750 million.[120]

Yet it was also reported that according to TEPCO's calculations, even if there was no nuclear power generation in the summer of FY2012, it would be able to supply around 5,700 kW of power by increasing thermal power generation.[121] Also, while it has often been claimed that h utility fees, thereby accelerating the departure of firms for overseas locations, believe nuclear power generation is necessary need to state their position, the fact that it has caused great confusion in society is a problem. For example, there have

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[116]. Ministry of Internal Affairs and Communications, "Higashi Nihon Daishinsai ni kakawaru intaanetto-jo no ryugenhigo e no tekisetsu na taio ni kansuru denki tsushin jigyosha kankei dantai ni taisuru yosei" [Request to telecommunications-related organization with regard to the appropriate handling of false rumors on the Internet related to the Great East Japan Earthquake], April 6, 2012, http://www.soumu.go.jp/menu_news/s-news/01kiban08_01000023.html.

[117]. "Japan Held Nuclear Data, Leaving Evacuees in Peril," *New York Times*, August 8, 2011. http://www.nytimes.com/2011/08/09/world/asia/09japan.html?_r=1&pagewanted=print.

[118]. Of those, 67 percent selected "should be immediately abolished," while 31 percent selected "should be gradually abolished," for a total of 98 percent. The reasons given included "has a major impact on the environment," "problem of radioactive waste has not been solved," etc. "Materials of the 6th Meeting of the New Nuclear Policy Planning Council," AEC website, http://www.aec.go.jp/jicst/NC/tyoki/sakutei/siryo/sakutei6/siryo3.pdf.

[119]. Keidanren, "Second Proposal on Energy Policy," November 15, 2011, http://www.keidanren.or.jp/en/policy/2011/107.html.

[120]. "Datsu-genpatsu wa komaru" [Abandoning nuclear power is worrisome], *Asahi Shimbun*, December 1, 2011, http://www.asahi.com/national/update/1201/TKY201111300881.html.

[121]. "Toden ga 'genpatsu-nuki no natsu' wo shisan—kotoshi uwamawaru kyokyuryoku" [TEPCO makes preliminary estimates of a 'summer without nuclear power'—supply will exceed this year's level], Kyodo News, November 22, 2011.

been many claims by the relevant parties that halting the use of nuclear power will lead to instability in the electrical supply and raise electricity rates, and will therefore accelerate the trend of companies moving their operations overseas, according to a survey by Keidanren, out of the 87 companies surveyed, not one responded that they considered shifting their businesses overseas as an effective or practical strategy to deal with the power supply issue.[122] While it may be necessary to put forth the arguments for why nuclear power generation is necessary, the fact that those with vested interests were conveying information premised on the resumption and continued existence of nuclear power prior to having a satisfactory discussion with the general public, led to a great deal of confusion in Japan's society.

In addition, from a security perspective, another opinion is that nuclear power is necessary as a "deterrent."[123] The issue of a statement made by a TEPCO employee at a public forum remains fresh in our memories, but first there must be a specific and thorough debate on these different positions.

③ The responsibility of the industrial sector

The responsibility of the industrial sector to society has not yet been adequately debated. Within that context, many new business initiatives have started up related to the response and recovery from the accident. For example, on April 9, 2011—at a point when not even one month had passed since the accident began and no conclusion was in sight—nuclear equipment manufacturer Toshiba indicated to the government that it would be possible to decommission Unit 4 at Fukushima Daiichi in 10 years.[124] Moreover, in 2012, as part of its "recovery support," Toshiba developed a new treatment facility for radioactive soil and began a full-fledged "decontamination business" that undertakes decontamination work for a fee of several million yen per case.[125] However, in terms of the decommissioning plans, there is a great deal of distrust among the Japanese people in terms of the attitudes and responsibility of the nuclear power industry, as was seen when it was indicated that it would be rash to talk about business less than one month after the accident, and before a resolution to the problem was even in sight.

It is probably difficult to pursue the responsibility of the manufacturers, and undoubtedly new technological development is important from the perspective of making a medium to long-term contribution to accident response, but when one aims at containing the confusion in society and about having a public debate on the future policy toward nuclear energy, it is important that we begin to debate the question of what responsibility corporations should bear toward society.

④ Inconsistencies in government statements

At the G8 Summit held on May 26–27, 2011, each government made a statement on the Fukushima accident and the future of nuclear power usage. Then Prime Minister Naoto

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[122]. Keidanren, "Konka no denryoku jukyu taisaku ni kansuru ankeeto kekka ni tsuite" [Results of survey on this summer's measures on electrical supply and demand], October 21, 2011, http://www.enecho.meti.go.jp/info/committee/kihonmondai/11th/11-7.pdf.

[123]. In a news broadcast, Policy Chief Shigeru Ishiba of the Democratic Party of Japan (DPJ) stated that having the capacity to generate nuclear power implies that Japan can produce nuclear weapons whenever it wants to, and thus it represents a latent deterrent force. The statement aired on August 16, 2011, on TV Asahi's "Hodo Station" broadcast.

[124]. "Fukushima Daiichi Genpatsu '10-nen de hairo ni,' Toshiba ga keikakuan" [Toshiba drafts plan to 'decommission reactors in 10 years' at Fukushima Daiichi Nuclear Power Plant], Kyodo Tsushin, April 9, 2011, http://www.afpbb.com/article/disaster-accidents-crime/disaster/2794832/7065976.

[125]. Toshiba, "Kabunushi tsushin 2012-nen haru-go" [Shareholder news—spring 2012], http://www.toshiba.co.jp/about/ir/jp/library/or/or2012/sp/or2012sp.pdf; and "Josen bijinesu honkakuka—unpan-shiki sochi kaihatsu, 1-ken suhyakuman-en de jutaku" [Going full steam on the decontamination business—developing transport-type apparatus and getting millions of yen per deal], *Sankei Business News*, December 27, 2011, http://www.sankeibiz.jp/business/news/111227/bsc1112270502004-n1.htm.

Kan spoke about natural energy and conservation, but unlike what he had said within Japan, he stressed improving the safety of nuclear power and indicated that there would be no change in Japan's peaceful use of nuclear power in the future, effectively declaring the "continuation of nuclear power."[126] However, Prime Minister Kan subsequently announced in Japan that his fundamental policy was to "abandon nuclear power," thus making different statements to domestic and international audiences, so the message the public got was that the government was placing greater priority on its foreign relations, including exports of nuclear power, than it was on the safety of its own people. This inconsistency in government statements is causing anxiety and distrust among the Japanese people, and is creating chaos.

(3) Compensation issue

On April 11, 2012, under the Act on Compensation for Nuclear Damage (hereafter, Compensation Act),[127] a Dispute Reconciliation Committee for Nuclear Damage Compensation was established that was to determine guidelines such as the scope of compensation and the method for calculating the amount of compensation to be paid.[128] Interim guidelines[129] released on August 5 dealt with not only compensation for evacuation-related damages and damages related to restricted shipping of agricultural, fishing, forestry, and manufactured products, but it also dealt with damages from harmful rumors and indirect damage.[130] On September 12, in order to carry out the work of making compensation payments to victims, the government established the Nuclear Damage Liability Facilitation Fund.[131] In addition, the Dispute Reconciliation Center for Nuclear Damage was established under the umbrella of the Dispute Reconciliation Committee in order to encourage the resolution of conflicts.

It has come to light that roughly one month after the accident, Ibaraki Prefecture's National Federation of Agricultural Co-operative Associations (JA) Group applied to TEPCO for approximately ¥1.846 billion in compensation. Among the agricultural, fishery, and industrial industries, this was the first case of a confirmed request amount, and approximately ¥1.4 billion of the request was for damages caused by rumor and misinformation in March 2011

[126]. Speech by Prime Minister Kan at the G8 Summit, Deauville, France, May 26–27, 2011, http://www.mofa.go.jp/mofaj/gaiko/summit/deauville11/g8_sk_hatsugen.html. In addition, the final declaration at that summit also indicated the encouragement of peaceful usage of nuclear power while ensuring safety. See "G8 Declaration—Renewed Commitment for Freedom and Democracy," May 27, 2011, http://www.g8.utoronto.ca/summit/2011deauville/2011-declaration-en.html#nuclear.

[127]. According to the Compensation Act, nuclear operators bear unlimited liability without fault, but in the case of "a grave natural disaster of an exceptional character" the operator is exempt from responsibility. Through a compensation contract between the nuclear operator and the government, in the case of a nuclear power plant, the government pays the nuclear operator a maximum of ¥120 billion per site, and in the case that it exceeds ¥120 billion, the government will provide the necessary assistance. See http://www.oecd-nea.org/law/legislation/japan-docs/Japan-Nuclear-Damage-Compensation-Act.pdf.

[128]. Not only does the Dispute Reconciliation Committee for Nuclear Damage Compensation (hereafter, Reconciliation Committee) set the types of nuclear damage, the scope of compensation, the method of calculating the damages, and other general policies, but when a dispute arises, it also mediates reconciliation of any dispute arising from compensation of nuclear damage. See http://www.oecd-nea.org/law/legislation/japan-docs/Japan-Nuclear-Damage-Compensation-Act.pdf.

[129]. Reconciliation Committee, "Tokyo Denryoku Kabushiki Kaisha Fukushima Daiichi, Daini Genshiryoku Hatsudensho jiko ni yoru genshiryoku songai no han'i no hantei nado ni kansuru chukan shishin" [Interim guidelines on determining the scope of nuclear damage caused by the accident at the TEPCO Fukushima Daiichi and Daini Nuclear Power Plants], August 5, 2011, MEXT website, http://www.mext.go.jp/b_menu/shingi/chousa/kaihatu/016/houkoku/__icsFiles/afieldfile/2011/08/17/1309452_1_2.pdf.

[130]. According to the Reconciliation Committee, "damages resulting from harmful rumors" are defined as those damages incurred when consumers or business customers refrain from purchases or terminate deals based on reports, etc., that generate fear that products or services will be contaminated with radionuclides. "Indirect damages" refers to cases where the trade is non-replaceable, or in other words, damages where the business has customers that are geographically limited and there is a clear causal relationship indicated.

[131]. The Nuclear Damage Liability Facilitation Fund provides the funds needed for nuclear operators to compensate damages and carry out other functions. This is to be done in order to achieve the following: take every possible measure to promptly and appropriately compensate victims for damages; stabilize the condition of TEPCO's Fukushima nuclear power plant and avoid any adverse impact on related business operators, etc., dealing with the accident; and provide a stable supply of electricity. "Framework of Government Support to TEPCO to Compensate for Nuclear Damage Caused by the Accident at Fukushima Nuclear Power Plant," June 14, 2011, METI website, http://www.meti.go.jp/english/earthquake/nuclear/pdf/20110513_nuclear_damages.pdf.

alone.[132] Also, more recently, on March 29, 2012, the city of Kashiwa in Chiba Prefecture submitted a claim for approximately ¥2.825 billion for the acquisition of radiation detection equipment and decontamination costs.[133] As of March 9, 2012, it was reported that the total amount of compensation paid was approximately ¥445.5 billion. Applications from individuals and companies received to date totals approximately 104,700 cases, of which payments have been made in roughly 62,800 cases.[134]

With the goal of dealing with the compensation issue and securing co-ownership of stable electrical power, on July 31, 2012, the government's Nuclear Damage Liability Facilitation Fund injected ¥1 trillion in public funds into TEPCO, effectively completing the nationalization of TEPCO. The Fund and TEPCO submitted a comprehensive restructuring plan to the government in mid-April, which was approved in May, and it is hoped that they will respond more promptly hereon out with regard to compensation issues, which are expected to become increasingly complex.

The lessons that we can draw from the facts presented in this chapter are outlined below.

a. Construct a new prevention and mitigation system

To start with, our major premise is that as all accident data and experiences should be preserved. For the future, as much data as possible should be kept not only from the time of the incident but from before and after as well. Because our current expertise is insufficient, it is important that we comprehensively capture everything, including information that we might think is unnecessary at the present time.[135] It is also important to share that data globally.

On top of that, it is important to quickly discuss a system to preemptively avoid accidents and the measures needed to bring that to fruition. One would be a multinational cooperative initiative and the setting of common international "disaster guidelines." During the Fukushima accident, societal confusion was created by differences in the guidelines of the United States, Japan, and other. For example, the United States evacuated US citizens within an 80 km radius, which caused confusion among Japanese citizens. Today, at a time when large volumes of information are exchanged between individuals and corporations across national boundaries, it would seem that globally shared disaster prevention guidelines and standards of action are needed to prevent global panic as well.

The data from the CTBTO Preparatory Commission played a useful role in alleviating global concerns by conveying the information that the accident would not have an impact on a global scale, and some arrangement is needed to share that data publicly and without restrictions. The Government of Japan in February 2012 provided approximately ¥60,000,000 to the CTBTO Preparatory Commission for a capacity-building project related to its air

132. "Toden ni 18-oku-en wo baisho seikyu e—nosuisanbutsu no higai de hatsu" [TEPCO gets ¥1.8 billion in reparations claims—first for damages to agricultural and marine products], Kyodo Tsushin, April 25, 2011, http://www.47news.jp/CN/201104/CN2011042501000813.html.
133. "Higashi Nihon Daishinsai: Fukushima Daiichi Genpatsu jiko—Kashiwa-shi, Toden ni 28-oku-en seikyu/Chiba" [Great East Japan Earthquake: Fukushima Daiichi Nuclear Power Plant accident—Kashiwa requests ¥2.8 billion in compensation from TEPCO/Chiba], *Mainichi Shimbun*, March 30, 2012.
134. "Toden no baisho, shiharai sogaku 4455-oku-en—9-ka jiten" [As of March 9, TEPCO compensation, payments total ¥445.5 billion], *Sankei Shimbun*, March 11, 2012, http://sankei.jp.msn.com/affairs/news/120311/dst12031122060051-n1.htm.
135. For example, the distance attained by fission products is exceeding what was previously thought to be "common sense."

transport model (a forecasting system for the diffusion of airborne radioactive materials),[136] but simply providing the budget for such projects is not enough. A specific framework and initiatives should be proposed to apply that information as a one element of a new accident prevention and mitigation strategy.

However, the difficulties and limits of such efforts must also be calmly understood. Accidents involving such complex and massive technologies as nuclear power generation are not anomalies, but rather are 'produced by the system itself, or in other words are inherent to the system and are created as a product of the system at work'—in other words, they are not an anomaly but a normal condition.[137] In 1989, Jinzaburo Takagi offered "10 characteristics of modern accidents," and these characteristics seem to pertain to the accident at the Fukushima Daiichi plant.[138] Rather than dealing with accident prevention and mitigation through makeshift solutions, research is needed based on the study of accidents in light of today's mega science and technology. And the knowledge gained on nuclear accidents should not be kept within groups of experts, but should be shared more broadly with the general public. By doing so, the public can gain knowledge on nuclear accidents themselves and will break away from reliance on the myth of absolute safety, and as a result, this will help to avoid confusion in society (particularly the compensation issue and risk issues) and will help mitigate the impact of accidents.

Nobel Prize–winning economist Joseph Stiglitz explains, "When others bear the costs of mistakes, the incentives favour self-delusion. A system that socialises losses and privatises gains is doomed to mismanage risk."[139] In this way, there needs to be a deeper debate that starts with the essential issues and goes beyond the recovery from and analysis of the recent accident, Otherwise, we will have learned nothing from this accident.

b. The issue of "scientific accuracy" and "social correctness"

On June 20, 2011, the participants in the IAEA Ministerial Conference on Nuclear Safety commented on the Fukushima nuclear accident, noting that they "emphasize the importance of adequate responses based on scientific knowledge and full transparency" when such accidents occur.[140] However, it would seem that what this accident demonstrated was the difficulty politically and socially of making decisions on how to mitigate the societal impact of this nuclear power accident against the backdrop of the low-dosage radiation exposure issue, which is "an ambiguous event even scientifically." It seems clear from the extreme circumstances of the Fukushima events that what is accurate scientifically and what is correct for society are two different matters.

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[136]. MOFA, "Japan's Voluntary Contribution for the Enhancement of the Atmospheric Transport Modeling System of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)," February 27, 2012, http://www.mofa.go.jp/announce/announce/2012/2/0227_01.html.

[137]. Charles Perrow, *Normal Accidents* (Princeton NJ: Princeton University, 1984).

[138]. The characteristics were (1) the accident will be an unmistakably modern event; (2) at the same time, it will be exceedingly classic; (3) the accident will have multiple causes—in particular, both mechanical and human mistakes will contribute; (4) the accident will have been foreseen; (5) it will be impossible to completely clarify the accident; (6) operators are not fully prepared for the accident; (7) residents are completely unprepared for the accident; (8) the enormity of the accident will have military technology at its root; (9) the damage will not be visible to the eye; (10) the accident cannot be completely resolved. Jinzaburo Takagi, *Kyodai-jiko no jidai* [The era of mega-accidents] (Tokyo: Kobundo, 1989).

[139]. Joseph Stiglitz, "Meltdown: Not Just a Metaphor," *The Guardian*, April 6, 2011, http://www.guardian.co.uk/commentisfree/cifamerica/2011/apr/06/japan-nuclearpower.

[140]. This was included in the 4th item of a 25-point declaration. The full text reads, "(We, the ministers of the member states of the IAEA,) recognize that nuclear accidents may have transboundary effects and raise the concerns of the public about the safety of nuclear energy and the radiological effects on people and the environment; and emphasize the importance of adequate responses based on scientific knowledge and full transparency, should a nuclear accident occur." For the English text, see the IAEA website, http://www.iaea.org/Publications/Documents/Infcircs/2011/infcirc821.pdf.

As a result of the Fukushima accident, the public was suddenly asked to make their own decisions on a situation—low-dose radiation exposure—on which even the scientists are unable to conclusively decide. Because it was vague as to whether the government's explanation was based on what was accurate scientifically or on what was correct for society, as a result many in the general public were distrustful of the government and tried to get "correct" information themselves. Also, various people, including those with vested interests, made assertions based on their own positions, and those types of statements also blurred the lines between "scientific accuracy" and "societal correctness." In order to avoid confusing the public, it is important to distinguish between the two. Based upon the assumption of adequate disclosure of information, we need debate and as much clarification as possible with regard to what political and societal posture is being taken in response to a given situation and on what basis.

Chapter 3: Japan-US Cooperation and Crisis Management after the Fukushima Daiichi Nuclear Power Plant Accident

In responding to the accident at the Fukushima Daiichi Nuclear Power Plant, the cooperation of the Japanese and American governments and private sectors of both countries was significant for the management of the accident. In what was the first large-scale nuclear accident the international community has faced since the incidents at the Three Mile Island nuclear power plant in the United States and the Chernobyl nuclear plant in the former Soviet Union, the cooperative relationship that the two countries enjoy in so many fields was applied throughout the process, from managing the crisis when the accident occurred through to bringing it under control and then cold shutdown. In addition to preventing the accident from expanding, their efforts should be viewed as an example of adaptive measures in crisis management.

3.1 The Fukushima nuclear accident and Japan-US cooperation

Japan and the United States are leaders in the world's nuclear power industry, and in the areas of technological development and export promotion, they are both partners and rivals. Japan's peaceful use of nuclear power was encouraged through cooperation with the United States. The basis for that relationship was formed through such agreements as the 1968 Agreement for Cooperation between the Government of the United States of America and the Government of Japan Concerning Peaceful Uses of Nuclear Energy (former agreement; hereafter, Japan-US Nuclear Energy Agreement), and the 1988 Japan-US Nuclear Energy Agreement (new agreement), which enabled Japan to steadily carry out research and development on the nuclear fuel cycle. In that sense, in terms of the promotion of the nuclear power industry, the relationship between the two countries can be described as one of co-existence and co-prosperity.

The United States and Japan have maintained an alliance for more than 50 years, and particularly in the post–Cold War era they have agreed to deepen the joint operations of the Self-Defense Forces (SDF) and US Armed Forces in the areas of both security and crisis management. Particularly since 2005, the two countries have been establishing and refining the necessary measures during non-emergency, or "peacetimes" . [141] And this deep cooperative Japan-US relationship that had been developed before the Great East Japan Earthquake formed the basis for effective joint action at the time of the Fukushima nuclear plant accident.

As a result of the Great East Japan Earthquake, there was both the direct damage inflicted by the earthquake and the ensuing tsunami, such as the destruction of the social infrastructure and the rupture of the IT networks, as well as damage caused by intervening societal factors, as was the case in the accident at the Fukushima Daiichi Nuclear Power Plant. The scale of each individual disaster was enormous, and looking back at it today, even if Japan had implemented efforts through a "whole of government" approach, it is difficult to clearly assess whether they could have responded effectively and efficiently. Many are of the opinion in the U.S. says that, as has been said in the United States, Japan took the best steps it could in the face of a situation that was similar to the Northridge Earthquake, Hurricane

[141]. Security Consultative Committee, "US-Japan Alliance: Transformation and Realignment for the Future," October 29, 2005, MOFA website, http://www.mofa.go.jp/mofaj/area/usa/hosho/pdfs/henkaku_saihen.pdf.

Katrina, and the Three Mile Island nuclear accident occurred at single instance. If that type of multiple-disaster scenario had happened in the United States, it is doubtful whether they could have effectively dealt with it either.

However, there is a major difference between the United States and Japan in terms of the awareness of the crisis management system, and even within crisis management situations, the US approach differs greatly from that of Japan in terms of how the nuclear power issue is positioned. The United States experienced a nuclear accident at Three Mile Island accident in 1979,[142] when the reactor coolant was lost, and the US Navy is operating nuclear-powered vessels. Accordingly, the United States takes a strict approach toward nuclear disasters. Japan as well experienced a critical accident at the JCO nuclear facility in Tokai-mura in September 1999, but it is difficult to make a straight comparison between these cases, and it is also difficult to tell just how much the lessons from that accident were applied in the case of the Fukushima Daiichi Nuclear Power Plant accident.

In the Fukushima accident, the rapidity of the initial American crisis management response stood out. One characteristic of US crisis management is that they quickly coordinate at the policymaking level. For example, immediately after the earthquake struck, the relevant staff convened an emergency meeting at the White House. In addition, for the purpose of gathering and consolidating information, a teleconferencing system was secured for liaison and coordination with the US embassy in Japan. In order to gather and convey information from each department and agency, the web-based system established by the embassy in Tokyo was fully utilized in particular. The United States also set up a system that enabled relevant staff posted primarily in the Asia Pacific region to quickly and easily travel to Japan with the objective of encouraging the emergency deployment of key crisis management personnel, In these efforts to gather and consolidate information, a situation arose in which the flow of regular information from Japan other than social media was "interrupted," and officials on the US side, driven by frustration, went outside the institutional frameworks for the exchange of information and contacted the Japan side.

The gathering of crisis management personnel from the Asia Pacific region is done through the use of the US Agency for International Development program known as the Disaster Assistance Response Team (DART).[143] In the case of the Fukushima nuclear accident, the US Department of Health and Human Services (in charge of the health impact of radiation exposure) and the NRC (with the objective of providing advice to the Japanese government on nuclear power issues) were among the organizations that played a central role under DART. There is a system in place that allows funds related to crisis resolution to be allocated through DART from the USAID's humanitarian assistance funds without the need for supplementary budget requests. In addition to USAID funds, the Office of Foreign Disaster Assistance (OFDA), which is under the jurisdiction of the USAID, and with partly in cooperation with Defense Department, handles the costs of activities by nuclear scientists and others. Those funds ended after three months and were thereafter covered by the Department of Energy.

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[142]. Three Mile Island was a level 5 accident on the INES scale (accident with wider consequences). The Tokaimura JCO accident was a level 4 (accident with local consequences), and the Fukushima Daiichi accident was a level 7 (major accident). The only other accident that reached a level 7 in the past was Chernobyl.

[143]. The conditions for the mobilization of DART are that a request is made by Japan, that the scale of the disaster exceeds Japan's response capability, and that responding is in the interests of the US government. Recognizing the severity of the Fukushima nuclear accident, the Los Angeles and Fairfax county fire departments, which had signed agreements with DART, dispatched personnel to assist with search and rescue operations, while at 12:00 a.m. the following day (US Eastern Standard Time), 21 scientists from the Nuclear Regulatory Commission, Department of Energy, and the Department of Health and Human Services were assigned as members of DART.

Moreover, the US response to nuclear energy and nuclear weapons issues differs greatly from that of Japan. To begin with, there are separate government organizations to handle the promotion of nuclear energy policy and regulations. In particular, crisis management and nuclear security are handled by the Nuclear Regulatory Commission (NRC), which is independent of the government. Immediately after the accident occurred, the NRC was called upon to gather information, and at the same time it was transmitting advice on the measures that the Japanese government should implement. If one looks at the NRC meeting minutes, e-mail messages, and other records of updates, which have been released to the public based on the Freedom of Information Act, the NRC was concerned about meltdowns in Units 1–3 immediately after the accident occurred, and on March 16, the agency was deliberating on the necessity of an 80 km (50 mile) radius evacuation zone. Based on its own forecast model of the dispersion of radioactive materials, the NRC was envisioning the worst-case scenario. In fact, NRC Chairman Gregory Jaczko expressed his concern after hydrogen explosions had occurred in Units 3 and 4, that the spent fuel that was stored in the six nuclear reactors of the Fukushima plant would explode.[144] Chairman Jaczko also indicated to the media that the NRC analysis was pessimistic on the water level in the spent fuel pool in Unit 4.[145]

The United States took a very cautious approach in terms of crisis management related to the radioactivity. On March 15, dosimeters on the nuclear-powered aircraft carrier *George Washington*, stationed at Yokosuka, detected low-level radioactive materials. Following that, on March 17, the headquarters of the US Armed Forces Japan recommended a voluntary evacuation of military families and civilian personnel at the bases in Yokosuka and Atsugi. In addition, the same day, Ambassador Roos advised all US citizens living within a 50 mile (approximately 80 km) radius of the Fukushima nuclear plant to evacuate. The response of the US military, which possesses nuclear-powered aircraft carriers and submarines, was even more sensitive, and on March 21, the George Washington urgently left port for repeated repairs at sea, and those repairs in Japan's coastal waters (they entered the port of Sasebo) continued until April 20[146] .

Compared to the Americans' maximum approach to crisis management and their rapid response, the Japanese crisis management response is more gradual, and judging just by the Fukushima Daiichi nuclear accident, it did not function adequately. However, while the approach of the two countries to crisis management differs greatly and the United States was growing increasingly frustrated with the Japanese response, the fact that despite its frustration the United States continued to be cooperative in responding to the accident was of course due to the existence of the Japan-US alliance relationship that had been built up during the postwar era and which had deepened since the end of the Cold War. The fact that the United States provided material assistance to Japan in the form of a non-compensated grant may in part be a result of the way in which US disaster assistance measures are regulated, but its unhesitating provision of technological and response capabilities is something that would not have happened had the Japan-US alliance not existed. When the United States proposed the grant, the Japan side initially interpreted the US propose as a loan or sale, and this misunderstanding led to a delay in the provision of relief goods in the early phase.

[144]. See NRC accounts of the events at http://www.nrc.gov/reading-rm/foia/japan-foia-info/2012/.

[145]. On May 25, 2012, Unit 4 of the Fukushima Daiichi plant was opened to the media, and it was confirmed that the spent fuel pool in that unit was full of water. Immediately following the accident as well, the SDF visually confirmed the existence of water, but the NRC was dubious about that information. As a result, although the Japan side's observations were correct, the US took a conservative approach to crisis management.

[146]. Considering that the Fukushima nuclear accident occurred in Japan, it was natural that the SDF, at the request of the prime minister, would have to incur risks, such as spraying water as a coolant on the reactors from a helicopter after measures were implemented to minimize the damage from radiation. Straight comparisons are difficult, but the fact is that the US methods of gathering and disclosing information greatly differed from those of Japan.

Another factor behind the proactive US assistance to Japan was its fear of the negative impact on the global growth of the nuclear power industry if the nuclear accident worsened. The sudden expansion of the global nuclear energy market—dubbed the "nuclear renaissance"—has presented significant business opportunities for the US and French nuclear power industries in particular, and thus in order to maintain that business environment, it was essential to limit the damage and quickly resolve the Fukushima accident. In this sense, the United States and France shared a common interest.[147] However, because of the background of the Japan-US alliance, it was the United States that was actively involved in efforts to resolve the situation, while the French were involved onsite and also in the work within the reactor buildings, in part through the provision by AREVA of technology for the absorption of radioactive materials.

If we look at the difference in the level at which the Americans and the French were engaged, whereas the United States was able to strengthen the relationship through official channels such as the Ministry of Foreign Affairs (MOFA) and the Ministry of Defense, France deepened its ties to Japan based on industry-to-industry cooperation, with its efforts centered on its ties to the Ministry of Economy, Trade and Industry (METI) Agency for Natural Resources and Energy among others. For that reason, within the framework of international cooperation in responding to the Fukushima nuclear plant accident, France's ability to make proposals on information gathering or the provision of technology was more limited than that of the United States.

3.2 A chronology of Japan-US cooperation and crisis management

This section will provide a chronological look at the development of Japan-US cooperation.

At 2:46 p.m. on March 11, 2012, a major earthquake struck, centered off the Sanriku coast. At the Fukushima Daiichi Nuclear Power Plant, the reactors that were operating at that time (Units 1, 2, and 3) automatically shut down. Approximately 30 minutes after the earthquake, a large-scale tsunami hit, causing a total power outage, following which the reactors lost their cooling function and it remained out. At 3:42 p.m. on that day, the operator of the plant, TEPCO, issued a notice that an incident as stipulated in Article 10 of the Act on Special Measures Concerning Nuclear Emergency Preparedness (hereafter, Nuclear Emergency Preparedness Act) had occurred. At 4:45 p.m., when the emergency core cooling devices in Units 1 and 2 became unable to inject water into the reactors, it issued a notice under Article 15 of the Act,[148] and additional notices under Article 15 were made intermittently as a result of a rise in radiation doses within the boundaries of the site, the abnormal rise in pressure within the containment vessel, the loss of cooling functions in the reactors, and so on. On March 12, at 3:36 p.m., a water vapor explosion occurred in Unit 1. In Units 2 and 3, injections of fresh and salt water were carried out and the vents of the containment vessel were opened in an effort to decrease the pressure, but at 11:01 a.m. on March 14, a water vapor explosion occurred in Unit 3, and on the 15th, around 6:30 a.m., explosions in Unit 2 and Unit 4 damaged the containment vessels.

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[147]. French President Sarkozy's visit to Japan on March 31, 2011, was the first by the leader of a major nation since the accident, and he pledged full cooperation from France's AREVA in dealing with the Fukushima nuclear accident. In addition, at the G8 Summit held in France in May, leaders agreed to create new international standards for nuclear energy safety, and at the Japan-France bilateral summit held at that time, the leaders of both countries confirmed the need for their respective nations to rely on nuclear energy. See G20-G8 France 2011 website, http://www.g20-g8.com/g8-g20/g8/english/home.18.html.

[148]. Article 15 deals with the declaration of a nuclear emergency situation, based on which a Nuclear Emergency Response Headquarters is to be establish, as stipulated in Article 16.

Immediately following the initial events on March 11, the Japanese government set up a Cabinet Response Office to handle the accident at the Fukushima Daiichi Nuclear Power Plant, and at 7:03 p.m., the government issued a declaration of a nuclear emergency situation and established a Nuclear Emergency Response Headquarters Related to the Fukushima Daiichi Nuclear Power Plant. A second declaration of a nuclear emergency situation was issued on March 12, at which time the name of the headquarters was changed to the Nuclear Emergency Response Headquarters Related to the Accidents at the Fukushima Daiichi Nuclear Power Plant and the Fukushima Daini Nuclear Power Plant.

Following the explosion at Unit 1, the Japanese government had been focusing on the conditions in Units 2 and 3, but the United States was focusing its attention on Unit 4, where spent fuel was stored. It was difficult to assess the impact of the seismic motion on the water levels in the storage pools, but subsequently the Japanese were able to obtain data, in part through observations made through a crack in the rubble of the damaged Unit 4, that confirmed it was not in a state of "heating an empty kettle." Until that was confirmed, the United States was concerned that a chain reaction of nuclear damage would occur. On March 15, under Article 64, paragraph 3 of the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors, the Minister of Economy, Trade and Industry ordered TEPCO to extinguish the fire and prevent the reoccurrence of criticality in Unit 4's spent fuel pool, and to inject water into the reactor in Unit 2. On the same day, at 11:00 p.m., the minister further ordered that "water be injected into the spent fuel pool of Unit 4 as quickly as possible." This order was intended as a measure to stop the spread of the damage after an explosive event occurred in Unit 4.

The disaster response of the Ministry of Defense and the SDF, such as offsite efforts to evacuate residents as prescribed under the Ministry of Defense's Disaster Management Operation Plan, came to the forefront after the prime minister issued orders on March 20. Of course, that is not to imply that the Ministry of Defense and SDF were not involved in the nuclear accident prior to March 20; as noted above, they were involved in such actions as the effort to douse the reactors with water from helicopters, and there were SDF officers involved in disaster response onsite as well (in fact, several SDF troops sustained injuries when the Unit 3 reactor building exploded as they were involved in efforts to supply water). According to the Ministry of Defense's Disaster Management Operational Plan, the plan for handling a nuclear power disaster calls for the dispatch of the SDF by order of the minister, and while the content of their activities will differ according to the nature of the disaster and the status of assistance from other agencies, it fundamentally includes the following: (1) monitoring support, (2) damage assessment, (3) evacuation assistance, (4) search and rescue of the missing, (5) fire fighting, (6) emergency medical assistance and relief, (7) emergency transport of personnel and supplies (transport of nuclear specialists and nuclear-related materials and equipment), (8) securing or eliminating risks, and (9) others (actions that are within the capabilities of the SDF and are required at that time). The duties outlined above are wide-ranging. Prior to the establishment of the Nuclear Emergency Response Headquarters, they were to be mobilized as designated by the relevant ministries and agencies; subsequently, they were to be mobilized at the instruction of the head of the Response Headquarters. However, in terms of their onsite activities, the SDF's duties were not spelled out and the methods and procedures for coordinating with other agencies were not clarified.

However, the March 20 order stipulated the form that the SDF involvement should take. As an order from the director-general of the Nuclear Emergency Response Headquarters (i.e., the prime minister), based on Article 20, paragraph 3 of the Act on Special Measures Concerning

Nuclear Emergency Preparedness, it was declared that (1) in terms of the specific guidelines to be applied onsite with regard to dousing the facilities at the Fukushima Daiichi plant with water, observing, and other necessary tasks, the SDF would take the lead at the onsite coordination center and would make final decisions based on coordination with the relevant government institutions and TEPCO, and (2) the SDF forces dispatched to the site will centrally manage the implementation of work according to the applicable guidelines at the onsite coordination center.

In terms of the US actions, from March 13, the day after the accident occurred, an NRC team comprised of experts on reactor safety, protective measures, and international relations was stationed in Tokyo and began holding discussions primarily with the NISA.[149] In terms of cooperation on cooling the reactors, US forces are forbidden by regulation to enter the zone within an 80 km radius of a nuclear disaster that occurs overseas, so they have been cooperating mainly through the provision of equipment. As part of its emergency assistance supplies, US forces provided two of their high-pressure water canon trucks. The SDF sprinkled (approx. 80 tons of water) the Unit 3 spent fuel pool on March 17 at 9:48 a.m., the police sprayed water on at 7:05 p.m. that day, and then the SDF fire trucks doused the pool again at 7:35 p.m. Then on March 18 at 2:42 p.m., TEPCO used the US high-pressure water canon trucks to douse the spent fuel pool (approx. 2 tons). The US trucks were used by TEPCO again on March 21 to douse Unit 4 as well.

Because the reactors' cooling equipment was damaged, it was necessary to continue pouring water onto the reactors to cool them, and also to inject water inside the reactors to maintain the water level. Ideally, one needs to inject fresh water, but because fresh water was difficult to obtain, they decided to inject seawater, which caused significant damage to the inside of the reactor. This decision was made on March 12 at 6:00 p.m. at the direction of the prime minister (based on the prime minister's instructions, the minister of the economy, trade and industry gave the order under Article 64, paragraph 3 of the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors). On this point, the US NRC recommended to the Japanese government that they switch to fresh water as quickly as possible, and echoing that, the US sent two barges from its Yokosuka Naval Base. The provision of these barges was done prior to the conclusion of coordination work between the United States and Japan, and the US military moved forward on its own and started towing the boats. As noted earlier, the US forces cannot enter the immediate vicinity of the Fukushima nuclear plant, and so the barges were turned over to Japanese command at Onahama Bay, following which a Maritime SDF vessel towed them the rest of the way, with the first barge reaching the Fukushima Daiichi plant on March 31. The second barge left Onahama Bay on April 1, arriving at its destination early the following morning.

The area in which US cooperation in dealing with the nuclear disaster was most effective was the dispatch of a team from the Department of Energy to operate equipment for aerial analysis and assessment of ground deposition of radioactive materials with Aerial Measuring System:AMS. This team used two US Air Force helicopters and one unmanned reconnaissance plane, and from the time they arrived they provided daily aerial recordings of the status of ground contamination and aided with response and recovery activities. The data was made available to the public on the Department of Energy website, which played a role in making contamination status data open. In particular, there was a lag in making SPEEDI data available to the public, and so the US data was extremely valuable in coming up with

[149]. The key figure dispatched was NRC's Charles Casto, an expert on the Fukushima nuclear power plant and similar nuclear reactors.

plans and implementing the evacuation of citizens.[150] When the US team returned home, they gave the equipment used for gathering data and the software for data analysis to the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) at no cost, and since then the Japanese government has been operating it. According to the Department of Energy's monitoring data, after March 19 no radioactive materials were dispersed into the air in the area around the Fukushima Daiichi nuclear power plant, proving that the situation had successfully been brought under control and managed.[151]

In addition, another major area of cooperation was that in order to increase the analysis of agricultural soil samples and the number of tests for radioactive contamination on food and water, the United States provided germanium radiation detectors and cooperated in analyzing the absorption rate of radioactive isotopes in major food items. Also, if one looks at Japan-US cooperation related to the Department of Energy, in order to create a video record and radioactivity dose map, they provided a custom-made robot, a radioactivity sensor kit, a radioactivity tolerant camera, and a gamma camera, and they provided five large stainless steel tanks to store radioactive contaminated water.

3.3 Military-to-military cooperation

Because Japan-US cooperation in responding to the Fukushima nuclear accident took the form of the US military and others assisting the efforts of Japan's Defense Ministry and SDF, first we must understand the actions taken by the SDF.

Immediately after the disaster struck on March 11, at 6:35 p.m., 110 members of the Ground SDF Central Readiness Force and 4 chemical reconnaissance vehicles were placed on alert at Camp Asaka in order to be ready to respond to a nuclear disaster. At almost the same time, 80 members of the 44th Infantry Regiment (Fukushima) were departing for the Off-Site Center. It thus would seem appropriate to say that the SDF's initial response system was efficient. Having received the order to dispatch troops to address the nuclear disaster, at 7:30 p.m. the Ground SDF chemical reconnaissance vehicles from Camp Omiya headed out for the Fukushima Daiichi Nuclear Power Plant. These first response units reached the site before dawn on March 12. In addition, the Central Nuclear Biological Chemical Weapon Defense Unit (Asaka), the 6th Chemical Protection Unit (Koriyama), and the North Eastern Army left their bases for the gathering point at the Off-Site Center, and the North Eastern Army began negotiations to request that the US Armed Forces provide transport for personnel and vehicles.

In the initial stages, the SDF's work centered primarily on rescue assistance and information gathering, but the assistance for onsite cooling efforts soon increased. The 44th Infantry began work immediately after reaching the Fukushima Daiichi plant, helping to transport power sources. After March 12, SDF forces were actively carrying out radiation monitoring and assisting the cooling efforts. First, the Maritime SDF Fleet Air Wing 2 (Hachinohe) and others began carrying out monitoring activities using Geiger counters. On March 13, the 1st Helicopter Brigade (Kisarazu) sent a UH-60 Black Hawk to begin monitoring work. On the 14th, Fleet Air Wing 31 (Iwakuni) sent an OP-3C to assist in monitoring. From March 18 on,

150. SDF began aerial monitoring on March 24, 2011, and joint US Department of Energy/MEXT monitoring was carried out from April 6 on. The process through which the SPEEDI data was not publicly released is explained in the report presented by MEXT to the Diet's investigative committee, "Tokyo Denryoku Fukushima Genshiryoku Hatsudensho jiko chosa iinkai gosetsumei shiryo" [Explanatory materials for the Fukushima Nuclear Accident Independent Investigation Commission NAIIC)], http://www.naiic.jp/wp-content/uploads/2012/01/ik02_monbuka_shiryo.pdf.

151. US Department of Energy, "Radiation Monitoring Data from Fukushima Area," http://energy.gov/downloads/radiation-monitoring-data-fukushima-area.

the SDF forces were active in monitoring the areas around the plant with the objective of providing reconnaissance, thermography, dust sample collection, and so on.

However, the largest task the SDF would be involved in was "water" transport and cooperation in efforts related to cooling the reactors. The Air SDF's Central Air Defense Force (Kisarazu) had already transported water tank cars, cooling turbines, iodine pills, etc., to the region by plane on the 12th, and on the following day 9 water tank cars were sent from the Northern Air Defense Force, Central Air Defense Force, and other Air Defense Command Direct Reporting Units. Additionally, pump cars and tankers were provided along with other materials and supplies in response to the onsite requests. From that point on, these efforts were carried out continuously.

Through Operation Tomodachi, at the height of the crisis the US Armed Forces (including Navy, Marines, Army, Air Force, and the Chemical Biological Incident Response Force [CBIRF] of the Marines) deployed roughly 140 aircraft, 15 ships, and roughly 16,000 personnel. Although the main content of their work shifted over time, generally it fell into the categories of search and rescue, transport, restoring infrastructure, and nuclear disaster response.

According to documents compiled by the Defense Ministry, the US forces' assistance in the latter category consisted of assistance in reactor cooling efforts (provision of 2 fire engines to TEPCO, loan of 5 fire pump trucks, provision of 100 radiation suits, loan of 2 fresh water barges and pumps, and provision of approximately 9 tons of boric acid), data gathering and analysis (aerial radiation measurement and imaging, etc.), dispatch of experts (3 people were stationed in the Defense Ministry's Joint Staff Office), and dispatch of roughly 140 people from the CBIRF.[152]

Outside of displaying their equipment and receiving inspections, the CBIRF's activities in Japan did not stand out, but essentially its primary role seems to have been as part of a deployment exercise. In the United States, there was apparently some opposition to sending troops to Japan even for a short time that are intended to be used in the event of a nuclear disaster in the United States, but in Japan the presence of the CBIRF seems to have been welcomed. Within the SDF, some people, particularly in the Chemical Protection Units, praised the CBIRF for sharing its insight on decontamination and medical assistance, but conversely there were those who believed that there was no significant difference in the performance of the CBIRF and the Chemical Protection Units.

3.4 Differences in American and Japanese approaches to crisis management and the role of the Bilateral Joint Operations Coordination Center

In providing relief supplies as part of its disaster management response, the United States uses a method whereby, before having determined whether items are needed or not, they gather supplies that they think might be needed at the site and then select items at the site according to the actual needs. The Japanese crisis management approach, on the other hand, is to prepare the necessary relief supplies after ascertaining the onsite needs, and from that perspective the US assistance appeared to the Japanese side to be redundant and wasteful.

[152]. Materials of the 6th meeting of the Investigative Committee on Emergency Measures in Response to the Great East Japan Earthquake, "Higashi Nihon Daishinsai ni okeru Boeisho/Jieitai no katsudo jokyo (zai-Nichi Beigun to no kyoryoku)" [Status of Ministry of Defense/SDF efforts in response to the Great East Japan Earthquake (cooperation with the US Forces in Japan)], October 2011, http://www.bousai.go.jp/3oukyutaisaku/higashinihon_kentoukai/6/kentoukai6.html.

Also, under the US military's assistance system, it is anticipated that the units and personnel in charge will automatically start efforts in response to changes in the situation, and there were cases where US support personnel arrived in Japan before the Japanese side was prepared to receive them.

This problem was reported by the media as Prime Minister Kan having refused US offers of assistance in the early stages of the nuclear crisis. According to one investigative report in the media, from the evening of March 11, the US embassy faxed over a 20-item offer list of the assistance it could provide via the MOFA North American Affairs Bureau. Among the items on the list were unmanned reconnaissance planes and coolant. In response to that offer, Prime Minister Kan stated at a meeting in the Kantei that priority should be placed on Japan's independent response to the accident, which then led to the report that the MOFA and Defense officials misconstrued that statement and rejected the US offer.[153] In addition, because the NRC personnel sent by the United States were not able to contact the Japanese government side, Ambassador John Roos was largely frustrated over the Kantei response and instead contacted the government through Defense Minister Toshimi Kitazawa. This was not, however, a result of the Japanese government's distrust of the United States, but rather of the initial chaotic state of the government's response to the accident.[154]

Immediately following the disaster, there were multiple channels between the United States and Japan for receiving relief assistance and supplies from the United States, and the aid was not implemented effectively for some time. This was even more serious in the case of the nuclear accident, and while there were many offers of cooperation from the government and other nuclear power companies, it does not appear that Japan took effective and optimal advantage of those offers. Even looking at what has been reported, there is a lot of unconfirmed information, such as the Prime Minister's refusal of the offer of coolant for the reactor, and we are told that the supply of aid was not compatible with the demands. One can imagine that there were three factors underlying this problem.

First, Japan's own response capability assessment was delayed. In responding to a crisis, it is essential to first assess what response capabilities exist within the country and then rely on international cooperation to fill in the missing pieces, or in other words, "matching." During the first few days, the nuclear accident was unfolding and the Japanese side was being pressed to respond to the emergency. Naturally it was impossible to accurately assess just how bad the situation would become, and as the situation progressed, the equipment and supplies needed changed. When one considers the particular nature of the nuclear accident crisis and the changing equipment that was needed, it is not realistic to assemble those items in advance, and what is needed is to prepare emergency mobilization capabilities. Once mobilized, in order to rapidly determine what "matching" is needed, there must be a centralized gathering of information and someone who has the authority to make decisions.

Second, when coordinating the acceptance of international cooperation, there were no other official channels other than those between the Ministry of Defense/SDF and the US Armed Forces. No framework existed in other government agencies or in the private sector for the coordination of international assistance. When it came to the Fukushima nuclear accident, as a result, the Ministry of Defense/SDF coordination framework functioned from the initial stages of the accident and the content of that coordination gradually expanded. US Ambassador Roos also visited the Ministry of Defense to get information and coordinate on response strategies, and thus the Ministry of Defense/SDF played an extremely important role

153. *Mainichi Shimbun*, April 22, 2011.
154. Ibid., April 30, 2011.

in the response to the Great East Japan Earthquake. The Japan-US cooperation and coordination framework was taken over by the Kantei from March 21 on, led by Goshi Hosono, special advisor to the prime minister, and the so-called "Hosono Initiative" began functioning as a comprehensive coordination mechanism.

Japan-US bilateral coordination centers are a framework originally created for the scenario of an emergency in Japan, and while they did function in response to the Great East Japan Earthquake in areas such as search and rescue operations and recovery efforts, they were not intended to coordinate government actions overall.[155] Moreover, as long as information gathering and processing, as well as decision making were limited to just Japan and the United States, the information management risk was low, but if other agencies got involved, when one considers the risk of various kinds of data leaking out, the continued existence of this framework is not optimal. In addition, the fact that the Ministry of Defense/SDF was able to step in and coordinate on behalf of the entire government in the early stages of the crisis had a political backdrop in the form of the personal trust between Defense Minister Kitazawa and Prime Minister Kan. For this reason, there remains the danger that if relations between individual politicians are bad, other political considerations may take priority.

After the March 11 disaster, bilateral coordination centers for coordinating joint Japan-US action were established in the Ministry of Defense (Ichigaya), the Headquarters of the US Forces, Japan (Yokota), and the Ground SDF North Eastern Army Headquarters (Sendai). The establishment of the bilateral coordination centers was originally premised upon an emergency situation in Japan, and so in this case they were established in a form that was appropriate to the Great East Japan Earthquake. In the 1997 Guidelines for Japan-US Defense Cooperation, under the section specifying "Actions in response to an armed attack against Japan," paragraph (3)b sets forth the creation of a "bilateral coordination mechanism" and states, "In order to conduct effective bilateral operations, US Forces and the Self-Defense Forces will closely coordinate operations, intelligence activities, and logistics support through this coordination mechanism including use of a bilateral coordination center."[156]

Although Japan-US coordination overall is within the scope of the guidelines, more specifically it provides for coordinating conferences, mutual dispatch of liaisons, and indication of contact points in the case of an armed attack on Japan or situations in areas surrounding Japan, noting, "As part of such a bilateral coordination mechanism, US Forces and the Self-Defense Forces will prepare under normal circumstances a bilateral coordination center with the necessary hardware and software in order to coordinate their respective activities." The Ichigaya bilateral coordination center is a facility established for that purpose. The Yokota bilateral coordination center was a place used for the Bilateral Joint Operations Coordination Center, but the Sendai center was chosen specifically because of its proximity to the disaster site.

Third, in terms of the crisis management of the nuclear accident, there was confusion surrounding information management and control on the part of the Japanese government. The problems encountered at the bilateral coordination centers were lack of necessary personnel and issues surrounding information. Reflecting the importance of the center's role, the personnel problem was gradually improved. This was in part due to a lack of preparation by the Ministry of Defense/SDF and the US Armed Forces to strengthen the functions of the

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155. A US-Japan bilateral coordination center was established in Yokota as part of the "Strengthening Bilateral and Joint Operational Coordination" recommendation, which appears as the first recommendation made to the two countries in the document "US-Japan Alliance: Transformation and Realignment for the Future," which was agreed upon at the 2+2 meeting held in 2005 (see MOFA website, http://www.mofa.go.jp/region/n-america/us/security/scc/doc0510.html).

156. "The Guidelines for Japan-US Defense Cooperation," MOFA website, http://www.mofa.go.jp/region/n-america/us/security/guideline2.html.

centers. The bigger issue, however, was the information problem—including issues that arose because the information-sharing counterpart was unclear, and confusion in the flow of information caused by the division of labor between each center (in terms of information sharing) and the need to change the location of the Fukushima Off-Site Center because of the radiation issue. The final problem is also related to the issues of information-flow facilities, and the fact was that the earthquake damage had decreased the number of information routes leading to the central government.

As a result, the information on materials, assistance, and so on that the United States could—and wanted to—provide could not be conveyed in a timely fashion to the Japanese side, and ended up having to go through multiple processes before actually being conveyed. Until the Japan-US intergovernmental meetings (the Hosono Process), launched on March 21 (it began functioning from the 22nd) with the goal of sharing information between the US and Japanese governments and between the government and TEPCO, started to function, the complex situation surrounding the two countries' supply and demand of information continued. This situation was in some part due to the Japanese and American political systems. In contrast to the United States, which has a presidential system that allows a concentration of authority, Japan has a cabinet system that decentralizes the policy decision-making process, so the shift from normal times to a state of emergency is slow, and they are not accustomed to quickly acting autonomously in keeping with previous "promises." Moreover, while the provision of information to the cabinet secretariat is guaranteed according to the system, in practice they were unable to overcome the interests of each agency. This obstacle can be attributed to the personnel system.

In addition to the bilateral coordination centers that were established between the SDF US Armed Forces, the Japan-US policy coordination meetings (the Hosono Process) mentioned above were set up to implement government-level coordination and they smoothly carried out policy and operational coordination. With Hosono serving as moderator, the policy coordination meetings included the participation of the relevant ministries and agencies on the Japan side, the SDF Joint Staff Office, TEPCO executives, and others, while on the US side, officials from the US embassy, the US Armed Forces in Japan, NRC, and the Department of Energy participated. Within the context of the meetings, project teams were set up on topics such as shielding radioactive materials, disposal of nuclear fuel rods, disposal of contaminated water, medical support and daily living support, and so on, which enabled discussions on the necessary measures in each field. The meeting on March 28 was attended by Ambassador Roos, Commander of the US Pacific Fleet Patrick Walsh, and NRC Chairman Jaczko, and it functioned as the core for Japan-US decision making.

3.5 Overall evaluation of Japan-US cooperation

Japan-US cooperation in dealing with the accident at the Fukushima Daiichi Nuclear Power Plant generally went very smoothly and can serve as a model for multilateral and bilateral cooperation if nuclear disasters occur in the future. However, to some degree this was also a test of whether the alliance could implement joint action smoothly in the face of a nontraditional threat, and it should be understood that there would be some difficulty in trying to adapt the Japan-US collaborative system for dealing with the Fukushima nuclear accident into a model for other cases. Also, since the 2004 tsunami that resulted from the earthquake off the coast of Sumatra, the United States has been strengthening its disaster cooperation ties to each country in the Asia Pacific region. But in the process of deepening those ties, it has never considered industrialized nations as the target of assistance. Because the cooperation with Japan in responding to the Great East Japan Earthquake and the Fukushima nuclear plant accident entailed dealing with a country whose administrative institutions were still firmly in place, there were many new issues that had to be addresses.

Part of the reason that Japan-US cooperation in response to this accident went as smoothly as it did was first because Japan had put in place a crisis management system following the 1995 Great Hanshin Earthquake. When that earthquake struck, there was no crisis management system in place, and Japan's chaotic decision-making process caused delays. Moreover, there was no system established yet to effectively use the capabilities of the US military in a disaster. What is of particular note in the case of the Great East Japan Earthquake and the Fukushima nuclear accident is that the Japan-US coordination centers based on the Guidelines worked effectively for the first time in conditions that were close to a militarily emergent event. US and Japanese headquarters exchanged personnel, facilitating decision making and exchanges of information. In addition, attention should be paid to the cooperative relations between the Japanese and American troops, which had been strengthened since the mid-2000s.

In particular, the goodwill and respect that the Americans held for the Japanese people, which has been cultivated over the course of the history of Japan-US relations, was extremely significant when it came to cooperative efforts. In many interviews, the phrase "Japan is special" was heard, and that sentiment was not only focused on Japan's strategic value.

However, if one looks at the crisis management aspects, there were a number of problems with the response to the nuclear accident. Crisis management of a nuclear disaster, whether it be Chernobyl or Three Mile Island, has always been centered on that country's own response. But in today's international community, no matter what country it is, there are foreigners living or visiting there, and their safety needs to be considered as well. In that sense, government coordination with each country's embassy is essential. Those embassies also serve as a window through which the Japanese government can convey information to the world, and so it must proactively make use of that function.

The US embassy in Japan also serves as a contact point for cooperation in dealing with the nuclear disaster. In that regard, it is essential to build personal relationships and networks. In the case of the Fukushima nuclear accident, the personal connections that Ambassador Roos had built up in Japan were extremely significant. Relying on chance to develop personal ties is dangerous; rather, such ties must be proactively and strategically expanded.

In the context of the nuclear accident, the following points must be considered.

(1) Information

First, in terms of the Japanese government response, there were issues with information gathering and the sharing of information between the United States and Japan. Immediately after the earthquake struck, an accident at the nuclear plant was predicted, but damage to the IT infrastructure had cut communications between the site and the central government. Communications with an NISA employee who had been dispatched to the site were also cut off, and the policy decisions in the central government began with trying to confirm the current conditions at the plant. Although the situation could not be helped, one must assume that there was inadequate preparedness for this type of worst-case scenario.

The response in the first few hours of a nuclear disaster is decisively important. The same pertains to the evacuation of residents in the areas surrounding the accident site. Information such as the radiation dispersion predictions from SPEEDI and others is vital when evacuating residents, but due to technical problems, that information was not adequately conveyed to the residents of Fukushima. This was because the reliability of SPEEDI's data was questionable, but the fact that its release to the public was delayed of course increased the public distrust of the government's response.

The Japanese government was initially hard pressed to respond to the crisis and to coordinate among organizations, and Japan-US information exchange did not proceed smoothly. The NRC representatives from the United States apparently did not know what department or person to contact in Japan to obtain information. For that reason, there is a high probability that US know-how on nuclear disasters was not fully utilized. The United States was gathering its own data on radiation distribution, and later it transferred that system to the Ministry of Education, but when the accident occurred and in later work, it is not clear how the US data was utilized. The US side as well was in a state of confusion in its response to the Great East Japan Earthquake and the nuclear disaster. Although it is difficult to solve this problem, it should serve as a reference point when planning future crisis management measures.

The distrust of the United States within the Kantei also had an impact. The DPJ has shown a high level of distrust of the United States, as seen by former secretary-general Ichiro Ozawa's championing of "politics that can stand up to the United States," and in some respects they used the dissatisfaction over the Americans' somewhat unrealistic demands following the disaster to support their own cause. A consensus should be encouraged among the Japanese people regarding the danger of using relations with the United States as a political slogan.

Because reliable data gathering could not be done on the Japan side, the United States carried out its own data gathering and response, but by announcing this through the media, it created anxiety within Japan. Media reports reflecting the DPJ's distrust of the United States exacerbated the suspicions by saying that the United States was "doing as it pleases" within Japan or that it was using the nuclear disaster for the benefit of the American nuclear industry, and that probably was caused by the frustrations that occurred between the two countries in the initial stages.

(2) Channels of Dialogue

Next, one issue related to both Japan and the United States was that there were problems with the dialogue channels between the two countries. Although one would think that, given the history of Japan-US relations and the alliance relationship, there would be many diverse channels between the two countries, in reality it became clear that, particularly when it comes to politicians, there is an extremely low level of dialogue. Some believe that this is related to political leadership and assert that the dialogue channels between bureaucrats should be raised to the level of politicians, but there were problems with the channels between bureaucrats (practitioners) as well.

Between the militaries of Japan and the United States, dialogue and strategic coordination went smoothly, and they were in very close communication with regard to the earthquake, tsunami, and then the nuclear accident. Within the SDF, dialogue channels with the United States have been increasing since the 1990s, and have been pluralistic in terms of the people and institutions involved. For that reason, when the nuclear accident struck, a number of key people, particularly those on the Japan side who were trusted by the United States, played an important role in Japan-US cooperation. Cooperation manuals and procedures for Japan-US cooperation already existed and they were invoked for this purpose.

However, outside of the military to military framework, actors were unable to identify their respective counterparts, in part because of the differences in the two countries' governmental and bureaucratic structures, and that created confusion. METI, which is the lead agency for nuclear disasters, comprises organizations such as the NISA and the Nuclear Safety Commission, but because of personnel rotations and such, Japan-US cooperation channels and personal relationships are not maintained over time. For that reason, the Americans at NRC had difficulty gaining access to the relevant parties at TEPCO and elsewhere, which created a major obstacle in gathering information.

This was not just an information issue, but it also was reflected in Japan's inability to appropriately coordinate in terms of the provision of supplies from the United States as well. As noted above, the US material assistance has an element of applying "material resources tactics." For that reason, they provide large quantities of material resources to the disaster site, whether they will be used or not. However, the Japanese side was not prepared to accept those supplies, resulting in surpluses in all locations. In addition, the process of identifying what supplies were needed was chaotic on the Japan side, so they were not able to effectively convey that information to the United States. The fact that Japan was not accustomed to being on the receiving end of relief supplies also had a major impact. As a result, the biggest mistake in the crisis was that multiple channels were established and began operating at the same time, which made overall Japan-US cooperation difficult.

The personalities of a handful of relevant actors such as Defense Minister Kitazawa played a large role in bringing that chaos under control.

(3) Issues on the US side

The US embassy took the lead in the US response, and the launch and implementation of the crisis management mechanisms went very smoothly. Ambassador Roos's public information efforts were praised, and the Japanese people's feelings of gratitude and trust toward the United States far surpassed those toward their own government. In particular, when Ambassador and Mrs. Roos, along with Admiral and Mrs. Robert Willard, visited the Watanoha Elementary School in Ishinomaki on March 23, 2011, the ambassador's words encouraged the victims. He told them, "Nature—it can destroy precious human life, it can destroy property, but it cannot destroy the human spirit, and today here I've witnessed the best of humanity." These words left a deep impression on the hearts of the Japanese people.[157]

However, it is also true that there are points that must be considered on the US side. In particular, the major impact within Japan of the actions taken by the US embassy and the US military should have been understood. In particular, the decision on the scope of the evacuation advisory for US citizens, the movement of the nuclear materials detector and aircraft carrier from Yokosuka, and the way in which relief supplies were provided all increased the sense of distrust that the Japanese people were harboring toward their own government. In order to have unrivaled trust during a crisis, the United States and the US Armed Forces need to base their actions and public information efforts on a firm understanding of the impact they will have within the country in question.

We must point out that, unfortunately, since the latter half of the 2000s, there has been dissatisfaction with the United States within Japan, and that complicated matters. Underlying the Japanese distrust of the United States is a mixture of structural factors and policy-related

[157]. Statement by Ambassador Roos—Disaster Relief Shelter at Watanoha Elementary School, March 23, 2011, US Embassy website, http://japan.usembassy.gov/e/p/tp-20110323-72.html.

factors. Structurally, the "lost era" resulting from the stagnation of the Japanese economy in the post–Cold War period has eroded the people's confidence, and the shifting power balance in the Asia Pacific region has lowered Japan's relative standing in the international community. For that reason, the deepening of Japan-US cooperation in such arenas as the Iraq War has not increased Japan's national strength but rather is viewed as having relegated Japan to the status of America's junior partner. Moreover, as if playing on the dissatisfaction that exists among the Japanese people, the support for Japan's DPJ, which advocates the "Japan-US-China triangle theory," has risen, which has undeniably cast a shadow over any progress in Japan-US policy cooperation.

(4) The transition from normalcy to emergency conditions

During the Fukushima nuclear accident, there were problems that occurred during the shift from normalcy to emergency mode that must be made when responding to a crisis.

The declaration of a nuclear emergency situation in response to the Fukushima nuclear accident was announced early on in the process (March 13), thereby consolidating the authority of the government and granting wide-ranging command authority to the prime minister. Of course, this emergency declaration also enabled the establishment of the Off-Site Center. However, the Kan cabinet issued a "Proclamation of a Disaster Emergency Situation" based on the Basic Act on Disaster Control Measures, and the Kantei did not implement any measure that exceeded the authority granted under Article 40, paragraph 2 of the Act for Establishment of the Cabinet Office. Neither did they issue a "Declaration of a State of Emergency" based on the Police Act. In the absence of any regulations for the state to assume emergency powers, the declaration of an emergency under these two laws is extremely significant in handling the situation.

Since the Great Hanshin-Awaji Earthquake, a Crisis Management Center has been in place, and the position of deputy chief cabinet secretary for crisis management was created. That post has been filled by persons who have experience as the superintendent general of the Tokyo Metropolitan Police. The duties of the post are to handle issues related to crisis management (the handling of emergency situations that occur or are feared will occur that produce significant dame to the life, limb, and assets of the Japanese people, or the prevention of such an emergency), excluding issues related to national defense. In cases such as the Fukushima accident, where the SDF and police must work together in a coordinated manner, the question remains as to the scope of the post's command authority given the intricacy of the scope of each ministry and agency's jurisdiction. Accordingly, consolidating the chain of command and information in the cabinet by declaring a state of emergency should make it possible based on the current system to utilize intelligence from the Ministry of Defense, offers of assistance from foreign nations that are received by MOFA, and the resources of METI and other relevant ministries and agencies.

This issue was evident in the efforts to douse the nuclear reactors with water. From March 17, the SDF continued to carry out the dousing, but originally the SDF was not expected to be involved in onsite efforts, and so they were compelled to carry out activities that exceeded the scope of what had been, prior to the accident, their expected role in accident response. In particular, in the dousing efforts, the fire department should have been hosing down the reactors from the ground, but since the preparations for the transfer and setting up of the necessary equipment was delayed, as an emergency measure, it was decided that it would be necessary to pour the water on the reactors from the sky, where there was a high risk of radiation exposure.[158] This decision was reached between the Kantei and high-level officials of the Ministry of Defense/SDF, and the work was carried out from the 17th until circulating injections of water became possible. To sort out this confusion during that time period, a document written on March 20 confirmed that the SDF had command and control authority with regard to the police and fire departments.

When one considers the history of the friction between the National Police Agency and the Ministry of Defense within the Cabinet Secretariat in terms of authority over crisis management, the decision made on March 20 was epoch-making. After it was decided in the Kantei to sort out the authority of each ministry and agency, no confusion arose over the chain of command, and one can say that it was at that point that the shift to an "emergency" system took place. The lesson demonstrated by this example is how important political decisions are in that shift from "normalcy" to "emergency." It should also be noted that the gap in the timing of that shift between the United States and Japan created problems for both countries as they worked to cooperate.

3.6 Japan-US defense cooperation and nuclear safety

Finally, let us conclude with a word about the cooperation between the two militaries. The fact that key personnel from the United States and Japan worked together at each other's headquarters and elsewhere helped strengthen the unity of the alliance and showed the world that it is possible to carry out mutually interconnected unit operations. The necessary preparations and training should be continued in order to allow this type of unit operation to be carried out in the case of a future nuclear disaster not only in Japan but in other countries as well.

On June 21, 2011, at the Japan-US Security Consultative Committee (2+2), Japan and the United States announced a document titled "Cooperation in Response to the Great East Japan Earthquake," in which it was written, "This kind of unprecedented multi-dimensional disaster has important lessons for the international community. In light of Japan's experience, it is incumbent on all countries to be better prepared to respond to complex emergencies and to assist one another in such circumstances." In addition, it stated that "Operation Tomodachi" was the successful result of years of bilateral training, exercises, and planning, and that the communication and operational coordination seen at the bilateral coordination centers (in Ichigaya, Yokota, and Sendai) will serve as a model for future responses to contingencies.

In addition, the report pointed to the lessons of the nuclear reactor as being "the importance of bilateral and multilateral mechanisms to promote real-time information sharing, effective coordination, and comprehensive 'whole-of-government' responses to complex emergencies," "the importance of strengthening the Chemical, Biological, Radiological, and Nuclear (CBRN) Defense Working Group as a venue for policy coordination and cooperation in such areas as information sharing, protection, decontamination, and consequence management," and the fact that "the participation by US forces in disaster drills conducted by local authorities contributes to stronger relations among the US forces and base hosting

[158]. There are many debates on whether or not the spraying of water from the SDF helicopters was actually tied to the cooling of the reactors and other facilities, or to replenishing the coolant. In terms of the response of the American side to the aerial spraying of water, there are some who assessed it as being the desire of the Japanese as the parties concerned, but there are some US nuclear energy experts who are of the opinion that it was an inappropriate response.

communities." In particular, the participation of the US forces in disaster drills will strengthen the communication between them and local governments.[159]

When one considers that the SDF began participating in the disaster drills held by local governments following the Great Hanshin-Awaji Earthquake, then using the opportunity of the Great East Japan Earthquake and Fukushima nuclear accident to move ahead with preparations for Japan and the United States to jointly respond to various emergencies, including nuclear disasters, would seem to signify a turning point for bilateral relations in crisis management. In crisis management, if the ability to coordinate and combine the efforts of two or more countries rather than relying solely on the ability of an individual nation can lead to the mitigation of damage from a disaster, then it is the duty of Japan and the United States to present their model of cooperation. In particular, they must clearly delineate between areas in which cooperation was possible because of the existing alliance, and areas in which the cooperation was possible that went beyond the alliance, and must present one model to the international community.

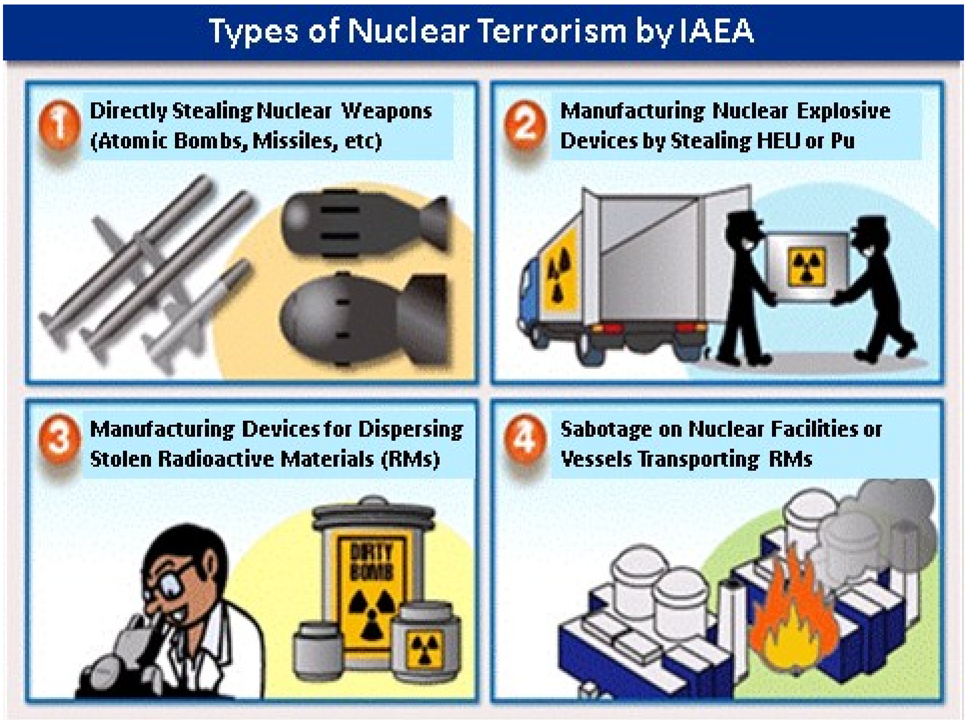
[159]. Security Consultative Committee, "Cooperation in Response to the Great East Japan Earthquake," June 21, 2011, http://www.mofa.go.jp/region/n-america/us/security/pdfs/joint1106_03.pdf.

Chapter 4: Vulnerabilities in Nuclear Security

In recent years, there has been concern over the risk that terrorists will steal nuclear material and manufacture nuclear bombs, or that they will attack facilities handling nuclear material and cause harm to the public through the release of radiation. There is now a widespread recognition of the need for measures to prevent such acts before they happen, and of the importance of implementing measures to discover and recover stolen nuclear material and to mitigate radiation damage if such events do occur.

The accident at the Fukushima Daiichi Nuclear Power Plant was caused by a natural disaster, namely the tsunami that was triggered by the Great East Japan Earthquake, but from a nuclear security standpoint, it raised the fear that a terrorist could cause a similar accident by an act of sabotage against a nuclear plant.

Figure 4-1. Types of nuclear terrorism

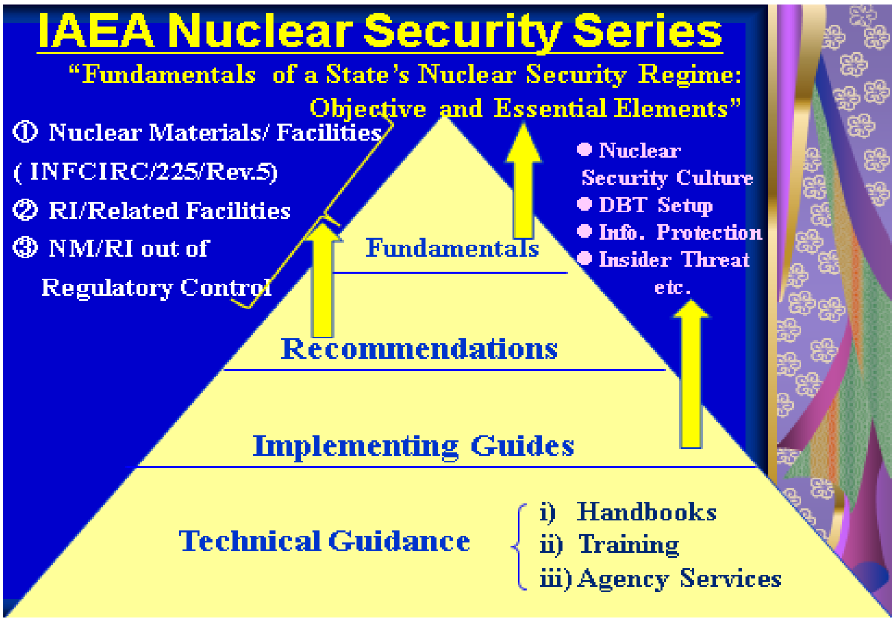


Source: Ministry of Foreign Affairs website.

4.1 The international background of expanding and strengthening nuclear security policy

Since the terrorist attacks on the United States on September 11, 2001, international discussions have increasingly been held, particularly in such forums as the IAEA, on ways to strengthen and enhance "nuclear security" measures in order to respond to this type of nuclear terrorism. For instance, at the spring 2002 IAEA Board of Governors meeting, the IAEA member states approved a Nuclear Security Plan (originally for the 2002–2005 period) for the purpose of assisting the member states in enhancing and strengthening their nuclear security measures. Since that time, the nuclear security plans have been revised and implemented every four years (2006–2009, 2010–2013), and some member states have made voluntary contributions that are managed and dispersed as the Nuclear Security Fund. Also, the IAEA began publishing the Nuclear Security Guidelines Series as a guideline for member states to establish and maintain effective nuclear security regimes. This series comprises four tiers of publications, the primary one being the Fundamentals document, followed by Recommendation documents, Implementing Guides, and Technical Guidance publications.

Figure 4-2. Nuclear Security Series publication structure



What, then, does the concept of "nuclear security" entail? The Advisory Group on Nuclear Security (AdSec), which was established in January 2002 to advise the IAEA director general in formulating the Nuclear Security Plans noted above and evaluating the status of their implementation, uses the following working definition of "nuclear security":

> The prevention and detection of and response to theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities.[160]

Examining this definition, the following points may be noted:

- It covers not only nuclear material but also other radioactive substances.
- It covers not only the theft of radioactive material, but also acts of sabotage against facilities that handle such material.
- It covers not only measures to prevent such acts, but also responses to them, such as detection and recovery should the theft of radioactive material occur, for example, or close cooperation with security forces should a nuclear security event arise.

From a historical perspective, the changing circumstances surrounding nuclear security, the heightened awareness of its importance, and other factors have altered and expanded the object of protection. We can break the timeframe down roughly into three periods: (1) the

[160]. Working definition established by the fifth meeting of the AdSec, December 1–5, 2003.

period of the Cold War between the United States and the Soviet Union, (2) the period of chaos following the collapse of the former Soviet Union, and (3) the period following the 9/11 terrorist attacks on the United States.

One characteristic of the Cold War era was that the primary focus was on the "protection of nuclear material," or in other words the prevention of nuclear material being diverted through illegal transfer for the purpose of constructing nuclear weapons, and so emphasis was placed on rigorous control in order to prevent the theft of nuclear material from nuclear facilities. The IAEA recommendation on the physical protection of nuclear material (INFCIRC/225) was first published in 1975, but at that time it covered only the physical protection requirements associated with the use, storage, and transport of nuclear fuel. However, there was subsequently a heightened debate, led by the United States, about the need to protect against not only theft but sabotage as well, and in the successive revisions of the IAEA recommendation that concern was duly reflected as well. Incidentally, in the fourth revision in 1999, the title was revised from the previous "Recommendations on the Physical Protection of Nuclear Material" to "Recommendations on the Physical Protection of Nuclear Material and Nuclear Facilities," clearly indicating that the prevention of acts of sabotage against facilities should be included in the scope of protective measures.

With the collapse of the former Soviet Union, there were repeated cases exposed at the borders with the West of attempts to smuggle nuclear material and radioactive substances out of former Soviet Union countries where their control was lax. As a result, in 1995 the IAEA Illicit Trafficking Database (ITDB) was established to promote information sharing and international collaboration on trafficking in nuclear material. Currently, 113 nations participate in the ITDB.

In addition, in the aftermath of the 9/11 terrorist attacks on the United States, because of the need to treat the possibility of a terrorist attack using a "dirty bomb" as a plausible threat, there was a heightened interest in expanding "nuclear security" to include not only the protection of nuclear material but also of radioactive material.

In response, at the IAEA Board of Governors meeting in November 2001, in addition to approving the Nuclear Security Plan, the establishment of the AdSec for the purpose of formulating the plan, the start of revisions to the IAEA nuclear security guidelines, and the launch of capacity-building support for member states, it encouraged voluntary contributions for nuclear security assistance and expanded related projects. Also, as will be discussed below, various international initiatives were started to strengthen nuclear security.

4.2 International and domestic responses to strengthening nuclear security measures

(1) International responses

Even before 9/11, as early as the 1970s, the IAEA had been involving experts in the task of drawing up guidelines on the protection of nuclear material, and in 1975 they published their first recommendations (INFCIRC/225). Subsequently, as the situation surrounding nuclear material protection has changed, they have revised those recommendations a number of times. These recommendations themselves are guidelines and are not legally binding, but they are referred to as the standard of protection that must be applied to the transfer of nuclear material based on bilateral agreements for cooperation concerning peaceful uses of nuclear power that Japan has signed with nations that supply nuclear material and equipment, and they therefore are de facto legally binding based on those agreements. In fact, as subsequent revisions were made to the guidelines, the supplier countries requested that Japan adapt to the newest recommendations since the level of nuclear material protection in Japan did not necessarily satisfy those new standards, and that is what led in December 2005 to major revisions to the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors (hereafter, Nuclear Material and Reactor Law).

Meanwhile, in parallel with the efforts to draft the nonbinding IAEA recommendations, there was an increasing push for the creation of an international treaty that would oblige its signatories to take appropriate measures for the physical protection of nuclear material. However, most countries at that time were inclined to favor the argument that domestic measures should yield to national sovereignty, and therefore the scope of the treaty was limited to the international transport of nuclear material, which was viewed as being particularly vulnerable. Drafting work was carried out at the IAEA for a nuclear material protection treaty that would require the signatories to implement the necessary protective measures, that would criminalize the theft of nuclear material, that would make the extradition of such criminals mandatory, and so on, and the final text was adopted as the Convention on Physical Protection of Nuclear Material (CPPNM) in October 1979. Having been ratified by 21 countries, the treaty entered into force in February 1987.

However, it was after the 9/11 attacks in 2001 that the international response to the protection of nuclear material became more serious. First, it was argued that items related to nuclear security should be incorporated into the existing Code of Conduct on the Safety of Radioactive Sources, and a revised version, i.e., the Code of Conduct on the Safety and Security of Radioactive Sources, was approved by the IAEA General Conference (September 2003). To date, more than 100 member states have expressed their support of the code.

Figure 4-3. International support for the Code of Conduct on the Safety and Security of Radioactive Sources (as of May 6, 2010)

Source: IAEA website.

Convention on the Physical Protection of Nuclear Material Amendment Conference (July 2005)

Photo: IAEA website.

Moreover, in July 2005, the final text to amend the Convention on the Physical Protection of Nuclear Material was adopted, obliging contracting parties to apply protection measures not only to the international transport of nuclear material but also to the use, storage, and transport of nuclear material within a country, as well as to criminalize the act of sabotage. At the second Informal Open-Ended Expert Meeting to discuss whether there is a need to revise the convention (May 2001), the participants recommended to the IAEA Secretariat that Fundamental Principles for Physical Protection of Nuclear Material be drawn up based on INFCIRC/225/Rev.4. Accordingly, the September 2001 IAEA Board of Governors and General Conference approved the "Physical Protection Objectives and Fundamental Principles" that had been produced by the Secretariat.

Also, the UN General Assembly unanimously adopted the International Convention for the Suppression of Acts of Nuclear Terrorism at the 59th General Assembly (April 2005; effective from July 2007), the objective of which was to prevent the use of radioactive material in terrorist acts by criminalizing specific acts—e.g., the possession or use of radioactive material with the intent to cause death or serious bodily injury, or to cause substantial damage to property or to the environment—and by creating legal frameworks to resolutely prosecute such offenses.

Meanwhile, the presidents of the United States and Russia called for the creation of a Global Initiative to Combat Nuclear Terrorism (GICNT; July 2006) to combat the threat of nuclear terrorism worldwide, and this initiative currently has 85 partner nations.

In addition, President Barack Obama's appeal for "a world without nuclear weapons" (April 2009) led to the convening of world leaders for a Nuclear Security Summit in Washington DC (April 2010) to deliberate on ways to enhance nuclear security, and the leaders agreed on a joint communiqué and work plan. At that time, then Prime Minister Yukio Hatoyama made a commitment to (1) establish an "Integrated Support Center" for strengthening nuclear security in Asia, (2) develop technology related to measurement and detection of nuclear material and nuclear forensics, (3) contribute to IAEA nuclear security programs, and (4) host a World Institute for Nuclear Security (WINS) conference in Japan, thereby showing Japan's proactive stance toward making international contributions.

First Plenary Meeting of the GICNT was held in Rabat, Morocco (October 2006) with 13 countries participating

Photo: US Department of State website.

2012 Seoul Nuclear Security Summit

Photo: Summit website.

The second summit was held in March 2012 in Seoul, South Korea, and it topped the previous meeting with participation by 53 national leaders and 4 heads of international organizations. The meeting reviewed the progress made to date in implementing the pledges made by participants at the previous summit on strengthening their measures to combat nuclear terrorism. The communiqué adopted by the leaders was based upon a common understanding that nuclear terrorism is a real threat, and it confirmed the need for each country to adopt practical measures to reduce that threat and the importance of cooperation in overcoming it, touching on the need for new security measures for radioactive material, and the need to promote synergy between nuclear safety and security.

(2) Domestic responses

In response to these global trends toward the strengthening of the physical protection of nuclear material and nuclear security, Japan has been adopting the necessary domestic measures. In keeping with the movement to formulate the IAEA Recommendations on the Physical Protection of Nuclear Material and the entry into effect of the Convention on the Physical Protection of Nuclear Material, an Advisory Committee on the Physical Protection of Nuclear Material was established within Japan's Atomic Energy Commission to consider the best approach for Japan to take on the issue. The advisory committee issued its first report to the commission in September 1977 and its final report was released in June 1980. That report touched on the various trends both within Japan and abroad surrounding the physical protection of nuclear material: the publication of the IAEA recommendations (INFCIRC/225/Rev.1); the adoption of the Convention on the Physical Protection of Nuclear Material; the movement, as part of the deliberations since 1975 on export guidelines, for nuclear power supplier nations to require importing nations to apply physical protection measures; and the decisions by Canada and Australia, as part of their new nuclear energy export policies, to revise existing bilateral cooperation agreements to incorporate the requirement that importing nations apply physical protection measures. Based on these developments, while the report noted that the actual status of physical protection in Japan satisfied the IAEA guidelines on the whole, they were not clearly specified as legal requirements under Japan's Nuclear Material and Reactor Law, and it was thus recommended that the necessary legal provisions be made. And in addition to specifying the necessary physical protection measures that must be included in domestic regulations, the report also urged the immediate ratification of the Convention on the Physical Protection of Nuclear Material. The report also addressed specific issues related to the establishment of physical protection systems by licensees, regulatory authorities, security agencies, and other relevant organizations; the necessary research and development; international cooperation; and other areas, and thus proposed measures for enhancing and strengthening Japan's physical protection regime.

Based on that report, the Atomic Energy Commission requested the relevant organizations to institute the necessary measures to further develop their systems for the physical protection of nuclear material. At the same time it indicated its policy to make the necessary provisions or revisions to the Nuclear Material and Reactor Law and other related laws and regulations, and to carry out the necessary preparations for the ratification of the Convention on the Physical Protection of Nuclear Material. As a consequence, the Nuclear Material and Reactor Law and the penal code were amended, with physical protection of nuclear material being clearly indicated as one of the objectives of the Nuclear Material and Reactor Law, thereby incorporating the necessary requirements for physical protection into the law and its regulations (May 1988). In this way, having ensured the required level of protection for the international transport of nuclear material, and having guaranteed the stipulated punishments for criminal acts under Japanese law, Japan was able to ratify the Convention on the Physical Protection of Nuclear Material (October 1988).

The Physical Protection of Nuclear Material (INFCIRC/225)—the IAEA recommendations that served as the basis for the deliberations by the Advisory Committee on the Physical Protection of Nuclear Material—was its first revision, but as the situation surrounding physical protection has changed over time, those recommendations have been revised successively. Up until the third revision, however, the revised content did not require any changes to the Nuclear Material and Reactor Law. It was in response to the fourth revision of the IAEA recommendations that major changes were made. Namely, the law was revised to incorporate the specification of design basis threat by the state, the establishment of protective measures in response to the design basis threat, the introduction by the state of regular inspections of the physical protection measures instituted by licensees, the obligation to maintain confidentiality with regard to physical protection secrets, and so on (December 2005). Meanwhile, the Act on Punishment of Acts to Endanger Human Lives by Generating Radiation was enacted and came into force, and the above-mentioned International Convention for the Suppression of Acts of Nuclear Terrorism was ratified as well (September 2007).

Figure 4-4. Chronology of INFCIRC/225 Revisions

Chronology of INFCIRC/225 Revisions

Timing	Documents	Major Points of Revision
1975.9	INFCIRC/225	First Publication
1976.2	INFCIRC/225(Corrected)	Correction of Typographical Errors
1977.6	INFCIRC/225/Rev.1	・Revision of Nuclear Material Categorization
1989.12	INFCIRC/225/Rev.2	・Protection of Reactor Facilities ・Quality Assurance, etc.
1993.9	INFCIRC/225/Rev.3	・Exclusion of Vitrified High Level Wastes ・Control of Transportation Information ・Revision of Nuclear Material Categorization
1999.6	INFCIRC/225/Rev.4	・Title Changed to Include Facility Protection ・Presenting DBT to Operators by State ・New Chapter on Sabotage

Source: Nuclear Material Control Center.

Following the publication of the fourth revision of the IAEA recommendations, the threat environment dramatically changed, particularly following the advent of the 9/11 terrorist attacks. There was also a need to provide guidelines to the newly emerging nations that were developing plans for nuclear power generation as part of the nuclear energy renaissance. These factors, as well as the newly compiled Physical Protection Objectives and Fundamental Principles, were reflected in the arguments made by the United States, which had taken the lead in the previous revision process, to revise INFCIRC/225/Rev.4, and those deliberations began in full swing in 2008.

Up until this point, Japan's deliberations on physical protection and nuclear security tended to be more passive responses in order to fulfill obligations under bilateral agreements, but after 9/11, nuclear terrorism came to be seen as a realistic threat, and Japan thus became more aggressive in strengthening and expanding measures to protect against that risk. For example, the riot police permanently stationed at nuclear power plants and Coast Guard patrol boats guarding the coastline near nuclear power plants have been equipped with the necessary personnel and equipment so that they can respond appropriately and suppress a nuclear terrorist attack.

Meanwhile, because ensuring nuclear security is above all an international challenge, Japan has sought to actively contribute to the support of developing countries and the setting of international guidelines. Japan has dispatched experts to participate in the discussion meetings on the IAEA Nuclear Security Series documents to ensure that Japanese opinions are duly reflected. Also, in addition to making special contributions to the IAEA Nuclear Security Fund, which provides operating funds for strengthening the nuclear security systems of member states, Japan is also carrying out the three commitments it made at the Washington Nuclear Security Summit—to establish an "Integrated Support Center" for strengthening nuclear security in Asia, develop technology related to measurement and detection of nuclear material and nuclear forensics, and host a WINS conference. In addition, Japan provides an expert to serve on the AdSec committee that advises the director general of IAEA on its nuclear security work, and contributes greatly to those discussions.

A WINS workshop held in Tokyo, September 2010

Photo: Kaoru Naito.

Meanwhile, in keeping with the trends in the drafting of the Nuclear Security Series documents, Japan established the Advisory Committee on Nuclear Security within the Atomic Energy Commission in December 2006 in order to comprehensively discuss the basic policy on nuclear security, including not only the existing physical protection of nuclear material, but also the protection of radioactive material, and the committee has been holding regular meetings since that time, taking into account the development of international norms such as the top-tier document, Fundamentals, as well as the second-tier documents, the three Recommendations.

As a result, in September 2011, the advisory committee presented to the Atomic Energy Commission its report, titled "Fundamental Approach to Ensuring Nuclear Security," which responded to the top-tier publication in the Nuclear Security Series, Fundamentals. In response to the report, the Atomic Energy Commission called on all relevant organizations to take full account of the content of the report and promote sound initiatives on nuclear security.

During the course of those deliberations, on March 11, 2011, the tsunami caused by the Great East Japan Earthquake led to an accident at the Fukushima Daiichi Nuclear Power Plant, bringing about significant radioactive contamination. While the accident itself was caused by a natural disaster, it was recognized that a similar accident could be caused by a terrorist attack. Accordingly, the advisory committee also considered the lessons of the Fukushima accident from a nuclear security perspective and incorporated those findings into the September 2011 report. In short, the report cited the lessons as being the need to (1) strengthen nuclear security measures for facilities and equipment of nuclear power plants, (2) strengthen measures against internal threats, (3) strengthen education and training, and (4) strengthen the nuclear security regime. It also listed the advisory committee's future tasks as being to deliberate on (1) how to reflect the other three IAEA recommendation documents, including INFCIRC/225/Rev.5, in Japan's nuclear security policy, and (2) what more specific measures should be implemented in light of the nuclear security lessons from the Fukushima Daiichi Nuclear Power Plant accident.

Subsequently, the Advisory Committee on the Physical Protection of Nuclear Material established a working group to consider these issues and put together more specific measures drawing on the lessons from Fukushima; a progress report was submitted to the Atomic Energy Commission in November 2011. The commission, finding the advisory committee's recommendations to be appropriate, decided that licensees, regulatory authorities, and public security authorities should take full consideration of the findings of the report and immediately take measures in response, and that they would be expected to report to the commission appropriately on their progress.

The advisory committee further deepened the deliberations of the working group, and based on that they presented a report to the Atomic Energy Commission on March 21, 2012. The report stressed the need in particular for checks of individual trustworthiness—calling for the start of discussions on how specifically to create a system for implementing such checks—and for prompt implementation of measures based on the Fukushima accident. Another point emphasized in the report was the need to nurture a nuclear security culture within organizations responsible for ensuring nuclear security, as well as among the individuals within those organizations, whereby they recognize their own responsibilities and work continuously to review and revise nuclear security measures. It noted that public understanding and cooperation are essential in order to effectively and efficiently implement nuclear security measures including access control and restrictions on items to be brought into protected areas. And moreover, it stated that, as a member of the international community, Japan must strengthen its own nuclear security measures and at the same time contribute to global efforts on nuclear security measures as well. The Atomic Energy Commission issued a statement that the content of the report was appropriate and requested that regulatory bodies, public security authorities, other relevant government bodies, and licensed operators "observe the contents of the report and strengthen nuclear security measures steadily while bearing in mind the importance of reinforcing mutual collaboration, while at the same time obtaining public understanding and cooperation."

4.3 Japan's response to the nuclear security lessons learned from the Fukushima accident

The Fukushima accident caused considerable damage from radioactivity and highlighted nuclear safety issues at the country's nuclear power plants, but in addition, it also raised nuclear security concerns. In another words, it exposed the vulnerability of safety measures at nuclear power plants, and revealed to the entire world that it is possible to cause a similar type of serious nuclear accident by sabotaging vital facilities. It also demonstrated the need to maintain protective functions even when there are high levels of radiation both within and outside of a nuclear power plant site after an accident occurs.

Minister of Economy, Trade and Industry Kaieda at the June 2011 IAEA Board of Governors Meeting

Photo: METI.

(1) Report of the Japanese Government to the IAEA Ministerial Conference on Nuclear Safety

These nuclear security concerns were recognized immediately after the accident and were touched upon in a report submitted by the Japanese government to the June 2011 IAEA Ministerial Conference on Nuclear Safety, as outlined below.

- Since measures against terrorism, which is another external event, are becoming more and more important in recent years, and because the measures that take into account the recent accident are also conducive to effective counterterrorism, we will request the utilities to establish measures to further enhance protective measures, by thoroughly implementing intrusion prevention of unauthorized personnel, etc. by collaborating with the security authorities in order to make assurance doubly sure.[161]

[161]. Nuclear Emergency Response Headquarters, Government of Japan, "Attachment XI-1: Specific Countermeasures in Japan Based on the Lessons Learnt from the Accident at Fukushima Dai-ichi Nuclear Power Station of Tokyo Electric Power Co. Inc.," "Section III-1. Enhancement of Preventive Measures against Severe Accidents," in "Report of the Japanese Government to the IAEA Ministerial

- We will also request the utilities to enhance training for anti-terrorism, which is becoming more and more important in recent years.[162]
- The government will also improve its disaster prevention scheme, including emergency response at the plants, evacuation and securing the safety of residents, assistance for nuclear sufferers, environmental monitoring, radiation protection, medical support and anti-terrorism measures, through reforming the roles, mandates and organizations and maintaining and expanding of the necessary materials and equipment.[163]

(2) Deliberations and report of the Advisory Committee on Nuclear Security (Sept. 2011)

Meanwhile, as previously noted, the Advisory Committee on Nuclear Security carried out deliberations on the fundamental approach to ensuring nuclear security in Japan, based on the IAEA's Fundamentals document of the Nuclear Security Series, and at the same time reviewed the nuclear security lessons learned from the accident at the Fukushima Daiichi Nuclear Power Station. The results were included in a report submitted in September 2011, which offered the following basic views in response to those lessons.

• Strengthen Nuclear Security Measures

In light of the accident, it is clear that it is necessary to strengthen nuclear security measures for facilities and equipment of nuclear power plants. The licensees should strengthen nuclear security measures for facilities and equipment, in cooperation with the regulatory bodies and related administrative bodies. Also, the related administrative bodies should strengthen nuclear security systems and assure the necessary equipment and materials in order to strengthen nuclear security measures for facilities and equipment, in cooperation with regulatory bodies and licensees.

•Strengthen Measures Against Internal Threats

It is now evident that the access control was insufficient at the earlier stage of the accident. The licensees should strengthen measures against internal threats, including thorough measures to prevent trespassing by adversaries.

•Strengthen Education and Training

It is evident that it is important to conduct emergency response exercises with the assumption of severe deterioration of an emergency event. The regulatory bodies, related administrative bodies, and licensees should postulate more practical situations in their education and training programs to respond to criminal acts or intentional violations acts such as thefts or acts of sabotage targeted at nuclear materials, related facilities, and related activities.

• Strengthen Nuclear Security Regime

It is evident that it is important to quickly respond to emergency situations under a clear chain of command. Similar to ensuring nuclear safety, the government should clarify the allocation of roles and the chain of command within the governmental bodies for the purpose of ensuring nuclear security, as well as clarify how to assure radiation safety during emergencies.

Conference on Nuclear Safety—The Accident at TEPCO's Fukushima Nuclear Power Stations, June 2011," http://www.kantei.go.jp/foreign/kan/topics/201106/pdf/attach_11.pdf.

162. Ibid., "Section III-2. Enhancement of Measures against Severe Accidents."

163. Ibid., "Section III-4. Enhancement of the Infrastructure for Securing Nuclear Safety."

(3) Deliberations and report of the Advisory Committee on Nuclear Security (March 2012)

Subsequently, the Advisory Committee created a working group to discuss the issue further and compiled more specific measures based on the lessons learned from the accident at the Fukushima Daiichi Nuclear Power Station. A progress report was submitted to the Japan Atomic Energy Commission in November 2011. In the final report, which was submitted to the Japan Atomic Energy Commission on March 21, 2012, the subject of "Nuclear Security Issues Derived from the Accident at the Fukushima Daiichi Nuclear Power Station," which was touched upon in the progress report, was revised to reflect subsequent changes—including measures taken by the NISA, public security authorities, and licensees. Essentially, the report presented the following analysis, as was also contained in the progress report, and specific measures needed for nuclear power facilities to respond to these nuclear security issues.[164]

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(1) Basic recognition of nuclear security based on the accident

The accident at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Co., Inc. (TEPCO), following the Tohoku-Pacific Ocean Earthquake and subsequent tsunamis on March 11, 2011, caused serious damage to Japan. The effects of this accident were totally different from previous accidents. Nuclear hazards jeopardize the lives and safety of citizens, seriously contaminate the environment in which many people live, significantly impact on the national economy, and provoke social turmoil. We have learned these things from the accident.

The accident revealed the possibility that terrorism at a nuclear facility may have the same serious effects on society. It is Japan's obligation to enhance not only safety but also security of nuclear power plants based on the lessons learned from the accident, share this information with the international community, and reflect it in international efforts for reinforcement of nuclear security.

Licensees, regulatory bodies, security authorities, and other related parties should take into account the possibility of terrorism targeting nuclear facilities in implementing nuclear security measures. It is necessary for them to strengthen their security systems based on the report by the Advisory Committee on Nuclear Security, "Fundamental Approach to Ensuring Nuclear Safety" (September 5, 2011), and at the same time, to cooperate in taking effective nuclear security measures.

(2) Threat of nuclear terrorism against nuclear facilities based on the accident

The following acts of terrorism against nuclear facilities should be considered based on the accident at the Fukushima Daiichi Nuclear Power Plant:

1) Increased interest in nuclear facilities.

The damage resulting from the accident has been devastating, and the interest in nuclear disasters has not been restricted to the general public of Japan but spread worldwide. There is a concern that this may have also increased the interest of terrorists in this area as a target of terrorism.

2) Equipment of nuclear facilities that have emerged as effective targets of terrorism

The conventional security of nuclear facilities mainly assumes terrorism targeting the nuclear reactor and other nuclear equipment that contains nuclear fuel, and strict measures have been taken accordingly.

However, the Fukushima accident taught us that it is important to prevent the loss of three major functions-- loss of all power supply, loss of cooling function of the nuclear reactor facility, and loss of cooling function of the spent fuel pool. The protection of all these facilities should be reinforced.

3) Assumed acts of terrorism

[164]. Advisory Committee on Nuclear Security, Atomic Energy Commission, "Strengthening of Japan's Nuclear Security Measures," March 9, 2012.

In reinforcing nuclear security measures for these nuclear facilities, it should be noted that the equipment installed on the periphery of protected areas may be targeted by terrorists, and one should assume the possibility that employees who are authorized to access nuclear facilities may act as terrorists.

4) Necessity of continued and enhanced security activity in an emergency

In line with the above (1) to (3), nuclear security in an emergency due to an accident (e.g., high radiation doses, loss of power supply, etc.) should be reinforced more than ever.

(3) Issues of nuclear security at nuclear facilities

Nuclear security measures at nuclear facilities are provided by identifying the facility/equipment to be protected, assessing the importance of protected objects after taking into account various risk information, and based on this assessment, designing protective measures for protected objects according to the principles of a graded approach[165] and defense in depth.[166]

The nuclear security measures at nuclear facilities are composed of detection, notification, delay, and response functions. Specifically, the perimeter of protected areas is equipped with sensors to detect unauthorized access at an early stage, whereupon the licensee notifies the security authority of such unauthorized access as required, a fence or similar impediment installed at the perimeter of the protected area helps delay access, and if required, the security authority goes into action for an appropriate response. To ensure the implementation of effective nuclear security, training and the development of an effective nuclear security system are also important.

An immediate response is required for the above-mentioned acts of terrorism, and equipment requiring reinforced protection is usually placed at the perimeter of the protected area. Taking these as elements of risk information, the licensees, regulatory bodies, security authorities, and other parties should immediately take protective measures suitable for solving the following nuclear security issues in addition to the conventional security measures.

1) Early detection of intrusion

An early detection of intrusion is essential to ensure a timely notification and response. The licensees are strongly urged to install a series of intrusion detection sensors near the site boundary in addition to sensors in conventional locations (new installation, reinforcement). The regulatory bodies must provide appropriate regulations based on related laws and regulations to ensure such security measures.

As the site is narrow in Japan, discussions of improvements in intrusion detection at the perimeter of the site (land and sea) are required.

2) Delay against acts of terrorism

Prevention of intrusion at the point of entry is vital to delay unauthorized access and allow for a timely report and response. In addition to conventional impediments such as fenced-off protected area, the licensees must install (or reinforce) physical barriers at the site boundary. The regulatory bodies need to provide appropriate regulations based on related laws and regulations to ensure the security measures.

Based on the situation that the site is narrow in Japan, etc., the licensees and regulatory body must discuss the delay control and the roles of related organizations in line with the opinions of the security authority for each facility.

3) Improvements in the robustness of protected equipment

The licensees are requested to improve the robustness of protected equipment against terrorist attacks with explosives, etc., through such measures as the installation of covers made of rigid materials. The licensees are also requested to place protected equipment near the protected area, wherever possible, for stricter protection. The regulatory bodies need to provide appropriate regulations, based on related laws and regulations, to ensure such security measures are done.

165. A “graded approach” entails the establishment of measures that vary according to the importance of the target of the defensive efforts and impedes criminal acts or willfully illegal acts against that target.

166. “Defense in depth” refers to secondary defensive measures to prevent a terrorist attack from occurring should the primary defensive measures fail, and tertiary defensive measures to minimize the harmful effects of such an attack if it does occur.

4) Maintenance of the protection system

All possible measures should be taken to establish an effective nuclear security system at ordinary times so that prompter notification and response are assured and such nuclear security activities can be continued in the event of an emergency.

For this purpose, the licensees should be equipped with sufficient resources of personnel, material, and equipment necessary for detecting an unauthorized access and notifying it to the security forces in such an event, and the same applies to those of the security forces that are to respond to intruders when receiving such a notification. The licensees and the regulatory agencies should review specific measures and the division of their respective roles by taking into account specific conditions at an individual NPS site, and in good consultations with the security agencies. In this context, the licensees may be requested to provide the security forces stationed at NPSs with a stronghold or other facilities/ equipment for their effective response actions.

5) Preparations for mitigation

In order to prepare for an event where protected equipment is destroyed, measures for mitigating the damages by a terrorist attack should be taken in advance in accordance with the concept of defense in depth. It is important to carefully examine if the measures concerned will fully function as designed at the time of such act of terrorism. Contingency plans among the licensees, the regulatory agencies and the security agencies should be prepared for the mobilization of additional personnel and equipment as well as the effective plan for safe evacuation of the staff members, the casualties, and neighboring residents in the event an act of terrorism is conducted that is beyond the scope of the existing nuclear security regime. Further, it is desirable to make prearrangements for smooth communication among the organizations involved in such mobilization and evacuation.

6) Exercises and Evaluations

The licensees, the regulatory and the security agencies should more closely collaborate in conducting more practical exercises and feeding back the evaluation results of these exercises in order to make the security measures more effective. In addition, the integrated exercise should be conducted at a nuclear facility, involving many organizations possible including those involved in mobilization and evacuation as mentioned above.

7) Measures against Insider Threat

More thorough checking of an ID pass, scrutinized search of personnel and accompanying items at the time of access control should be ensured by the licensee. The system for establishing “trustworthiness” should be introduced in Japan with due consideration of international practices. Pending its establishment, such measures as two-person rule should be strictly adhered to as an interim alternative in order to enhance the effectiveness of measures against insider threat.

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Elsewhere, the report notes that a frank and close exchange of views by those in charge in the field should be conducted among the licensees, regulatory body, and security authorities in regard to specific measures at individual facilities in order to promptly implement those measures. Moving forward, the licensees and regulatory body must continue their discussions on the preparations, training, and assessment of mitigation and other measures, and those measures must be steadily implemented. Also, the report stresses the critical importance of continuously reviewing all protection systems, starting with the systems of the licensees and security authorities.

(4) Actions taken by regulatory and other bodies in response to the report of the Advisory Committee on Nuclear Security

Based on the discussions at the Advisory Committee and the “Strengthening of Prevention of Terrorism against Nuclear and Other Facilities” (Decision by the Headquarters for the Promotion of Measures Against Transnational Organized or Other Crime and International

Terrorism, November 14, 2011), the regulatory and other bodies have improved the preventive measures against terrorism targeting nuclear facilities.

The NISA and the MEXT have been reviewing, as regulatory bodies, issues on nuclear security associated with the accident at the Fukushima Daiichi Nuclear Power Plant. The NISA also amended the ministerial ordinance “Regulations Concerning the Installation, Operation, and Other Actions of Nuclear Reactors for Power Generation” in December 2011 to reinforce nuclear security measures based on the accident at the Fukushima Daiichi Nuclear Power Plant. The amendment provides for the establishment of limited access areas, the protection of facilities that may indirectly cause the leak of specified nuclear fuel material when damaged, and measures against cyber terrorism. In addition, the NISA further amended these regulations at the end of March 2012 to reflect other key points indicated in the report by the Advisory Committee on Nuclear Safety.

Meanwhile, as of January 2012, the security authorities had decided to strengthen their security regime by increasing the number of police officers stationed onsite at nuclear facilities and providing them with the equipment and instruments required to improve their capacity to respond to a terrorist attack using explosives. The bolstering of other necessary personnel and equipment, review of and training on site alert guidelines, and reinforcement of interorganizational collaboration are also currently being implemented or are under discussion.

Licensees are preparing for stricter access control at the boundary of limited access areas (screenings of vehicles and persons at access points) in response to the above amendments to ministerial ordinances and are installing the required equipment. Improvements in nuclear security capability in the event of natural disasters and the provision of such things as onsite security headquarters for the security authorities are currently under discussion.

4.4 Threat perceptions in the United States and Japan prior to and after the Fukushima accident

After the events of September 11, 2001, the United States Nuclear Regulatory Commission (NRC) issued orders to nuclear power plant licensees to adopt mitigation strategies using readily available resources to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities to cope with the loss of large areas of the facility due to large fires and explosions from any cause, including beyond-design-basis aircraft impacts. (Referred as B5b, which is the number of clause.)

As a result, all existing nuclear power plants in the United States implemented measures that would allow them to restore power in the event of a total power failure. Following the subsequent inspections, it was confirmed that all required measures had been taken. Also, at an NRC meeting held 10 days after the Great East Japan Earthquake, it was acknowledged that the enhanced security measures called for under B5b, which had been implemented by the United States, could have been effective in responding to an accident like the one at Fukushima as well.

NISA was informed in 2006 and 2008—well before the Fukushima accident—that the United States was implementing these additional security measures, but similar measures were never implemented in Japan, and the end result was significant radiation damage. The cause of this substantial difference in the responses of Japan and United States could be attributed to the gap between the two countries’ perceptions of the nuclear terrorism threat.

The World Trade Center buildings in flames after the 9/11 terrorist attacks

Photo: Steve Ludlum, *New York Times,* http://www.nytimes.com/slideshow/2002/04/08/national/09puli.1.slideshow_2.html.

The United States in fact experienced terrorist attacks on 9/11, when terrorists hijacked large airplanes and crashed them into skyscrapers and the Pentagon. At the World Trade Center, the crash caused a huge fire when massive amounts of jet fuel ignited and as a result, the buildings collapsed and many lives were lost. For that reason, the United States recognized that the risk (threat) of a terrorist attack in which terrorists crash into a nuclear power plant using a hijacked aircraft could in fact happen, and therefore the US government issued the B5b as countermeasures to prevent such an act.

On the other hand, in Japan, measures against the theft of nuclear materials or sabotage of nuclear facilities have historically been categorized as part of the "protection of nuclear materials" and therefore fall under the jurisdiction of the Japan Atomic Energy Commission. For that reason, the argument had been rejected over the years that countermeasures to prevent nuclear accidents caused by human acts should also be placed under the jurisdiction of the Nuclear Safety Commission because there is no difference in terms of the radiation released between an event caused by natural disasters and one caused by human acts. (Historically, the reason why the protection of nuclear materials is under the jurisdiction of the Atomic Energy Commission is because preventing terrorists from illegally obtaining nuclear fuel materials to build a nuclear bomb is considered to be part of the commission's mandate to ensure the peaceful use of nuclear energy.)

As a result, even when senior officials in the safety division at the NISA were informed that the United States had issued the B5b order for the purpose of counterterrorism, they did not recognize that such measures were relevant to their own work. Additionally, due to a general perception that the risk of terrorist attacks like 9/11 occurring in Japan is low, one can assume that the NISA failed to consider this when conveying information to the divisions that are in charge of acts of sabotage against nuclear facilities.

However, under Japan's regulatory reforms currently being contemplated, prompted by the Fukushima accident, the coordinating function for counter–nuclear terrorism measures, which had been under the Japan Atomic Energy Commission, will now be consolidated in the Nuclear Regulation Authority that was created, and therefore it is expected that mistakes like the one made by the NISA will not be repeated.

After the Fukushima accident, Japan's perception of a nuclear terrorism threat has greatly changed. Specifically, and as mentioned before, the report by the Advisory Committee on Nuclear Security did point out that a terrorist attack on a nuclear power plant should be considered as plausible and stressed that countermeasures against terrorist attacks should be implemented. In addition, as Japan's equivalent of the B5b, the NISA has requested that all electric power companies implement countermeasures to deal with the total loss of power supply—a lesson learned from the Fukushima accident.

The Fukushima accident served to highlight the discrepancy in the awareness of the threat of nuclear terrorism between Japan and United States. Moving forward, we must strengthen the cooperative efforts of Japan and the United States and strengthen the information sharing among Japan's regulatory bodies in order to avoid making the same mistake twice.

Chapter 5: Strengthening Japan-US Cooperation in the Nuclear Security Field

In April 2009, President Barack Obama delivered a speech in Prague, Czech Republic, in which he stated his goal of "a world without nuclear weapons."[167] In that speech, President Obama declared that the United States would take the lead in seeking a peaceful and secure world without nuclear weapons, and he called for improved nuclear material management, the break-up of the nuclear black market, and a stronger framework for international cooperation. He also referred to the importance of the war against nuclear terrorism, proposing that these topics be addressed at a summit on strengthening nuclear security that the United States would host. This became the starting point for substantive Japan-US cooperation on nuclear security.

5.1 The history of Japan-US cooperation in the nuclear security field

As a result of Obama's Prague speech, the goals of nonproliferation and stronger nuclear security gained momentum in the international community, and in September 2009 the first UN Security Council Summit on Nuclear Nonproliferation and Nuclear Disarmament was held. In a speech at the summit, then Prime Minister Hatoyama renewed Japan's commitment to the Three Non-Nuclear Principles and pledged to take the lead in working toward the total elimination of nuclear weapons. At the same time, with regard to the use of nuclear energy for peaceful purposes, he stressed the need to adhere to the highest level of standards in the so-called "3S" of nuclear safety, safeguards, and security.

In November 2009, when President Obama visited Japan, a summit was held that produced the "Japan-US Joint Statement toward a World without Nuclear Weapons,"[168] which stated that the United States and Japan would cooperate in efforts to strengthen nuclear security through human resource development, training, and infrastructure assistance, and in such fields as the development of nuclear material measurement and detection technologies. The commitment expressed in this joint statement was also connected to Japan's national statement at the Nuclear Security Summit held in Washington DC in April 2010.[169] At that summit, Japan made commitments in the following four categories:

(1) To establish a center within the Japan Atomic Energy Agency (JAEA) for strengthening nuclear security in Asian and other countries (tentative name: Integrated Comprehensive Support Center for Nuclear Nonproliferation and Nuclear Security for Asia), and to contribute to human resource development, capacity building, and network building for those involved in nuclear nonproliferation and nuclear security.

(2) To conduct cooperative Japan-US research to develop technologies that contribute to the advancement of the measurement and control of nuclear material, as well as technologies related to the detection of nuclear material and nuclear forensics that contribute to the identification of the sources of nuclear material illicitly trafficked.

167. "Remarks by President Barack Obama," Prague, Czech Republic, April 5, 2009, http://www.whitehouse.gov/the-press-office/remarks-president-barack-obama-prague-delivered.
168. "Japan-US Joint Statement toward a World without Nuclear Weapons," MOFA website, http://www.mofa.go.jp/region/n-america/us/pv0911/nuclear.pdf.
169. "Japan's National Statement at the Washington Nuclear Security Summit," April 12, 2010, MOFA website, http://www.mofa.go.jp/policy/un/disarmament/arms/nuclear_security/2010/national_statement.html.

Within an approximate three-year timeframe, Japan will make increased contributions to the international community by establishing these technologies with more precise and accurate capabilities in detection and forensics and by sharing the fruits of these new technologies with the international community.

(3) To contribute personnel and financial support to the IAEA for nuclear security projects (on the scale of approximately US$6 million).

(4) To host a WINS conference in Japan to share best practices.

In terms of the first commitment, in December 2010 the Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (hereafter, Integrated Support Center) was established within the JAEA's Ricotti, a building located near the Tokai Station in Ibaraki Prefecture that also houses the agency's programs for communicating risk to the regional community and disseminating findings. On the second commitment, the JAEA began conducting R&D under a grant from MEXT. Japan also began implementing the remaining two commitments in FY2010. All of the commitments have been fulfilled as planned. The progress made since the 2010 Washington Nuclear Security Summit was detailed in the National Progress Report presented at the 2nd Nuclear Security Summit, held in Seoul in March 2012.[170]

At the time of the November 2010 Japan-US Summit Meeting, the two governments agreed to establish a Japan-US Nuclear Security Working Group (NSWG) in order to review and ensure the smooth implementation of the commitments made at the Washington Summit, and to collaborate and produce results as they looked ahead to the 2012 summit in Korea. The NSWG set specific goals in the following nine areas and began conducting cooperative initiatives in each area:

1. Cooperation within the Integrated Support Centre for Nuclear Non-proliferation and Nuclear Security
2. Research and Development of Nuclear Forensics, Measurement and Detection Technologies, and Sharing of Investigatory Best Practices
3. Cooperation on Safeguards Implementation
4. Sharing of Best Practices for Nuclear Security in New Facility Design
5. Cooperation on Transport Security to Reduce the Chances of Theft or Sabotage
6. Convert Reactors to Reduce the Use of Highly Enriched Uranium (HEU) and Complete Down-Blending Operations
7. Implementation of INFCIRC/225/Rev.5
8. Integration of Response Forces into Dealing with Theft and Sabotage at Facilities
9. Joint Study on Management of HEU and Plutonium: Reduction of Material Attractiveness

A fact sheet on the cooperative work of the NSWG was distributed at the 2nd Nuclear Security Summit in Seoul.[171]

170. "National Progress Report—Japan," March 27, 2012, MOFA website, http://www.mofa.go.jp/policy/un/disarmament/arms/nuclear_security/2012/pdfs/report.pdf.
171. "United States–Japan Nuclear Security Working Group Fact Sheet," March 2012, MOFA website, http://www.mofa.go.jp/policy/un/disarmament/arms/nuclear_security/2012/factsheet.html.

5.2 Strengthening Japan-US cooperation

As noted above, Japan-US cooperation on nuclear security has been moving forward as the government-established NSWG works toward the objectives set out in each of the nine areas listed above.

The accident at the Fukushima Daiichi Nuclear Power Plant following the Great East Japan Earthquake on March 11, 2011, offered a number of lessons for nuclear security, including the need to strengthen the protection of facilities that are vital to the safe operation of nuclear power plants—e.g., the electricity sourcing system for daily and emergency use, the systems handling the core cooling functions in the reactor, the coolant systems for spent fuel storage pools, etc.—and the need for countermeasures against insider threats. Deliberations are also underway on how to incorporate the latest IAEA Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Rev.5),[172] which was released in January 2011 into domestic laws. As Japan moves toward strengthening nuclear security domestically, it is essential that we further strengthen Japan-US cooperation by building upon new developments such as the lessons from the Fukushima accident. There are many areas in which Japan and the United States should work together, such as the drafting of measures to prevent the sabotage of nuclear power plants, the establishment of an emergency response system to handle the aftermath of an incident, the implementation of training based on those scenarios, and so on. The following sections will examine ways in which medium- to long-term Japan-US cooperation can be strengthened.

(1) Human resource development

In December 2010, as noted above, the Integrated Support Center was established within the JAEA to strengthen nuclear nonproliferation and nuclear security primarily in the Asian region.[173] Including past projects, the JAEA has technical development and operational experience that spans the entire nuclear fuel cycle, including the development of uranium-related technologies (mining, refining, conversion, enrichment, and nuclear fuel manufacturing), the development of reprocessing technology, the development of new models of nuclear reactors, the operation of test reactors, the operation of reactors in the test stage that are on the same scale as those used in commercial nuclear plants (the prototype reactor at the Fugen Nuclear Power Station, the Monju fast breeder reactor, etc.), and research on the treatment and disposal of high-level waste. These R&D sites handle a wide variety of nuclear materials and thus have a tremendous amount of knowledge and experience on the physical protection of that material, and on accountancy and safeguard measures. Along with the promotion of the peaceful uses of nuclear Energy, the JAEA has been participating in international cooperation frameworks that include the IAEA and the United States in efforts to develop verification technology—in particular to verify that nuclear material is not converted for use in nuclear weapons (safeguards, nonproliferation measures)—and those efforts have been produceda lot of outcomes. Based on these experiences, the JAEA was asked to establish the Integrated Support Center and carry out capacity building in the fields of nuclear nonproliferation and nuclear security.

Starting as early as 1996, the JAEA in cooperation with the IAEA has been providing a two- to three-week annual training course, primarily for the Asian region, on accountancy and safeguards, and already 240 students from 35 countries have completed the course. On the

172. See IAEA website, http://www-pub.iaea.org/MTCD/publications/PDF/Pub1481_web.pdf.
173. See the Integrated Support Center website for further information: http://www.jaea.go.jp/04/iscn/index_en.html.

other hand, in the nuclear security field, despite having onsite experience with the physical protection of nuclear material, the agency has not offered any training courses on this subject. For that reason they are beginning by building their own capacity through cooperation with the United States, which has a great deal of experience in nuclear security–related training.

Based on the "Agreement for Cooperation in Research and Development Concerning Nuclear Material Control and Accounting Measures for Safeguards and Nonproliferation" between the US Department of Energy and the JAEA, a project action sheet was agreed upon in January 2011 and the two sides launched a cooperative initiative that is now in its second year. This project comprises training for the development of lecturers within the JAEA (August 2011), the provision of textbooks, joint curriculum development, and support for international training courses. In October 2011, following the establishment of the Integrated Support Center, a two-week training program (based on the Regional Training Course developed at the Sandia National Laboratories in the United States) was carried out for personnel in the Asian region on the theme of "The Physical Protection of Nuclear Material and Nuclear Facilities." A total of 28 people from 14 countries participated. Through cooperation with the Department of Energy and the Sandia National Labs, one-third of the lectures were given by JAEA lecturers and the other two-thirds were by Americans, and while the instructors for the practice subgroups received assistance from the US side, the JAEA was in charge of the training course. In 2012, the two sides are working together again to conduct the training course, this time with a higher ratio of lecturers from the JAEA. The goal is for the JAEA to be providing training courses on its own in about five years, and thus continued Japan-US cooperation will be needed to achieve that target.

The Sandia-developed Regional Training Course that the JAEA is introducing is comprised of a combination of lectures and tabletop exercises on such topics as the concept of physical protection for nuclear material and nuclear facilities, information necessary for designing a physical protection system, methods of designing a protection system, methods of evaluating the system's performance, and so on. Participants are divided into groups of six to eight for training exercises on the protection system of an hypothetical research reactor in an hypothetical country, during which they evaluate and improve the system so that by the end of the course, they have redesigned the entire physical protection system of that hypothetical research reactor and have learned physical protection methods.

In order to prevent terrorists from acquiring information related to physical protection systems on actual nuclear facility , licensees must treat that information as classified. As a result, training on physical protection cannot be carried out using actual nuclear facilities. In FY2011, the JAEA prepared a physical protection training field by building a model of a physical protection system within its research site at Tokaimura that will allow training on actual sensors, surveillance cameras, entry control systems, and so on. In constructing the training field, the JAEA studied similar facilities such as the Russian Interdepartmental Special Training Centre and the Sandia National Labs, consulted with experts within Japan and abroad, and then designed and installed it. In addition, the JAEA introduced a virtual reality system in FY2011. They constructed a hypothetical nuclear power plant in cyberspace that, when used with a large 3D screen, allows trainees to be feel as if they are actually inside a power plant. These developments are being shared between Japan and the United States so that they can be incorporated in the Regional Training Course, which has previously only used tabletop training, and new curriculum is being developed as well. This type of training course is unique in the world. An international training course using the physical protection training field and the virtual reality system will be conducted in October 2012. Also, before holding the international course, a pilot course is planned for experts within Japan. The JAEA has been coordinating these efforts in such a way that they can be used for capacity building not only for Asian countries, but for relevant actors within Japan as well.

Moreover, in a statement made by Prime Minister Yoshihiko Noda at the March 2012 Nuclear Security Summit in Seoul, within the context of international initiatives to strengthen nuclear security, Japan pledged to expand human and material assistance to developing countries, in particular through the expanded hosting and training of human resources at the Integrated Support Center.

(2) Japan-US joint outreach efforts

Another productive theme for Japan-US cooperation is joint outreach efforts aimed at strengthening nuclear nonproliferation and nuclear security in Asia, and the two countries have begun putting that into action. In the region, there are many countries such as Vietnam that are still moving forward with plans to introduce nuclear power even after the accident at Fukushima. Japanese companies are currently bidding on the second phase of Vietnam's plan to introduce nuclear power, and it is important that the company constructing the plants not only export the nuclear plant itself but also firmly transplant to the recipient country the ability to handle nuclear nonproliferation and nuclear security through a tie-up with the Integrated Support Center. As a non–nuclear weapons country, Japan is one of just a handful of nations that has pursued the peaceful uses of nuclear energy while firmly addressing nonproliferation, and it must use its experience to contribute to the strengthening of regional nonproliferation and nuclear security as various countries in Asia plan to adopt nuclear power. The United States also has high expectations for Japan's role in this area.

With regard to cooperation on nuclear nonproliferation and nuclear security, which are closely connected to the export of nuclear power, the Integrated Support Center has already begun sharing information and coordinating with Japanese companies. In October 2011, the center held a nuclear security seminar in Vietnam, and in March 2012 they held a seminar at the Integrated Support Center on peaceful uses of nuclear energy and nuclear nonproliferation/security for 10 operators from Vietnam Electricity. Also, the center held a workshop in July 2012, in Da Lat, Vietnam, on the subject of declaration based on the IAEA Additional Protocol, which was being conducted in cooperation with the IAEA, the United States, the Nuclear Material Control Center, and others.

As seen in the ties between Hitachi and GE, and between Toshiba and Westinghouse, US and Japanese companies are connected as well, and so it is extremely significant that the US and Japanese governments—through the Integrated Support Center, Department of Energy, and other agencies—carry out cooperative outreach efforts in the field of nuclear nonproliferation and nuclear security.

As mentioned previously, there is a trend within Japan toward stronger nuclear security based on INFCIRC/225/Rev.5 and the lessons of Fukushima, and that needs to be applied in the Asian region as well. In particular, in November 2011, an international workshop was held at the Integrated Support Center through Japan-US collaboration that sought to encourage the incorporation of INFCIRC/225/Rev.5 in domestic regulatory systems. In the future as well, such cooperation in efforts to encourage the broader adoption of INFCIRC/225/Rev.5 should continue, drawing on the experiences of Japan and the United States in incorporating the recommendations in their own domestic laws.

Since 2008, the United States has been carrying out the Next Generation Safeguards Initiative (NGSI).[174] The objective of the NGSI is to encourage international cooperation in strengthening the IAEA safeguards by strengthening the infrastructure, technological development, and human resources for sustainable safeguards. In 2012, the fourth NGSI meeting will be held in Hanoi, Vietnam, and Japan is actively collaborating on this type of safeguard-related activity, with plans to gain more joint outreach experience. By sharing information on their Asian outreach activities, Japan and the United States can avoid duplicating their efforts. It is also important to coordinate so that information can be shared not just bilaterally, but with other institutions as well that are conducting outreach in Asia, such as the IAEA and Euratom. In particular, Japan and the United States should carry out joint outreach on such themes as the universalization of the IAEA additional protocol on safeguards, export controls, and so on.

(3) Development of technology for measuring and detecting nuclear material

① Development of nondestructive measurement of plutonium contained in spent fuel

At the Washington Nuclear Security Summit, Japan committed to work together with the United States to prevent nuclear terrorism by developing technology for measuring and detecting nuclear material that will facilitate the discovery of the illicit import, export, or transfer of nuclear material, and to contribute to the international community by sharing the results of their development efforts. Measurement and detection technology can be used not only to detect attempts to transport illicit nuclear material across national borders, but can also be used for nuclear material accountancy in nuclear power plants. Already, Japan and the United States have a track record of cooperation spanning a quarter century in developing measurement technologies for use in accountancy at nuclear fuel cycle facilities and in IAEA safeguards (the above-noted "Agreement for Cooperation in Research and Development Concerning Nuclear Material Control and Accounting Measures for Safeguards and Nonproliferation" between the US Energy Department and JAEA). Currently, Japan and the United States are cooperating on joint technological development to accurately quantify the amount of plutonium and uranium contained in spent fuel through nondestructive assessments.[175,176]

In the United States, there was a plan to dispose of spent fuel from nuclear power plants (light-water reactors) in a repository at Yucca Mountain, but that plan is back at square one, and for the time being spent fuel continues to be stored at each site. Immediately after spent fuel is removed from the reactor core, the surface is highly radioactive due to radioactive fission products, so it is difficult to access, but with long-term storage, the radiation attenuates and it becomes possible to draw near. In spent fuel, roughly 1 percent is plutonium. Because it would be possible to discretely remove a small fuel rod from the fuel assembly, extract the plutonium, and convert it for use in a nuclear weapon or dirty bomb, technology is needed to detect when even a small number of fuel rods are removed, and to accurately measure plutonium in spent fuel through nondestructive assessments. In the Department of Energy's Next Generation Safeguards Initiative, the development of nondestructive assessment technology to measure plutonium in spent fuel is an extremely high priority

[174]. For information, see http://nnsa.energy.gov/mediaroom/factsheets/nextgenerationsafeguards.

[175]. Adrienne M. LaFleur et al., "Comparison of Fresh Fuel Experimental Measurements to MCNPX Calculations Using Self-Interrogation Neutron Resonance Densitometry," *Nuclear Instruments and Methods in Physics Research Section A* 680, no. 11 (July 2012): 168–78.

[176]. Jeremy Lloyd Conlin and Stephen J. Tobin, "Predicting Fissile Content of Spent Nuclear Fuel Assemblies With the Passive Neutron Albedo Reactivity Technique and Monte Carlo Code Emulation" (paper presented at the International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering [MC 2011], Rio de Janiero, Brazil, May 8–11, 2011).

among the technological development projects underway, and 14 candidate technologies have been proposed.[177] For two promising technologies among those 14, Japan is planning to provide a location for measurement technology testing. There is a roughly three-year plan to carry out empirical testing of the two measurement systems, following which further development will be carried out to improve the level of accuracy.

In Japan, spent fuel will be reprocessed at the Rokkasho Reprocessing Plant. In nuclear power plants, the amount of plutonium contained in spent fuel is determined based on the calculated value of the burn-up analysis code, which gives a low degree of accuracy. On the other hand, at reprocessing plants, by using actual measurements of the dissolved spent fuel, they can get an accurate calculation. The difference in these measurements at the reprocessing plant is the shipper/receiver difference (SRD), and as the amount of spent fuel to be processed becomes larger, the SRD above a significant amount (in the case of plutonium, 8 kg) is calculated. It is therefore better to have as small an SRD as possible, and improving the measurements at the nuclear power plant would be effective for that purpose. If accurate nondestructive measurement technology for spent fuel can be established, then the accuracy of measurements at nuclear plants will improve, thereby contributing to a decrease in SRD.

② Development of nuclear resonance fluorescence–based nuclear material detection technology using Laser-Compton scattering gamma rays

As a component technology for the nondestructive measurement of nuclear material, cutting-edge technological development is underway using the phenomenon known as nuclear resonance fluorescence (NRF).[178] The technology uses the NRF phenomenon, whereby irradiation with a specific energy's gamma rays excites the nucleus plutonium (or uranium), which then emit the same energy's gamma rays from the excited nucleus. Gamma rays are used as a probe for measuring nuclear material, but the development of light source technology to produce mono-energetic gamma rays through the use of electron accelerators and lasers (Laser-Compton scattering gamma rays) is also needed, and work is being done to combine these technologies. An extremely high level of gamma-ray energy is required to produce the NRF phenomenon—for plutonium, at least 2 mega-electron volts (MeV), and for uranium-235, at least 1.7 MeV—and it is thus possible to detect nuclear material concealed within thick shielding, making it applicable for detection of illicit import, export, or transfer of material at borders or in harbors (see fig. 5-1).

At the same time, because accelerators and other facilities require extremely large-scale equipment, there are many components that must be developed for this technology, including equipment (accelerators) to produce light sources at a lower cost. Japan-US cooperation can facilitate efficient technological development.

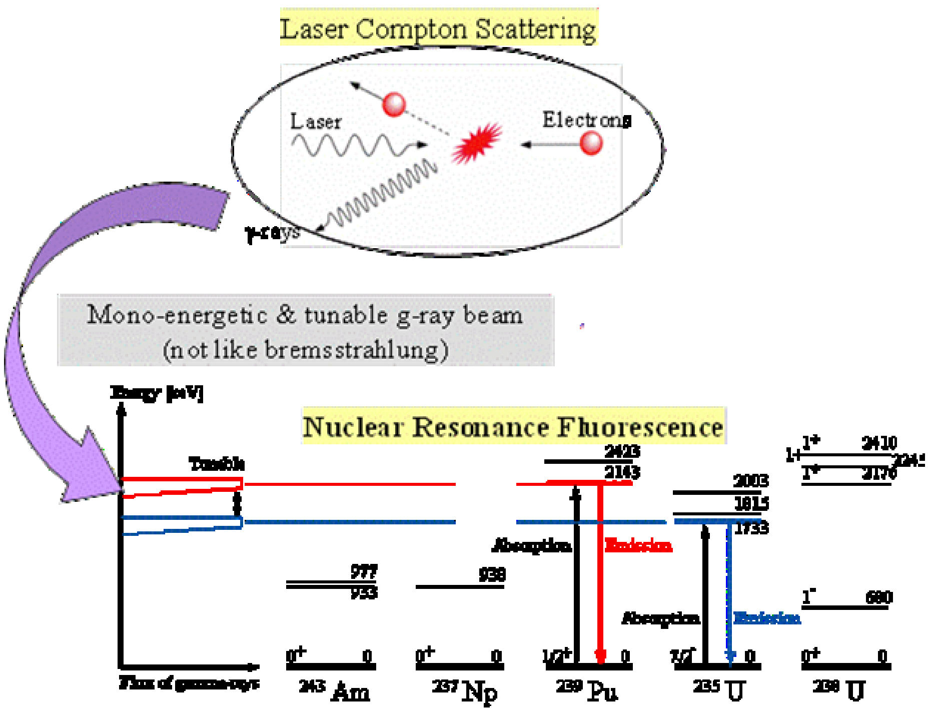
Currently, Japan is independently carrying out technological development in the area of light-source equipment, and is conducting basic testing of the NRF phenomenon using gamma rays emitted from that equipment, while Japan and the United States are jointly conducting simulation analysis of the detection device. This is a theme where Japan and the United States should work collaboratively to evaluate the results of those tests and move ahead to the development of the technology for practical application. If this technology is developed, it

177. Stephen J. Tobin et al., "Next Generation Safeguards Initiative Research to Determine the Pu Mass in Spent Fuel Assemblies: Purpose, Approach, Constraints, Implementation, and Calibration," *Nuclear Instruments and Methods in Physics Research Section A* 652, no. 1 (October 2011): 73–75.

178. Takehito Hayakawa et al., "Nondestructive Assay of Plutonium and Minor Actinide in Spent Fuel Using Nuclear Resonance Fluorescence with Laser Compton Scattering," *Nuclear Instruments and Methods in Physics Research Section A* 621, no. 1–3 (September 2010): 695–700.

has the potential to be applied for nuclear material detection in large-scale ports, or as a nondestructive measurement technology for spent fuel.

Figure 5-1. Gamma ray creation and nuclear resonance fluorescence using Laser-Compton scattering

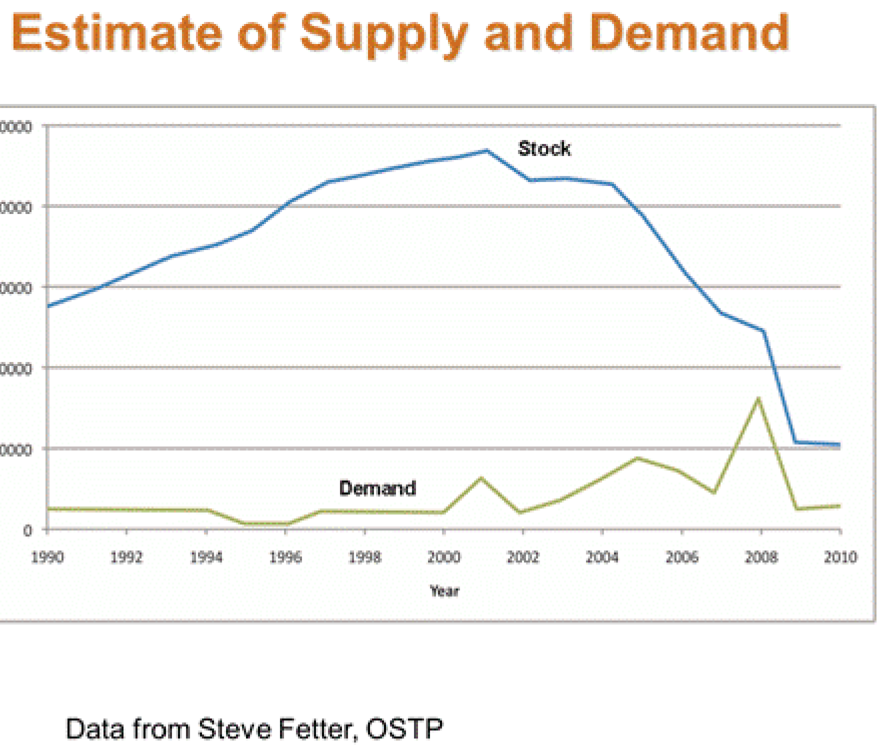


Source: Ryoichi Hajima et al., "Proposal of Nondestructive Radionuclide Assay Using a High-Flux Gamma-Ray Source and Nuclear Resonance Fluorescence," *Journal of Nuclear Science and Technology* 45, no. 5 (2008): 441–51.

③ Development of He-3 replacement neutron measurement technology

Most of the methods used for nuclear material accountancy determine the quantity of nuclear material by measuring the neutrons emitted from that material. The measurement is generally done by loading an ionization chamber with He-3, a helium isotope gas, and taking measurements using the nuclear reaction between the He-3 and neutrons. The world's main supplier of He-3 is the United States. He-3 is formed as a byproduct of tritium (tritium, which has a half-life of approximately 12 years, beta decays into He-3), one of the materials used in making a hydrogen bomb, but as a result of nuclear disarmament, tritium is no longer being produced, so as shown in figure 5-2, the stock of He-3 has been rapidly shrinking since 2000. As a result of the rapid drop in the supply of He-3, it is no longer possible to manufacture the He-3 ionization chambers for use as neutron detectors. Accordingly, technological development of the He-3 detector, which had been included in the aforementioned US NGSI list of 14 proposed technologies for the nondestructive measurement of nuclear material in spent fuel, has had to be discontinued.

Figure 5-2. Trends in stock and demand for He-3



Source: Richard Kouzes, Institute of Electrical and Electronics Engineers Workshop on He-3 Alternatives for Neutron Detection, Valencia, Spain, October 28, 2011.

As nuclear security is strengthened, the need for measurement and detection of nuclear material is rising, but there is now a growing shortage of measurement and detection equipment, and so a fierce competition has emerged among the world's measurement instrument manufacturers and R&D institutes who are vying to develop He-3 replacement neutron measurement technology. At JAEA, scientists are currently developing measurement technology using a zinc sulfide (ZnS) solid scintillator (ceramic) that contains B-10 (an element that is a boron isotope with a large neutron absorption cross-section),[179] and in the United States and elsewhere, development is underway of technology using B-10 lined tubes and liquid scintillators that emit light when neutrons are absorbed.[180,181] In order to strengthen nuclear security, He-3 replacement neutron measurement technology will be an extremely important area for component technology development, and thus Japan-US cooperation on the achievement of measurement equipment with an equivalent level of accuracy to the He-3 ionization chamber will be very significant. In particular, because Japan possesses nuclear fuel cycle facilities and has an environment in which non-sealed nuclear material including plutonium must be measured, it can provide the United States with an appropriate testbed for the equipment it has developed.

179. Masatoshi Kureta et al., "Development of Scintillation Neutron Detectors for Non-Destructive Assay of Nuclear Fuel (1) Master Plan and Feasibility Study on Nuclear Reaction Probability by Monte Carlo Analysis" (paper presented at the Institute for Nuclear Materials Management (INMM) 52, Palm Desert, California, July 17–21, 2011).

180. Robert D. McKeag et al., "Characterisation of ^{10}B Lined Tubelet Proportional Counters to Replace ^{3}He Detectors for Nuclear Material Neutron Measurements" (paper presented at the INMM 52).

181. Jennifer L. Dolan et al., "Neutron Measurement and Spectroscopy With Capture-Gated Organic Scintillation Detectors for Nuclear Safeguards Applications" (paper presented at the INMM 52).

If He-3 replacement technology can be established, it can also be used in IAEA inspections, and so it can make a significant contribution to strengthening the nuclear nonproliferation system.

④ Development of nuclear forensics technology

Nuclear forensics is a technological tool for analyzing the composition and physical/chemical form of nuclear, radioactive, or other relevant material that has been seized or discovered by law enforcement authorities in order to determine the source, history, transport route, objective, and other aspects of that material. As was the case with nuclear material measurement and detection technology, Japan made a commitment at the Washington Nuclear Security Summit to develop nuclear forensics technology within the next three years and share that with the international community as part of its global contribution.

Starting in FY2011, JAEA began work on a MEXT-funded technological development project to establish nuclear forensics technology.[182] JAEA already possesses technology, such as environmental sample analysis for safeguards, that measures and analyzes microscopic amounts of a nuclear material's isotopic composition, and it is authorized to act as one of the IAEA's Network of Analytical Laboratories for Environmental Sampling.[183] It is using these capabilities in its development of nuclear forensics technology. In order to apply the forensics technology that is developed, the plan is to first develop a domestic database within Japan. Given that Japan possesses facilities that correspond to the entire nuclear fuel cycle—nuclear power plants, uranium enrichment facilities, spent fuel reprocessing facilities, uranium fuel manufacturing facilities, MOX fuel manufacturing facilities, fast breeder reactors, research reactors, etc.—it is possible to construct various databases for all of these facilities. By creating these databases, it will be possible to identify the source of seized nuclear material. Japan and the United States have already begun cooperative efforts in such areas as creating domestic nuclear forensics databases and on technology development for age determination of reprocessed and refined (manufactured) nuclear material.

Because it is economically and technically difficult to have the full spectrum of nuclear forensics technical capabilities, it is important to have international cooperation in dividing up and building capacity in each region. The question of what is the minimum capacity needed to carry out nuclear forensics is now being debated, with discussions having begun in such forums as the Global Initiative for Combatting Nuclear Terrorism's Nuclear Forensics Working Group, the International Technical Working Group (an international group of experts conducting technological development in the area of nuclear forensics), and the IAEA. At JAEA, there are plans to hold training courses and workshops aimed at developing nuclear forensics capacity in the Asian region, which will be conducted primarily in cooperation with the United States and with other countries as well. Regional capacity in nuclear forensics technology is also important for stopping terrorism.

⑤ Cooperation on strengthening physical protection regulations

As noted above, the newly revised IAEA Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Rev.5) was released in

182. Satoshi Sakurai et al., "R & D on Nuclear Forensics at JAEA" (paper presented at the INMM 52).
183. Satoshi Sakurai et al., "Development of safeguards environmental sample analysis techniques at JAEA as a Network Laboratory of IAEA" (IAEA-CN-148/116) (paper presented at the International Safeguards Symposium on Addressing Verification Challenges, Vienna, October 16–20, 2006).

January 2011. Each country must incorporate these revised recommendations into their domestic regulations. In Japan as well, a new fundamental policy to address this was announced by the Japan Atomic Energy Commission's Advisory Committee on Nuclear Security.[184] Some parts have already been incorporated into Japanese law. The revised recommendations call for states to carry out performance testing to evaluate the physical protection systems of nuclear facilities, force-on-force exercises pitting "attackers" against a facility's guards and response forces, and so on. The United States has already incorporated these recommendations in its regulations and is carrying them out, and it is therefore extremely important to promote cooperation in this field in order to learn from the US experience. In particular, there is a great deal to learn from the United States in terms of how to apply and implement the method of having each operator evaluate their physical protection system since she has already done this. Also, one of the major lessons from the Fukushima accident was the need to create an efficient and effective system of coordination and cooperation among the relevant ministries and agencies in the event that a nuclear security incident does occur, and here again there is a great deal to learn from the United States.

⑥ Security by Design

Since the 2001 terrorist attacks on the United States, nuclear terrorism has been perceived as a real threat, and the requirements of nuclear security countermeasures have become stricter. In INFCIRC/225/Rev.5 as well, there are strict requirements, calling on nuclear facilities to give consideration, for example, to airborne threats and to "stand-off attacks" in which attacks are executed at some distance from the targeted facility. Also, another lesson learned from the Fukushima Daiichi Nuclear Power Plant accident was that there is inadequate protection of vital equipment, and it is therefore necessary to create additional physical protection. In the case of existing facilities, it is extremely expensive to keep adding on additional protection measures. Because nuclear security measures are costly, consideration must be given to ways to reduce those costs, and when building new nuclear plants, physical protection measures should be considered from the planning stages in order to simultaneously achieve lower costs and stronger nuclear security. In this field, it is also possible to think about ways to create synergy with safety design. The regulations for building permits for nuclear power plants require assessments of the appropriateness of the safety design, and similar assessments of the designs for nuclear security should be incorporated into this type of building permit as well. How to reflect nuclear security in the regulations is another potential theme for Japan-US cooperation.

As Japanese and American companies are working together to introduce nuclear power plants in other countries in the Asian region, the results of Japan-US cooperation on regulations can be applied in those countries as well. Within the framework of the JAEA's cooperation with the US Department of Energy, as mentioned above, work is currently underway on a handbook on how to incorporate security from the planning stages, and this is also an area of cooperation being pursued by the NSWG. These types of cooperative efforts should be continued.

[184]. Japan Atomic Energy Commission, "Wagakuni no kaku-sekyuritei taisaku no kyoka ni tsuite" [On the strengthening of Japan's nuclear security measures], March 9, 2012, http://www.aec.go.jp/jicst/NC/about/kettei/kettei120309.pdf.

5.3 Applying the lessons learned from the Fukushima Daiichi Nuclear Plant accident in Japan-US cooperation

The accident at the Fukushima nuclear plant made it clear that an act of terrorism at a nuclear facility could produce conditions that would have a similarly serious impact on society. For that reason, as noted in chapter 4 of this report (section 4.3), the Advisory Committee on Nuclear Security examined the lessons from the Fukushima accident and recommended that a number of protective measures be quickly implemented to strengthen Japan's nuclear power plants both in terms of nuclear power safety and nuclear security. Those measures are intended to 1) early detection of intrusion ; 2) delay of terrorists' action; 3) increase robustness for vital equipment; 4) fully equipped regime ; 5) preparation of mitigation measures; 6) exercises and evaluations ; and 7) measures against insider threat. Also, although not specific to the topic of nuclear security, the decommissioning measures for the Fukushima Daiichi Nuclear Power Plant will be a major theme for Japan-US cooperation in the future. Based on these points of view, this section will consider how Japan-US cooperation can apply the lessons of the Fukushima accident from the technological perspective.

(1) Preparation for mitigation

In a report on a study conducted by the Independent Investigation Commission on the Fukushima Daiichi Nuclear Accident, it is noted that, "Japan's nuclear security strategies emphasize the prevention of an attack or an intrusion into the site before it occurs, and that seems to have created a failure to strengthen our ability to respond once an event had occurred in order to minimize the damage and recover." The report also touched on the fact that Japan did not apply the measures that the United States had adopted after the 9/11 attacks to minimize damage at nuclear facilities in the case that they are attacked (the NRC's B5b measures).[185]

B5b was a regulation that required nuclear plant licensees "to adopt mitigation strategies using readily available resources to maintain or restore core cooling, containment and spent fuel pool cooling capabilities to cope with the loss of large areas of the facility due to large fires and explosions from any cause, including beyond design-basis aircraft attacks." In Japan, after stress tests were carried out following the Fukushima accident—in other words, tests conducted to determine how much key safety facilities and equipment can withstand when the magnitude of an earthquake or tsunami that strikes a nuclear plant exceeds the anticipated maximum level, with the amount then being gradually increased—and the overall margin of safety was assessed, various measures were taken to ensure safety, such as securing emergency generators and alternate coolant capabilities. These countermeasures are included in the safety standards for restarting the nuclear power plants that have been shut down. In order to keep the impact of accidents to a minimum, Japan must cooperate with the United States and learn from the US experience with the measures they implemented shortly after 9/11 to deal with large-scale loss of functions at nuclear power plants.

(2) Insider threat countermeasures

It has come to light that in the response and recovery work immediately following the Fukushima Daiichi Nuclear Plant accident, workers whose identity could not be confirmed in

[185]. *Report of the Independent Investigation Commission on the Fukushima Nuclear Accident*, 340.

the end had entered the facility. Confirmation of the individual trustworthiness of nuclear plant employees, inspectors, and others who enter the plant is an urgent issue in terms of countermeasures against insider threats. On the other hand, just how to carry out background checks within the context of the Personal Information Protection Law is a major issue. Although there are differences in the social systems, Japan should learn from the US experience, for example by studying the types of information that American nuclear plant operators gather to check the trustworthiness of the employees and laborers who work at their plants, and adopting those points that are applicable in the Japanese context. In particular, it is important to notice if an employee is doing something unusual, since fostering a nuclear security culture that clearly recognizes the potential for internal threats is also a countermeasure.

(3) Research on the synergy between nuclear safety and nuclear security

It has already been noted that Japan-US cooperative efforts should be implemented on the need to reflect nuclear security measures starting from the planning stages for nuclear power plants and on how to incorporate that into security regulations in order to create synergy. In both the United States and Japan, the nuclear power companies have abundant experience in operating plants. There are organizations such as the US Institute of Nuclear Power Operations (INPO) and World Association of Nuclear Operators (WANO) that share good practices in safe and stable plant operations. Whether through these organizations or through a newly created framework, research should be carried out by sharing good practices of nuclear security measures along with those nuclear power safety best practices in order to examine the synergy between nuclear safety and nuclear security. Through this synergy, one would expect that a higher level of safety and security could be achieved at a lower cost than if the two issues are considered independently.

(4) Implementation of INFCIRC/225/Revision 5

As Japan considers how to incorporate the IAEA's Nuclear Security Recommendations on Physical Protection of Nuclear Materials and Nuclear Facilities (INFCIRC/225/Rev.5) into Japanese law, it is important to learn from the United States, which already has experience in incorporating those recommendations into its own laws. Among the various issues to be considered, it would seem that areas such as the training of nuclear power plant operators and police forces (or depending on the country, the military) to respond to terrorists, or in other words force-on-force training, or methods for assessing the performance of physical protection facilities could be major themes for Japan-US cooperation.

(5) Strengthening nuclear security in the transport sector

At the 2012 Seoul Nuclear Security Summit, the Japanese government proposed a Transport Security Basket for Tighter Security in the Transport of Nuclear and Radioactive Materials.[186] It was decided that Japan, along with the United States, the United Kingdom, France, and South Korea will undertake the following initiatives to tighten transport security:

[186]. MOFA, "2012-nen Souru Kaku-Sekyuritei Samitto wagakuni basuketto teian 'yuso no sekyuritei' ni tsuite" [On the "transport security" basket proposed by Japan at the 2012 Nuclear Security Summit in Seoul], http://www.mofa.go.jp/mofaj/gaiko/kaku_secu/2012/statement.html.

① The participating countries in this basket will hold working group meetings to address the transport security issues amongst the representatives of the governments and relevant international organizations, focusing on (a) the effective implementation of the IAEA recommendations (INFRCIC/225/Rev.5); (b) building close relationships among relevant agencies and Centers of Excellence (CoE) to strengthen transport security; and 3) the development and research of equipment by related industries, relevant agencies, and CoEs. (The first working group meeting will be held in Japan by 2013.)

② The participating countries in this basket may consider organizing training exercises (including table-top exercises) for strengthened emergency preparedness.

③ A proposal will be submitted at the 2014 Nuclear Security Summit on strengthened transport security.

④ This basket group should work in cooperation with security-related officials from the International Maritime Organization, International Civil Aviation Organization, and the IAEA.

The above-mentioned Japan-US NSWG has also made transport-related nuclear security one of the themes for cooperation, and the strengthening of security for ocean and ground transport of nuclear materials is a field that warrants further Japan-US coordination and cooperation.

(6) Measures for decommissioning the Fukushima Daiichi Nuclear Power Plant

The Government-TEPCO Mid- to Long-Term Countermeasures Meeting produced a Mid- to Long-Term Roadmap toward the Decommissioning of the Fukushima Daiichi Nuclear Power Plant, which is a plan broadly divided into three phases: removal of fuel from the spent fuel pool (Phase 1; within 2 years); start removing fuel debris("material in which fuel and its cladding tubes, etc., have melted and resolidified.") (Phase 2; within 10 years) ; to the end of decommissioning (Phase 3; within 30 to 40 years). Under the Government-TEPCO Mid- to Long-Term Countermeasures Meeting, an R&D Headquarters was set up to oversee progress in the R&D projects needed for implementing the Mid- to Long-Term Roadmap, confirming and sharing the status of deliberations and implementation for each one. Under the R&D Headquarters, a Working Team for Preparation of Fuel Debris Removal, a Working Team for Radioactive Waste Processing and Disposal, a Joint Task Force for Remote Technologies, and so on were established to carry out research and development efforts. These R&D projects are tackling many difficult problems that have never been seen or experienced anywhere in the world, and they are cooperating with experts from within Japan and abroad as they gather intellectual input from around the globe, making these potential areas for significant Japan-US cooperation.

Chapter 6: Lessons and Recommendations

Improving Crisis Management and Response Capability—Capacity Building for Japan and the Japan-US Alliance

In the preceding chapters, we have focused on the response to the accident at the Fukushima Daiichi Nuclear Power Plant as a means of analyzing how well the Japan-US crisis management system performed in coping with the accident and what issues arose. We have also examined Japan's efforts to date to strengthen its nuclear security and have discussed from both a policy and a technology perspective the nuclear security issues that became evident from the post-event response.

In this chapter, while comparing the two countries' crisis management systems, we have pulled together the issues and failures that were identified through that analysis as *lessons*, and offer specific *recommendations* on what must be addressed in order to improve the situation and enhance our preparedness for the future.

Building on that, we have compiled recommendations on the type of contribution that the United States and Japan (or the alliance) should make to the global community. We must keep in mind that, underlying these recommendations are the international context and situations that require the United States and Japan to build closer cooperative ties for crisis management and emergency response. In other words, responding to nuclear disasters and other nontraditional threats (crises) is a way in which the United States and Japan, through their alliance, provide crisis management and emergency response capability as a global public good.

As was touched upon in chapter 3, a number of weaknesses became evident in the process of handling the Fukushima accident: the first was the Japanese government's lack of an integrated system for crisis management, and above all its weak decision-making mechanisms, including the question of leadership; second was its lack of an information-management system within the context of decision making (i.e., a system for sharing information between the site and headquarters, and the methods of processing the data needed for decision making); and third was the lack of established mechanisms within the Japan-US alliance for information sharing or joint response in times of crisis, such as the nuclear disaster or other types of "nontraditional threats." Below we will draw out the lessons learned with reference to these three issues and will offer recommendations in each area. Based on that, we will conclude with recommendations on the role that the Japan-US alliance, as a global public good, should play in the global community.

6.1 Decision-making and crisis-response mechanisms

The recent accident reminded us anew that a contingency like a nuclear disaster requires the mobilization of all types of policy resources. In the early stages of the response, there was an inadequate grasp of where government and civilian resources were located, making it more difficult to respond effectively.

When dealing with a nuclear disaster, efforts must unequivocally be made by the plant operators to bring the situation under control. However, if the situation worsens, as it did in the case of the Fukushima accident, then it requires not only the response capabilities of traditional forces such as defense, police, and firefighters, but also a system that facilitates the mobilization and integrated use of diverse expert knowledge (including scientific, technical and engineering expertise) and other policy resources, as well as the capacity to implement that system. Also, in terms of the interactions with society, the need may arise to impose certain restrictions, including the restriction of individual rights through forced evacuations and the barring of residents from entering specified areas, and the restriction and regulation of the private sector's business activities. Indeed the situation calls for the integrated use of diverse measures. And while the Japan-US alliance had produced a close, collaborative relationship prior to the fact, it was essentially a mechanism that was intended to be applied toward military threats, and thus, given the unique characteristics of the event, in the early stages of the disaster response it was faced with circumstances that differed from anticipated scenarios and had to operate in unanticipated ways, and thus initially it did not fully utilize its capabilities and did not function adequately.

One point to note here is that in Japan there is a decentralization of the responsibility and authority for crisis management measures, including those related to nuclear security, and in fact no unified system exists to carry out the command and control functions for all relevant activities. Based on the Act on Special Measures Concerning Nuclear Emergency Preparedness, a Nuclear Emergency Response Headquarters was set up with the prime minister at the helm, but this was not a body that could play a role in integrating the various government functions in crisis management and disaster relief situations the way that the White House's National Security Council or the US Department of Homeland Security can. Also, the Security Council that is supposed to be convened in the Cabinet to deliberate on measures for handling major security crises (as called for under the Act for Establishment of the Security Council of Japan) was not convened in order to respond to the accident. This was because the nuclear disaster was not deemed to be within the Security Council's mandate. On the other hand, it reminds that, in a context where one can envision various security crises in addition to the natural disaster and accident, there is no system envisioned under the existing policy structure that could serve in place of the Security Council to play a control-tower type of role in crisis management in order to supervise the government response as a whole in circumstances where an accident response requires the mobilization both of the SDF and of the Japan-US relationship—particularly cooperation through the alliance framework.

Accordingly, in the absence of a comprehensive legal system for crisis management (one would envision a National Crisis Management Basic Law, or a National Security Basic Law), the government's decision making was conducted through extremely ambiguous procedures. As noted above, a Nuclear Emergency Response Headquarters was set up based on the Act on Special Measures Concerning Nuclear Emergency Preparedness. However, when the disaster first struck, Prime Minister Kan and a small group of politicians around him were involved in the details of the onsite response while relying on unconfirmed information. The decision making was done through an ad hoc body that integrated the response headquarters of the Kantei (or Prime Minister's Office) and TEPCO, namely the Government-TEPCO Integrated Response Office, which was set up within TEPCO and did not necessarily have any clear standing under the current legal system. One could take a positive view of the fact that this ad hoc integrated headquarters, by unifying the response of TEPCO and the government during the recent crisis, was more effective than if each had maintained separate response headquarters and been forced to go back and forth between those two headquarters to make decisions. However, this is not the organizational form that is envisioned under the current law, and the policy coordination function that is supposed to be led by the Cabinet and the Kantei was not carried out systematically. In order to better handle crises in the future, a legal system should be created that envisions these situations and facilitates the effective gathering of information and expertise, centralizes the decision-making process, and clarifies where the responsibility lies in a time of emergency. In that context, there needs to be an appropriate information-sharing system that clarifies what information from among the various plant data should be shared between the plant operators and government regulators and in what way. At the same time, the onsite handling of the nuclear reactors is unquestionably the responsibility of the plant operators, and a proper balance must be established in terms of government involvement to avoid excessive (or politically motivated) interference from the Tokyo Response Headquarters when it has difficulty obtaining timely information from the site.

On the other hand, in the case of the United States, when the crisis arose, a meeting of the Deputies Committee was convened under the leadership of the deputy national security advisor in charge of crisis management, and subsequently telephone conferences were held to share information. In that sense, there was to some degree a shared awareness within the US government. However, in reality a multitude of channels exist between the United States and Japan—the State Department, Department of Energy, Nuclear Regulatory Commission, Department of Defense, as well as the US Pacific Command and the US military forces in Japan—and the Japanese side was perturbed to receive requests for information through these various channels all at once, showing that not all of the information exchanged between the two countries was being shared consistently throughout all branches of the US government.

The diversity of communication channels itself is not necessarily a bad thing if one views it as an indication of the depth of Japan-US ties. But at the same time, without being able to systematically carry out government-to-government communications, if the coordination along each channel is not going smoothly and the United States side is strongly pressing for information through various channels while Japan is trying to handle the crisis, then there is a good possibility that misunderstandings will arise in terms of mutual intentions on both the US and Japanese sides. In this case, the American side suspected that Japan was concealing information, while there were those on the Japanese side who questioned whether the strong US demands for information were a scheme to get hold of private-sector and government-related information. This mutual misreading of intentions was evident in the early phase of the crisis response.

In addition, the fact that the Japanese side viewed this as excessive interference by the Americans was because the same types of requests were being made through multiple channels. This implies that the functional integration within the US government was not fully made in the State Department task force, the National Security Council, the Defense Department, or the US Embassy in Japan. And at the same time, another problem was that when consultations were necessary between the two countries, because a single situation entailed consultations on issues that crossed several jurisdictions, even if the counterparts in charge of each issue consulted with each other, the information was not fully shared with other channels, making it difficult to unify the crisis management response.

In terms of the response to the Fukushima nuclear accident, until the Japan-US liaison and coordination conference was launched on March 22—the so-called “Hosono Process”—there was serious friction between the two sides, which reached a peak around March 16, when the United States informed Japan that it was setting the evacuation area for US citizens at 80 km based on a scenario that assumed the possibility that the water had been lost in Unit 4’s spent fuel pool. Once the Hosono Process was implemented on March 22, this type of friction began to fade and communication became smoother. But it should be remembered that the “Hosono Process” had no legal basis for its establishment.

In both the United States and Japan, but particularly in Japan, if a legal system and a system to unify the executive agencies’ responses are not established to rectify these types of deficiencies, then even if a decision-making mechanism is created, its implementation will be impossible. For that reason, it is of the greatest urgency that we create a crisis management mechanism that allows us to respond immediately after a disaster through preparedness of the “whole of government,” “whole of nation” (in such a way that allows for some degree of control of citizen-level cooperation and at times private company activities), and “whole of alliance” approaches.

<Lessons>

Lack of a centralized system and supporting mechanisms for command and control within the Japanese government

◆ Lack of functions, systems, and legal frameworks for controlling and coordinating crisis management

Under the Act on Special Measures Concerning Nuclear Emergency Preparedness, the prime minister shall issue a declaration of a nuclear emergency situation and shall establish a Nuclear Emergency Response Headquarters within the Cabinet Office (Article 16, paragraph 1). In the recent disaster, TEPCO reported the total loss of power at 3:42 p.m. as a specified event pursuant to Article 10, after which notifications were made according to Article 15, and at 7:03 p.m. the Nuclear Emergency Response Headquarters was established. However, this government headquarters did not necessarily function effectively, and the decision making by Prime Minister Kan and his inner circle was in a sense an anomaly. In addition, for the purpose of ensuring a smooth information-sharing process and to accelerate the decision-making process, at 5:26 a.m. on March 15, the government and TEPCO set up a joint Integrated Response Office inside TEPCO’s headquarters. This structure is not envisioned under the current legal framework. While one can positively assess the results of this non-regulation, ad hoc arrangement as having facilitated mutual understanding between the government and TEPCO and having encouraged decision making, it is certainly not optimal to rely on an ad hoc organization under these circumstances. Improvements are needed to the crisis management system both in terms of systems planning and in terms of the software for operationalizing that system. Based on the Fukushima accident, the Nuclear Regulation Authority and the nuclear regulation agency were newly established to ensure more independent and stronger oversight, and a system is needed whereby these organizations collect knowledge and facilitate the government’s ability to make decisions based on the appropriate flow of information and expert knowledge.

This would also suggest that in a situation such as a disaster at a nuclear reactor, where a private company must inevitably be involved as a main actor, we need to construct a system that facilitates smooth and close public-private cooperation (or rather a system that allows for a type of “intervention” by the government in a private company in emergency situations), or in other words a system (legal framework) for centralized command and control.

◆ Inadequacies of disaster prevention manuals and of the legal regulations and facilities for crises, and naiveté of scenarios on which they were based

A crisis response system does exist in the form of the Act on Special Measures Concerning Nuclear Emergency Preparedness, disaster prevention manuals, and so on, but the fact that the system did not function as intended in the recent disaster is a problem. The first cause was the fact that there were multiple disasters, as the natural disaster and the nuclear accident occurred at the same time, and nobody had foreseen a scenario in which accidents would occur at multiple nuclear reactors at the same time. Second was the fact that, because no preparations had been made to respond in cases where the national government, local governments, or other institutions are unable to carry out their functions as envisioned in the manuals (for example, the loss of function of the Off-Site Center for the Fukushima Daiichi Nuclear Power Plant), the manual could not be followed and it was therefore difficult to respond. Third, there were cases where even though the manual did coverer the situation, operations did not go smoothly in the actual crisis (there appear to have been problems both with the capability of the operators and the content of the manuals). And fourth, because the training conducted during normal times was based on scenarios and assumptions that were unrealistic, that knowledge and experience could not be applied when situations in fact occurred.

What can be drawn from this is, first, the key people in charge (in the government, the upper-level staff in departments involved in the decision-making process, and onsite, the key people handling the situation) need to be better acquainted in crisis response methods. That requires the training of personnel who are able to effectively carry out crisis management and the appropriate human resource policies to facilitate that. Second, there must be prior understanding of how to procure the materials and equipment needed for a response. In other words, in addition to emergency reserves of the necessary materials and equipment in that location, there must be an understanding of how those items can be procured from external locations and how they can be transported and brought in. In addition, if external procurement is necessary, then information is needed on where those necessary materials and equipment are located under normal circumstances. Third, in the case of the Fukushima nuclear accident, if one looks at the assumptions used in the crisis management manuals, the risk calculations used by the government, TEPCO, and the local governments were all overly optimistic and they did not assume a “worst-case scenario.” In other words, even though there was a manual, no preparations had been made that could be put to practical use, which meant that the response to the crisis could not be handled as stipulated in the manual. Fourth, there was a naivety in the assumptions regarding the changeover to an emergency structure and system. There were cases where if the most suitable person for crisis management was not in the position in charge of crisis management, then the response became delayed due to the need to reposition people, or where the decision-making methods within organizations remained in the same mode as under normal circumstances.

◆ Lack of a legally defined chain of command at the scene of a disaster

It is also important to have legislation that establishes the chain of command at the scene of a disaster when multiple organizations are involved in the response. On March 17, a Ground SDF helicopter doused water on the Unit 3 reactor, and then the following day they began pumping water from the ground. At that time, no clear, legally determined chain of command existed between the three parties carrying out the work at the site, the Ground SDF, the Police Department, and the Tokyo Fire Department. For that reason, on March 20, through a “directive” in the name of the director-general of the Nuclear Emergency Response Headquarters (i.e., Prime Minister Kan), it was ordered that the SDF would take the lead in coordinating and would carry out centralized management of the work. However, the emergency response measures actually envisioned in the law to be undertaken by the SDF in the case of a nuclear disaster were primarily offsite support work (e.g., rescue of disaster victims, securing of and emergency recovery of facilities and equipment, crime prevention, traffic control and other matters related to maintaining the public order, decontamination).

Although one could perhaps interpret the onsite water pumping efforts as falling under "measures to prevent the expansion of a nuclear disaster" (Article 26, paragraph 8), such tasks are not included in the Emergency Action Plan, and the SDF did not have the equipment on hand for such an event. For that reason, the SDF leadership in the water-pumping efforts was "unforeseen" in more ways than one.

◆ Lack of a "Security Council"–like control system in the Cabinet Office or Kantei

There is also a need to establish in advance who will be the final decision-maker when decisions need to be made, and who bears the ultimate responsibility for circumstances that may arise due to the measures that result from those decisions. The lesson of Three Mile Island was that, when making decisions on how to handle an accident, final judgments and decisions should be made by people at the site who have the most expertise and information. In the case of the Three Mile Island accident, an NRC executive was sent to the site to make decisions. But in the case of the accident at Fukushima, the Government-TEPCO Integrated Response Office set up within TEPCO and the Kantei with Prime Minister Kan at the top were involved in final decisions right up to the more technical points such as injections of seawater. At the site itself, although the government's Local Nuclear Emergency Response Headquarters was in place, in reality it still relied on the TEPCO staff to respond to the accident.

This type of structure is not what is envisioned under the current legal framework for emergencies in terms of the type of leadership role that the Kantei should play. But on the other hand, it confirmed the need to sort out what the respective roles of the company and the government should be, and under what circumstances the responsibility and decision-making authority should be delegated to the government from the company officials involved. Options should be considered based on the specific type of conditions involved and should be confirmed in advance.

Also, for decision making in this type of emergency, it is important to have a system for assembling expert knowledge to support the person making the final decision (the leader). During the recent disaster, Prime Minister Kan designated numerous experts as cabinet consultants in keeping with the advice of his personal network and those around him. However, there is no evidence that their insight was applied in any systematic or integrated way. Additionally, the fact that the final decisions were being made by a small group of politicians led by Prime Minister Kan would suggest that, rather than making judgments based on scientific and technical rationales, the emphasis was on political judgment—not necessarily on the standard principles for these types of decisions. Another problem is that when decisions are made by a group drawn from the same type of people, the potential for groupthink exists, whereby differing opinions tend to be excluded. In such cases, if mistakes arise in the group's approach, the dynamics can make it difficult to change course.

To be certain, under the current law, Japan's Security Council was not intended to be convened for a disaster such as a nuclear power plant accident (because such cases are not 'security' matters that Security Council must respond). However, in order to be able to deal with disasters such as those at nuclear plants, which can easily develop into complex disasters in the future, we must consider schemes for dealing with various situations simultaneously. A multidimensional response is necessary in order to maintain our national and economic functions. Whether it is a large-scale natural disaster, such as an anticipated major earthquake, or a large-scale industrial disaster of unknown origin (e.g., a nuclear disaster), whether it be a case of sabotage or an accident, the conditions must be examined from multiple perspectives, and so a system is needed that will facilitate faster decision making when resources must be mobilized, starting with the SDF. Moreover, deliberations at the site are important, but so too is rapid decision making and the sharing of information on response plans.

◆ **Lack of a support system that provides updated information to help understand (complex) situations**

In circumstances where one event can bring about a rapid change in the situation, how to quickly share information between organizations and within the hierarchy of a single organization becomes an important issue. If too much time elapses between the occurrence of an event and the transmission of information to the final decision maker, it is possible that the situation upon which the decision is premised will have changed in the interim. Accordingly, a system is needed not only organizationally, but in terms of the hardware as well that will allow the decision maker to have an ongoing grasp of the situation in as close to real time as possible, and that will also facilitate information sharing as needed.

<Recommendations>

(1) Whole of government

◆ **Establishment of a chain of command system**

A system should be created that will enable the rapid launch of a headquarters-type organization in the government. That organization, similar to the Security Council, should be given a framework that enables it to bring about unity of purpose in the government as a whole and comprehensively coordinate response guidelines, and should be able to oversee institutions that can facilitate information sharing. Moreover, a chain of command system must be established under this organization for the SDF, police, and other relevant institutions (for example, the NISA and TEPCO in the recent case) in the event of a nuclear crisis.

◆ **Personnel in charge of crisis management**

The deployment of support staff with expert knowledge (short-term posting) is needed, as is the creation of a personnel system whereby experts in crisis management can be utilized (long-term posting).

As a short-term measure, there should be mechanisms for specifying which human resources can respond to needs that arise when responding to a crisis, as well as for facilitating shifts in personnel deployments for emergency responses. As a long-term measure, when appointing personnel to posts such as the deputy chief cabinet secretary for crisis management, the personnel selection should emphasize aptitude in crisis management.

In organizations such as nuclear regulatory institutions or in the Ministry of Health, where the threat of pandemics is anticipated, for example, there is a need to create departments focused on crisis management that have the necessary authority and expertise. This post should not be included in the normal personnel rotations of people seeking to be generalists, but should rather be held by someone possessing a high degree of expertise, and there needs to be a scheme within the organization’s personnel system that allows people to accumulate knowledge and experience.

◆ Interagency communication infrastructure to gather and update information

Preparing the appropriate infrastructure is essential—for example, improving the layout and functions of the Kantei situation room (there must be coordination with the Emergency Control Center), creating a portal site for interagency sharing of information (along the lines of the Marine SDF portal), etc. The preparedness of the Kantei's Emergency Control Center also needs to be reconsidered.

◆ Adoption of a science and technology based decision-making system

When it comes to science and technology that require advanced expertise, and particularly in terms of the governance of technologies that can have a major impact on people and society, ensuring our safety should not be compromised to economic considerations or any other external elements. At the same time, a system must be adopted for making decisions on science and technology policy that reflect the appropriate advice and do not sacrifice scientific knowledge to political calculations.

Also, it would be advisable to create a post such as a science and technology aid to serve as a communicator who could assist the prime minister and other policymakers by "translating" scientific data into the type of information they require in the decision-making process.

(2) Development of the legal system

◆ Establishment of crisis-response laws

In order to be able to make decisions and act systematically and swiftly to deal with emergencies on the spot, emergency response laws must be created that place the police and fire departments under the command of the SDF (a lesson learned from the water pumping experience). At times of crisis, the central government and those at the site are pressed to understand and handle the situation, and so it is difficult to monitor whether all response unit and government agency operations are being carried out appropriately. For that purpose, the necessary legal preparations must be carried out in advance so that the chain of command and control is not consolidated spontaneously as the situation evolves, but rather the appropriate organization can be given broad discretion to respond based on the particular nature of the crisis and the changes in the situation.

◆ Establishment of intelligence-sharing and regulations for international cooperation

When carrying out international cooperation, a system must be established that can appropriately apply regulations related to the handling of sensitive information not only to the defense authorities but to other sectors as well.

The Ministry of Defense and SDF have a General Security of Military Information Agreement with the US military, but Japan has signed no similar agreements on protecting classified information with other countries that might offer their cooperation in times of emergency. This imposes certain constraints on the broadening of international cooperation based on military organizations. Accordingly, in order to allow smoother action by each country's implementing organizations within Japan, at the very least Japan should strengthen its punitive regulations with regard to stealing classified information, and relax its domestic vigilance with regard to those countries' activities within Japan.

At the same time, in order for the Ministry of Defense/SDF to increase their cooperation with organizations within Japan such as the police and fire departments, they should look to expand the breadth of that cooperation by helping the relevant organizations institute comprehensive information management and by instituting the necessary legal regulations.

(3) Improved preparedness: revision of disaster prevention manual and enhanced training

◆ **Modularization of disaster prevention manuals (increased flexibility)**

In a real emergency, it is rare that events unfold as previously imagined. For that reason, while improving the contents of the manual, it should not be a rigid, detailed manual, but rather should be modularized to facilitate the combining of necessary methods of handling the emergency in a way that allows a flexible response to evolving conditions. Operational expertise is needed to respond as well to such a modularization.

In the course of gaining that expertise, consideration should be given to methods for and feasibility of pairing up multiple modularized manuals.

◆ **Creation of a system to improve the skill level of utilization of manuals (and the ability to apply them)**

For example, blind desktop simulations should be implemented, and actual experiences with failures should serve as the basis for ongoing revisions to the manual, to the way in which the manual is applied, to its preparations, and so on. Accordingly, in order for the applicability of the manuals to be honed through trial and error during the training process, when errors emerge during practices and experiments, those mistakes must be applied to improving the manuals and a gradual evolution must be assured. The assumption should not be that a manual is something that is complete, and when there are failures, there should be no unnecessary responsibility borne by those involved.

◆ **Development of response guidelines and response capabilities that take into consideration the worst-case scenario**

Force-on-force training could be further enhanced to consider scenarios such as an attack on a nuclear power plant. It is important that Japan and the United States participate in each other's training as observers and seek to improve their capacity by sharing knowledge, experiences, and other points that they notice. By implementing this type of Japan-US joint training, the response capability will be improved in situations where Japan-US joint action is required.

(4) Creation of a system for private-sector cooperation: building a system to support a whole of nation approach

◆ **Clarification of rights and responsibilities for control of private-sector business**

The relationship between rights and responsibilities (compensation for work, etc.) should be clarified in the case that it becomes necessary to take control of private companies (or private organizations), as it did during the recent accident (TEPCO was placed under government management), and a legal framework should be prepared related to such areas as legal protection and exemption from responsibility in the case that a Japan-US or other cooperative structure between private companies is established.

◆ **Establishment in advance of methods for procuring materials and equipment for the purpose of crisis response**

A local emergency reserves system and mutual loan system for crisis response should be created at sites such as nuclear power facilities, and routes and methods for external procurement and delivery should be secured.

When responding to emergencies, it is in reality difficult to store all the necessary materials and equipment. For that reason, it is beneficial to think about such supplies based on principles of flow rather than of stock, and handle it by encouraging the smooth mutual accommodation between businesspeople within the country and abroad. To that end, using cloud methods to match needs and seeds would be a realistic approach to managing the required materials and equipment. In addition, in terms of the physical transfer of the needed items, strategies should be laid out that assume the use of multiple systems depending on whether the usual distribution system is functioning or not.

◆ **Design of a cooperative system that can make the shift from normal conditions to an emergency**

Adequate plans (hard and soft) must be implemented that can make the shift from normal conditions to emergency conditions in a form that includes not only government, but also businesses and local governments. Also, close consultations are needed between government and businesses on business continuity plans (BCPs).

The policy decisions made during the interim stages in the shift from normalcy to emergency are extremely significant. Whether or not that shift proceeds smoothly is determined by the existence of clear standards set forth at the time of systems planning for the conditions under which that change to emergency status should occur, and by the will to make the political decision to preventively apply those conditions. In order to ensure that the judgment of the decision maker is not swayed by vague information or a mistaken understanding of the law, a framework needs to be created during systems planning for ensuring that as comprehensive information as possible reaches the policymaker in an organized form. In addition, to ensure that the policymaker does not balk at making the decision to declare an emergency, a system should be maintained whereby the general public can still lead their normal lives even after that shift to a state of emergency is made.

◆ **Clarification of the way in which "residual risk" is received and protected against in society**

What the Fukushima nuclear accident demonstrated was the unease within society with regard to low-dosage radiation exposure, given that there is no clear scientific agreement on its impact. There is a great deal of difficulty in forming a consensus in society on how to evaluate that risk and its impact on society, as well as on how society should react and respond to this situation.

Meanwhile, in terms of nuclear terrorism, the threat level will change depending on the level of resilience within society toward that threat, or in other words, depending on whether the impact on society can be constrained. More precisely, social resilience can have an impact on the terrorist's calculations of the pros and cons of an attack, and thus it can to a certain degree have a deterrent effect. As a result, the sociopolitical attitudes toward this type of "residual risk" must be clarified and a consensus must be formed not only in the government but in society as a whole in order to strengthen preparedness against this type of risk.

6.2 The role of information in effective decision making

In situations such as the Fukushima nuclear accident, there is a need to have an accurate understanding of the reactor conditions and the on-site conditions in order to respond appropriately. A variety of factors overlapped—the total power outage, the loss of cooling functions in multiple reactors and fuel pools, the shredding of lifelines (external electrical supply, communications systems, transportation routes, etc.), and so on—creating a complex crisis where the latest information had to be conveyed accurately and quickly to decision makers in order for them to make the correct judgments. However, it would be difficult to say that information from the site was being adequately shared within the necessary parameters immediately after the disaster struck. The recent incident offered a valuable lesson on information-sharing rules and frameworks.

For a crisis management system, in addition to making it easy to grasp this type of on-site data, the use of intelligence is essential, but to protect nuclear security, data related to nuclear power protection must be handled with extreme care since it contains many sensitive aspects for states and companies. For example, in the recent effort to pump water into the Fukushima reactors, the fact that no detailed map of the premises or information on the locations of nuclear materials was provided to the units that carried out the pumping—SDF, police, firefighters, etc.—was called into question, but the reason that TEPCO hesitated to make that type of data openly available was because it was classified as sensitive information from the perspective of protecting their facilities. In order to respond more effectively, a system is needed to enable this type of company to share data quickly with relevant institutions even if it is sensitive information that must be protected under other regulations.

In such cases, it is difficult once a crisis occurs to quickly respond and provide information in a rush to the various organizations handling the crisis response. Accordingly, in developing a crisis response plan, among institutions bound by the duty of confidentiality under the Nuclear Material and Reactor Law, nuclear materials protection information should be shared in advance to the minimal degree necessary so that the crisis response can be implemented effectively and efficiently. Confidential information related to nuclear security is currently only known by a small number of relevant people (i.e., individuals at the NISA and at nuclear facility operators such as TEPCO), and the fact that they were not used in the prior development of an appropriate accident response plan or of nuclear security countermeasures was recognized as an issue and has been pointed to as an important lesson to be drawn from this accident.

In addition to sharing information, there needs to be more interaction in terms of being aware of the importance of nuclear security. For example, one reason that information on B5b that the US Nuclear Regulatory Commission had provided to the NISA disappeared during the policymaking process in Japan is that in the Japanese policymaking system, the authority and responsibility for nuclear security and nuclear terrorism countermeasures is decentralized and unclear. (This is the case, for example, in terms of the demarcation between the Atomic Energy Commission and the NISA.)

In terms of sharing information—including sensitive information—a legal architecture and inter-agency system are needed that can serve as a basis for improving the efficacy of setting countermeasures and actual crisis management while at the same time emphasizing confidentiality. In addition, between Japan and the United States as well, a framework needs to be established for sharing information to the extent possible and managing sensitive information, including intelligence such as terrorist-related data and technologically sensitive data. However, Japan does not currently have an integrated intelligence system, and while the Cabinet Intelligence and Research Office, the Defense Intelligence Headquarters, the Public Security Intelligence Agency, and the Ministry of Foreign Affairs (Intelligence and Analysis Service) do handle terrorism-related information, they handle only fragments of information related to nuclear security and the physical protection of nuclear materials. Under these conditions, it is possible that efforts to strengthen nuclear security measures will be incomplete.

Information related to the physical protection of nuclear materials is information that relates to national security, and it is thus not advisable to have it centrally managed and protected by nuclear operators alone, or shared only with the recently established Nuclear Regulation Authority—in other words, consideration has to be given to more than just reducing the risk of leaks. Measures must be devised and applied based on a legal structure and executive organization with clear authority and responsibility for the management and use of information.

<Lessons>

◆ Time lag between the event and the delivery of information to the organization's final decision-maker

As events are constantly evolving, it is necessary to improve the training level during normal times so that people are aware of what type of information needs to be updated and how often. If updates are too frequent, it can confuse decision-makers, but at the same time, they must avoid making decisions based on old data. The critical key to providing decision-makers with data in the most appropriate manner lies in the methodology used to distill the data.

◆ Lack of distillation of information at the decision-maker level and lack of infrastructure for that purpose

In order to take highly technical data and distill that to provide input that can be used by decision-makers as they form policies, it is essential to create a system to support that type of information distillation as well as quick and appropriately timed updating. In addition, it is critical to have the personnel infrastructure that supports communication in order to enable decision-makers to understand how this kind of data can be interpreted and reflected in policy measures. For example, within the US government, staff are dispatched from the NRC to USAID or other agencies to support them in interpreting data related to nuclear power. In Japan, there were cases where raw data on the nuclear reactor situation was being faxed as is from the NISA to MOFA, and that flood of information made it difficult for MOFA to provide the appropriate information to others. In addition, at the NISA, there was no dedicated line that onsite personnel could use to transmit information back to the Tokyo office, so there needs to be greater capacity both in terms of the hardware and the system itself for sharing information among onsite responders and between the site and headquarters.

◆ **Lack of information sharing about the site and spread of mutual distrust**

In the initial stages of a crisis, there will inevitably be confusion in the onsite gathering of information. In order for those giving directions to respond correctly, there needs to be a continuous supply of accurate information from the site. It is difficult to get an accurate picture of the changes in the fluid situation at the scene of the disaster, so even if the information from the site is conveyed up to the command center, those in command cannot be satisfied with that information. The onsite situation changes as time passes, so even if status reports are sent from the site to the command center, by the time those in command make a decision, there is a good possibility that information on the status at precisely that moment has not yet been conveyed to them. In the case of the Fukushima accident, there was significant miscommunication between the plant operators and the government regulators. The plant operators were lacking know-how regarding how to communicate the fluid conditions, and that, coupled with latent distrust on the part of the government toward the plant operators served to heighten the mutual distrust between them. In addition, the government side failed to consider the confusion on the ground at the site, and by issuing what appear to have been excessively detailed instructions, it introduced political considerations into the onsite decision-making process, and there was a failure to understand that it was emergency policymaking.

◆ **Lack of a national institution or integrated intelligence system to centrally handle nuclear security and proliferation-related information**

Needless to say, this is not intended for military purposes, but analysis of the latest data on nuclear security, nonproliferation, and nuclear power is extremely important not only for nuclear power plant accidents or disasters within Japan, but also in terms of foreign policy. Also, up until now there has been an absence of concern about such issues as how knowledge from abroad can be reflected in domestic efforts to improve safety, or how a crisis such as a nuclear power disaster or nuclear proliferation is connected to the safety and security of Japanese society as a whole, and the lack of that perspective is undoubtedly one reason why Japan as a whole has made insufficient efforts to improve the safety of nuclear power.

<Recommendations>

(1) Creation of a system for the management and sharing of information within Japan

◆ **Diversification of information-gathering means and creation of a mechanism for integrating information received**

When all power was lost at the Fukushima plant, it became impossible to confirm plant data from the central control room and the primary method of gathering data from the nuclear reactors was to actually read the gauges at the site. For that reason, sufficient plant data could not be gathered and the transmission of that data did not necessarily go smoothly either. In particular, the NISA (in other words, the government) did not have its own capacity to gather information on the condition of the nuclear reactors and was forced to rely on the infrastructure of TEPCO—the interested party in the accident—for data gathering. Of course, it is not always appropriate for the plant operator and regulators to be sharing information on all of the plant’s various parameters under normal circumstances. But at the same time, it is natural that the parties concerned and the government would come together as one to control this type of crisis situation, and in that sense the fact the government did not have its own data-gathering and transmission system was a major issue. At the very least, it is important to first come up with a plan that would create redundancy and diversity of power sources so that a total power outage does not occur, but at the same time, it would seem that a system should be adopted whereby plant data is provided to an inspector permanently stationed at the site.

Already, such things as an emergency reactor parameter display system for the offsite centers have been introduced, but it would seem that a system should also be introduced that fully considers cyberterrorism countermeasures and transmits critical plant data on nuclear reactors to the Nuclear Regulation Agency and others in an emergency. In any case, both hardware and institutional/systemic preparations are needed in order to provide the regulatory side with data and allow them to reach the appropriate decisions.

Accordingly, the nuclear regulatory authorities must improve the capabilities of personnel, and at the same time they must create a system that directly facilitates information gathering and transmittal. In terms of offsite responses as well, although the SDF, police, and others do have communications systems, in a situation where multiple actors are involved, a "portal" type of system is needed that allows for the summarizing and organizing of information that has been collected multilaterally. Also, because the earthquake and tsunami had knocked out electricity and the base station could no longer be used, the government's emergency cellular phone system was not fully functioning. To avoid a similar situation in the future, a backup system should be constructed.

◆ Improve preparedness during normal times to ensure that the above-noted system functions

First, authorities must convey information to the relevant institutions after making it clear that 100 percent definitive information does not exist in emergencies. When residents were evacuated as a result of the Fukushima accident, there was a lack of understanding of how communication works during a crisis, starting with the use of SPEEDI. This lack of understanding existed both on the side providing uncertain information and the side receiving it, and above all there was a lack of a shared understanding. Local governments that receive information from the central government must understand that point and must create the institutional preparedness that will enable them to still use that information in implementing evacuations and other measures.

Second, the national and local governments, as well as the police, fire departments, SDF, and other first responder organizations must have adequate exchanges of information during *normal times* both as a way of deepening mutual understanding and of improving responders' knowledge of the plant structure and of the disaster response plans that the plant operators and the local government have drawn up. If not, they cannot successfully respond during *emergencies*. In other words, this is connected to the need to consider how the mobilization of government and external resources can be effectively implemented during the transition process from normalcy to emergency.

Third, as noted above, a legal framework and executive body must be put in place that clarify authority and responsibility in terms of information management and use.

(2) Integration of information management of relevant government agencies, and establishment of systematic Japan-US information sharing

◆ **Establishment of a communication channel for bundled information management**

A channel must be established for bundled information management in order to avoid complications arising from information derived from multiple government-to-government channels, while at the same time being conscious of not hindering the smooth exchange of information between the departments that are in charge. A communication system is needed that can function even while the crisis is deepening. This must combine communicating with "one voice " between governments—which is necessary in order to alleviate mutual misunderstandings or mistrust in the decision-making process—with a system for sharing information that facilitates pluralistic information exchange as well as with a way of operating that ensures such a system is launched without fail during a crisis.

◆ **Comprehensive application of rules for Japan-US sharing and maintenance of information**

Close collaboration in Japan-US joint responses naturally entails the sharing of highly sensitive information. That requires the implementation of the appropriate rules on maintaining information. The rules for sharing and maintaining confidential information (the confidentiality system) that bind the Japan-US alliance authorities should be applied to and utilized by all ministries and agencies in both governments. In that regard, the confidentiality responsibilities of Diet members beyond the three top-ranking ministerial officials (minister, senior vice minister, and parliamentary secretary) must be spelled out.

6.3 The role of Japan-US joint action frameworks: the barrier of a vertically divided system of Japan-US counterparts

The United States and Japan cooperated extremely closely in response to the recent disaster. In particular, although it may not be the central mission of the alliance, the cooperative efforts in providing emergency humanitarian and recovery assistance following the earthquake and tsunami, including the US military's "Operation Tomodachi," can be offered as proof that bilateral cooperation through the alliance did work effectively.

However, certain issues did arise that derived from the close, multilayered relationship that exists between the two countries. When the United States was initially trying to obtain information from Japan, it was making approaches from multiple channels at the same time. On the Japanese side, the usual channels that manage the Japan-US alliance—namely the channels between the respective defense and diplomatic authorities—did not possess sufficient information on the status of the nuclear plant and so they were unable to provide the United States with the appropriate information. Meanwhile, the US Department of Energy was working to gather information through the Japan Atomic Energy Commission and other Japanese counterparts and personal connections, while the US Nuclear Regulatory Commission dispatched staff following the disaster and was exchanging information at the staff level. However, this multichanneled sharing of information between the two countries did not lead to information sharing among institutions on the US side. The fact that information would stall in one spot within the vertical divided bureaucratic structures on both the US and Japanese sides and not be shared (what is known as the "stovepipe phenomenon") led to mutual distrust between the two governments and, when it came to relief supplies from the United States, it created a less-than-perfect match between the needs in Japan and the relief items supplied by the United States.

In addition to improving capacity for decision making and information sharing, in order to facilitate smooth Japan-US operations it is important to further deepen the two countries' sharing of their perceptions of threats and issues, and to prepare policy frameworks (including legal systems) for joint responses.

From the perspective of the alliance's mandate, issues related to nuclear security and nuclear power–related disasters have not been important items on the agenda of the Japan-US alliance, which has functioned as a military alliance. In terms of nuclear proliferation and nuclear security, which are important international security issues, while the United States and Japan have held close consultations, they have not necessarily been considering these challenges as national security issues in a way in that is coordinated or effectively integrated with the functions of the Japan-US alliance.

The basic legal framework for regulating Japan-US relations as they relate to nuclear nonproliferation, nuclear security, and nuclear power safety is the Agreement for Cooperation between the Government of the United States of America and the Government of Japan Concerning Peaceful Uses of Nuclear Energy, but that agreement does not cover joint Japan-US nonproliferation measures or nuclear security regulations. Essentially the regulation of these types of issues does not fit well into a bilateral agreement that regulates bilateral cooperation on peaceful uses of nuclear energy, but in recent years there has been increased attention to this issue in the international community, and it has thus taken on greater relative priority in the bilateral relationship as well, which has elevated its importance as an alliance issue from the security perspective. As Japan-US alliance cooperation becomes increasingly diverse, consideration should be given to integrating efforts on nuclear nonproliferation and nuclear security within the context of the overall security strategy and giving the issue greater priority.

<Lessons>

(1) Lack of advanced preparations and scenarios

- **Gap in threat perception with regard to nuclear security**

The fact that Japan had neither agreed to nor introduced the US NRC safety requirements for handling severe accidents in nuclear terrorism (B5b) despite having received that information suggests that the Japanese side did not have a high level of concern about threats or risks from terrorism. In other words, a gap existed between Japan and the United States in terms of threat perceptions. As seen in the Fukushima accident, this resulted in a gap not only between the two countries' perceptions of a threat from nuclear terrorism, but also in their perceptions of the threat of a severe accident. These different levels of awareness became a source of misunderstanding about one another's intentions.

- **Lack of understanding on the US side about the operating system of Japanese government organizations**

Although within the alliance mechanism there was mutual understanding between those counterparts who work together in normal times to manage the alliance, organizations in both countries that are not normally involved in that mechanism lacked an understanding of what type of information-gathering and crisis-management systems the other country had. In particular, on the US side, given the severity of the Fukushima crisis, they at first assumed that Japan's defense authorities would be receiving information, and they thus expected that the Ministry of Defense would provide that information to the United States. For that reason, the United States became overly reliant on those individuals who are involved in the Japan-US alliance for providing nuclear-related information. Meanwhile, on the Japan side, because there was no system for having that type of information unequivocally gathered by defense authorities or others, they were unable to rapidly provide information, and that led to an increase in mutual distrust. Accordingly, it is important to have mutual understanding during normal circumstances in order to widen and deepen the understanding of the way in which each other's crisis management systems work.

◆ **Ambiguous position of "crisis management" within the treatment of nuclear security and nuclear safety issues in the Japan-US cooperative framework**

Previously, within the Japan-US alliance, ties involving extended nuclear deterrence did exist, and particularly through the 2010 Nuclear Posture Review process, mutual understanding was deepened. In terms of civilian nuclear power, there has been deepening cooperation between the two countries at the industry level, and there are regular exchanges of information and personnel between the regulatory authorities too. In the areas of nuclear security and nuclear safety as well, there have been exchanges of information and personnel between the regulatory authorities, but in terms of crisis management, it was not anticipated that the Japanese side would be asking for assistance, and so the level of information exchange and mutual understanding was not at a sufficient level for cooperative ties to suddenly be established and operate smoothly when a crisis did occur.

(2) Inadequacies in the post-disaster response

Japan-US relations following the accident are described in chapter 3 of this report, but a few of the key points that were made particularly clear in that chapter are listed below.

◆ **US confusion in understanding the assistance needs**

This problem resulted from the differences between the US thinking and system for providing assistance on the one hand and the Japanese system for receiving aid—which was practically nonexistent—on the other, and the differences in awareness between them. Both Japan and the United States have a great deal of experience in implementing aid, but neither has much experience on the receiving end. The United States takes a maximized approach to providing aid during a crisis, gradually scaling back from that level until they reach the optimal level. However, Japan tries to find the optimal approach from the start, including payments for relief materials. In addition, in terms of the legal regulations such as exemption for liability, they were unable to switch from their normal posture to an emergency posture and this led to delays in receiving aid. Even in the face of the Great East Japan Earthquake and the Fukushima Daiichi Nuclear Power Plant accident, Japan's administrative organizations remained solidly intact, and the approach therefore needed to differ from that of aid to a failed nation, for example.

◆ **Tension until a demarcation of the two countries' roles could be established in setting strategies for resolving the nuclear plant accident (proposals for short-term responses and medium- to long-term measures)**

Ultimately, through the Hosono Process, an implicit division of roles was established whereby Japan would propose short-term responses and would get US comments on them, while the United States would propose medium- to long-term measures for the Japanese to consider. But up until that point, it is certain that the Japanese side was becoming rather frustrated with the United States, which was coming up with various proposals. Of course it depends on the capacity levels of the countries giving and receiving assistance, but in order for the assisting side to have a clear understanding of what they can and should do, both sides must share information on the actual situation. (It should be pointed out that while this point may be quite appropriate when it comes to Japan and the United States, it may present extreme difficulties when it comes to relations with other countries.)

◆ **Creation of confusion and anxiety on the Japanese side by the US recommendation to its citizens in Japan to evacuate the area within a 50 mile (approx. 80 km) radius of the plant**

This was not only a sign of the US distrust of Japanese data, but at the same time it created distrust on the Japanese side, and particularly among the Japanese people, of the US approach and of the way in which the Japanese government issued its evacuation orders. Although it is said that there was a prior exchange between the leaders of the two countries, at the level of the general public, this discrepancy raised awareness that there appeared to be a lack of consistency in the two countries' responses, and it became a factor in the increasing distrust of the Japanese government. From the perspective of risk communication, greater coordination was needed between Japan and the United States, and greater explanation should have been provided by the Japanese government to the Japanese people.

<Recommendations>

(1) Establishment of a "whole of alliance" approach: creation of a mechanism for distilling policy resources in a time of crisis

◆ **Political leadership and alliance approach**

Up until now, Japan and the United States already have, in the form of their alliance, an established mechanism for creating the closest mutual understanding, and a decision-making mechanism is needed that organically fuses that alliance function with political leadership.

◆ **Establishing "one-voice" communication**

Information sharing between the military (SDF), police, and other relevant organizations (in this case, for example, the NISA and TEPCO) and their US counterparts must be done through a unified chain of command. In that sense, in order to promote close communication and practical coordination through the above-mentioned mechanisms at the political level, both countries need to be able to coordinate internally first and then speak to one another with "one voice," and they need to localize the communication on specific operations to the extent possible—i.e., coming to a mutual understanding with one voice at the location (country) of a disaster. (However, there is also a concern that in having "one voice" will require more meetings to coordinate within each government and that will lead to inefficient decision making, so thought needs to be given to the way in which this is carried out.)

(2) Methods of establishing the "whole of alliance" approach

◆ **Preparation of a system for Japan-US cooperation that includes all relevant institutions, starting from the level of defense authorities**

The fact that the relationship between defense authorities—which had already been carrying out close coordination and discussions—contributed to maintaining Japan-US relations during the Fukushima crisis is very important. However, because of the stovepipe phenomenon within both countries, the information sharing and information related to response plans and the status of efforts was not shared throughout the Japan-US cooperation system as a whole. While Japan-US relations to date have been organized with the alliance management mechanism at the apex, in terms of the response to the Fukushima accident, there was overlap between the network of the nuclear power authorities and the network of diplomatic authorities, and the ad hoc establishment of a mechanism for integrating the organic connections and activities at each level (i.e., the "Hosono Process") helped the communication between the two countries run more smoothly. That lesson shows that in a time of crisis, while the defense-authority-level mechanism (Japan-US bilateral coordination center) should serve as the basis, a system needs to be in place for launching deliberations that can bring together the two governments and each government agency.

◆ **Preparation of a legal framework for the expansion to a "whole of alliance" approach**

Legal preparations should be carried out, including the creation of confidentiality regulations to enable the smooth sharing of classified information as necessary during a crisis (either through improved application of existing regulations—e.g., the National Civil Service Law, the SDF Law, and the Act on Protection of Secrets Incidental to the Mutual Defense Assistance Agreement Between Japan and the United States of America—or through the establishment of new laws).

◆ **Sharing of threat perception (a threat's existence, terms, priority, etc., and the vulnerability of society to that threat) and clarification of the position of "nuclear nonproliferation, nuclear security, and nuclear power safety issues" within the Japan-US alliance's global strategy**

The United States and Japan must share a recognition that the international nuclear order is an important factor as they determine their own international strategies, and they must create a shared vision for that order. Above all, if many countries come to possess nuclear power generation and nuclear technology in the future, then along with reconfirming the importance of nuclear nonproliferation and nuclear security in terms of American and Japanese security strategies, close cooperation and coordination for the purpose of building the regulatory regime (nonproliferation, nuclear security, nuclear power safety) will be essential. Also, based on the foundation of international norms and rules, we need to effectively respond to emerging threats. For example, although Japan is on the outside of the "P5+1" (the 5 permanent members of the UN Security Council plus Germany) talks with Iran on that country's nuclear program, the United States and Japan have carried out close policy coordination, and the process of comprehensively coordinating on the two countries' demands in terms of energy security strategy—i.e., stabilizing the Middle East security environment, preventing nuclear proliferation, and so on—is itself important. That requires building trust between US and Japanese counterparts at each level, as well as communication and sharing between the two sides on data analysis and responses.

(3) Preparing for joint responses, conducting joint training

Drawing on these lessons, cooperation during normal times is important in order to foster more effective Japan-US joint response capability for nuclear security and crisis management capacity. More specifically, the following measures are called for.

◆ **Conducting of security peer review of critical facilities (nuclear power, etc.)**

Given that nuclear power plants and other critical facilities are highly susceptible to becoming the target of a terrorist attack, security countermeasures should be coordinated during normal times. The safety of these facilities is first and foremost the responsibility of the country that built it. However, when one considers the regional impact of the damage if a critical facility is destroyed, it becomes difficult for the country in question to handle the situation by itself, as became clear in the case of the Fukushima accident. However, even if there would be significance in jointly conducting security peer reviews of such critical facilities, when it comes to setting out the measures to cope with such situations, it would be a mistake for other countries to expect to be unconditionally involved. For that reason, when conducting reviews, organizational and legal measures, including the division of roles, should be examined during normal times, and as changes occur in the conditions or in technology, it should be reexamined. At that time, consideration should also be given to coming up with some type of institutionalized framework.

◆ **SDF–US Armed Forces joint response training (on nontraditional threats)**

When one considers the scale of damage to the international community that can be incurred from nontraditional threats, it is natural that military-type organizations that have practical capabilities would be in charge of handling such threats. However, the US military's operational capability to handle nontraditional threats is limited within the United States, and its ability to prepare for nontraditional threats abroad is also restricted. The SDF does not have a long history of viewing the handling of nontraditional threats as being its primary duty. Given the various economic issues facing both countries and the impact that has had on the defense budgets, it is somewhat difficult to call on either of the two countries to foster the capability to address nontraditional threats. For that reason, Japan and the United States should optimize their capacity to respond to nontraditional threats and should work to improve both their financial efficiency and their operational capacity by carrying out joint response training that will allow joint or integrated operations.

◆ **Implementation of Japan-US joint response training, including exercises with the participation of nonmilitary organizations and local governments**

During the response to the Great East Japan Earthquake and the Fukushima nuclear accident, the creation of a framework for joint action between the SDF and the US Armed Forces immediately after the events occurred was a natural action based on their need to respond to emergency conditions as military organizations. However, it would be difficult to say that cooperative frameworks other than that of the SDF and US Armed Forces functioned adequately. The United States has a set approach of having USAID take the lead in providing emergency relief, and immediately after the events occurred, that system began to operate, but as a recipient of that aid, Japan was lacking the institutional know-how to respond. Rather than being caused by insufficient preparations within Japan to deal with crisis management situations, this was more a factor of coordination among each domestic organization on emergency response not being carried out in a way that conformed to reality. For example, within Japan, there was a lack of understanding of the way that USAID operates, and the preparedness system did not take into consideration the strategic operations of the US forces. As a result, it is essential that in Japan-US exercises, the local governments receiving assistance be actively involved from the planning stages of the exercise so that participants can master response methods that more closely mirror actual conditions.

◆ **Implementation of Japan-US joint trainers' training (e.g., on nuclear security)**

The personnel working at the site of a crisis, whether in crisis management itself or major accidents such as those at nuclear plants, are not only the SDF and US military, but include personnel from private companies and local governments. However, it is impossible to demand that all of those diverse personnel have crisis management capabilities. One cannot put priority on crisis management alone, and the funds needed to carry out capacity building in this area are limited. For that reason, the most practical approach to crisis management education is to train the trainers, since this can be expected to have a ripple effect. The trainers' training methodology is not only used in the field of nuclear security, but has been used in export controls and other areas as well, and it has in fact shown results. In this way, we should refer to achievements in other security fields and actively introduce those things that can be effectively adopted.

6.4 Efforts by the United States and Japan (the alliance) toward the international community

Since the accident at the Fukushima nuclear power plant, Germany and several other European countries have changed course and are steering away from nuclear power. On the other hand, if you look around at the international community as a whole, there is still strong demand for nuclear power generation and there are many countries that are proceeding with the construction of new nuclear power plants. The trend is particularly strong in Asia, where at the current time China is planning on constructing 48–80 new reactors by 2020, India has plans for 20–26, and South Korea plans to build 3–6 more. Among countries just starting to adopt nuclear power, Vietnam is said to have plans to introduce 13 reactors by 2030, while Thailand, Indonesia, and others also have plans to build nuclear plants. If all of these plans are implemented, then the number of nuclear power plant being generated in Asia will be nearly triple the current amount by 2035. Improving the regulatory capacity for safety management and nuclear security among those countries that are newly adopting nuclear power and those that are planning large-scale nuclear power projects is an urgent task, and at the same time, we need to think about how to build capacity at the regional level to respond if a crisis does occur.

Among the dangers that can be anticipated when operating a nuclear power plant are such things as power outages or a failure of the cooling systems in the reactor or the spent fuel pool, as was evident in the Fukushima nuclear plant accident. Such events can be caused not only by a natural disaster, but also by human acts of subversion. More specifically, there is the potential for illegal acts such as attacks on nuclear facilities, or the theft or destruction of nuclear materials or their means of transport. In addition, one must consider the need to address failures of risk management (including protective systems) that would allow such acts to happen, and mistakes or internal threats (internal acts of subversion) in terms of information sharing or data manipulation, which could expand the crisis. These are unquestionably areas in which every country that possesses nuclear capabilities has a responsibility to strengthen their ability to respond. However, there are also some newly emerging countries that have not fully developed the capabilities needed to address these threats and risks. Accordingly, it is important that Japan and the United States, which have been playing a constant role in the peace and stability of the Asia Pacific region, play a similarly constant role in decreasing these types of increasingly apparent new risks related to nuclear power operations, or in other words, in addressing these new types of "nontraditional threats."

While in the past the mission of the alliance was limited to defense and diplomacy in Japan and its immediate environs, as the international order has become increasingly stable overall, the alliance has been expected to broaden its role to handle such fields as finance and economics or natural disasters. Through accumulated experiences and efforts on both sides, the Japan-US alliance has enhanced the level of trust between the two countries, and it has developed into a framework through which the countries can cooperate closely on issues such as risk management responses, relying on one another as their most trustworthy partner. This cooperative framework must be made even more effective to ensure that those capabilities can be applied to a crisis response in either country of course, but also to enhance the role of the Japan-US alliance as a public good in the Asia Pacific region.

In terms of strengthening Japan-US alliance cooperation on nuclear nonproliferation, nuclear security, and nuclear power safety, as noted in section 6.1 above, in addition to strengthening bilateral response capabilities, discussion is also required from the perspective of how the United States and Japan can cooperate in maintaining and strengthening the global order as it relates to these issues. As described in chapters 4 and 5, we must agree to strengthen Japan-US bilateral cooperation and use that cooperation as the basis to address nuclear nonproliferation, nuclear security, and nuclear power safety–related issues in the Asia Pacific—or in other words, maximizing Japan-US alliance cooperation should be conceived of as a way to address and prevent nuclear terrorism and nuclear power disasters. It is important that the Japan-US alliance be positioned as a public good in the Asia-Pacific region, and that a framework be created that allows for the alliance to comprehensively contribute on the issue of "nuclear risk reduction," including nuclear nonproliferation.

<Recommendations>

(1) Prevention

- **Strengthening of the international nuclear power safety and nuclear security regimes, and harmonization at the global level of nuclear security regulations and response policies**

Given the limitations of strengthening mandatory regulations through a universal regime, regulations on the "supply side" must be standardized. Cooperation among exporters can raise the effectiveness for the purpose of ensuring rule compliance among countries that are not inclined to fulfill their nonproliferation and nuclear security obligations. In addition, among countries that hope to become exporters of nuclear power, it prevents safety regulations and nonproliferation regulations from becoming ineffectual due to intensified export competition or to countries trying to get a jump on the competition.

- **Initiatives to improve information exchange between countries, and transparency within countries, regarding nuclear power activities (including the status of 3S implementation—safeguards, safety, security)**

What is most important in efforts to strengthen nuclear power safety, nuclear security, and nonproliferation in the Asian region is to raise the standards in the region as a whole. In other words, it is important not to create a weak link in the regulatory regime. If one country's regulations are weakening, then fears of proliferation or of a terroristic threat through the use of that loophole will increase. Accordingly, initiatives should be carried out to create international rules that strengthen transparency (to the extent possible without creating security concerns) with regard to one another's nuclear power–related activities, the storage conditions of nuclear materials, and so on, and Japan and the United States should play a leading role in such initiatives.

- **Formation of a regional cooperation framework**

When carrying out cooperation on nuclear power, one important element is to ensure that the capacity building and human resource development are adequate on the part of the recipient country. The role of the provider country is naturally to cooperate in setting up the systems—including the regulatory system. Moreover, that type of capacity building should not just be an initiative of the United States and Japan alone, but should be a globally standardized initiative. Also, at the regional level, the objective should be to build a framework for carrying out mutual cooperation (division of labor) for the purpose of improving capacity to guarantee the effectiveness of the safety and nuclear security standards of each nation in the region.

Additionally, as for the long-term prospects, consideration should be given to the possibility of collaboration at the regional level to implement the management and safe disposal of nuclear materials that are considered to require strict control for the purpose of nuclear security, including the disposal of spent nuclear fuel and international transport security for nuclear materials. The role to be played by Japan and the United States in that context should also be considered.

- **Higher global standards through the creation of international networks on such issues as detection technology and nuclear forensics, protective regulations, standard setting, and best practice sharing in security by design, detection capacity, etc.**

The key to whether or not nuclear forensics can become a practical anti-terrorism measure will be the establishment of the technology along with the construction of a universal database. If we assume that there may be countries that use the pretext of their "inalienable right" to the peaceful use of nuclear power as they seek to develop their own nuclear weapons, then we can envision those countries using that as a shield and turning their back on cooperation. The composition of the nuclear fissionable materials that a country possesses is extremely important information when trying to assess a country's nuclear weapons capability, or conversely it can be thought that sharing that information internationally is a major issue in terms of national security. Accordingly, while sharing information itself on the composition of nuclear materials may be difficult, the issue is how to create a cooperative mechanism for providing information in the case of incidents such as nuclear terrorism or smuggling, and how we can rise above that type of political impediment in order to ensure effectiveness. As a result, Japan and the United States need to lead the international community on the technological development front and provide technological and operational standards for nuclear forensics as a means to universalize nuclear forensics in the international community.

◆ **Thorough examination of the Fukushima accident and, based on that, the launch of "accident studies" research**

Insight from "accident studies" should be quickly converted into a database and shared globally. This event should not be treated symptomatically with accident prevention and mitigation strategies, but rather research should be carried out applying "accident studies," drawing on the massive resources of modern science and technology. And the findings should not feed only into the knowledge base of those in the community of experts on nuclear accidents, but should be shared more broadly with the general public. By doing so, the issue of nuclear accidents is shared with the public and that can help prevent chaos in society. At the same time, nuclear accidents are not a problem unique to Japan; they should be recognized as a universal problem that arises when operating an enormous system like nuclear power. A Japan-US initiative should be launched to deepen our understanding of the issue and to share that knowledge with the international community. In such instances, it is important to conduct research through a framework that can incorporate opinions not just from proponents of nuclear power, but from those with independent perspectives as well.

(2) Mitigation

◆ **Examination of how to make Japan-US joint response capabilities available to third countries**

In the Asia Pacific, where use of nuclear power is forecast to expand, the Japan-US joint response capability will be expected to play a role as a public good that can provide support in cases where countries have difficulty coping with a problem on their own. Needless to say, if a nuclear disaster occurs, the general rule is that a country must handle it by itself. It is preferable that each country have the capacity to do so. However, just as in the recent case where Japan needed support from other countries, one would have to say that there is a strong possibility that international assistance would be needed if a disaster occurred in another country. The types of capabilities, services, or material and equipment resources that Japan and the United States could provide in such a case should be incorporated as a scenario within the two countries' contingency plans.

However, there is one point that should be kept in mind. When it comes to Japan-US cooperation at the global level, or improving the Japan-US crisis response capability as a public good in the Asia Pacific region, as has been noted above, we must pause and think about the degree to which the lessons learned for Japan-US relations or the Japan-US alliance from the recent experiences—both from the "best practices" and from the "bad practices" of the first week of the initial response—can be presented to other countries.

The reason for this is because the closeness of Japan-US relations, and the importance of Japan for the United States, is quite exceptional in the Asia Pacific region. The reason that

US assistance was so forthcoming and on such a large scale was that the recipient of that assistance was Japan. It is a rather extreme case, but for example if the same sort of nuclear power disaster occurred in China, the United States would probably not have adopted the same type of assistance structure, and the Chinese would not have been prepared to receive such assistance.

However, if the adoption of nuclear power spreads among the newly emerging nations in Asia, one can easily imagine that those countries will have difficulty to simultaneously acquire the capabilities (and experience) needed to respond to a crisis on their own. If that is the case, then top priority should be placed on efforts in those countries to implement human resource development and technical assistance to prepare the foundation so that nuclear disasters do not occur, and to minimize risk. At the same time, from the perspective of addressing residual risk, a system must be put in place for proactively utilizing the capabilities that Japan and the United States possess in the event that a nuclear crisis does arise. In order to encourage that type of capacity building and regional cooperation, the idea of building an Asia Pacific crisis management network centered on the Japan-US alliance should be promoted, and Japan and the United States should take the lead in achieving that goal.

Afterword

The Fukushima Daiichi accident raises the fundamental question with regard to nuclear power, which mankind began using in the 20th century, of whether or not humans can control nature through science and technology. Although natural uranium is dependent upon the realm of nature, it is the technology of using that natural uranium and artificially causing nuclear fission to occur that gives rise to its two primary usages—on the one hand, as a means of creating a nuclear bomb, and on the other hand, as a means of generating nuclear power, or in other words, the "peaceful use" of nuclear power. Peaceful use, however, inevitably raises the issue of managing the radioactive materials that are a byproduct of uranium fuel fission. Peaceful use of nuclear power only becomes viable when you can proficiently manage nuclear safety. However, when it comes to science and technology, there is no absolute, and as demonstrated by the Fukushima Daiichi Nuclear Plant accident, it is dangerous to believe that nuclear power can be absolutely safe. The result of placing priority on having zero definite impact is the creation of the "myth of nuclear power safety," and they neglected the response to probable impact. In Japan, setting aside future energy choices, for the foreseeable future the country will have to use nuclear energy based on economic, energy security, environmental, and other considerations, and at the same time there is an ongoing trend toward the adoption of nuclear energy in Asia and elsewhere. In order to be able to enjoy that convenience, there is no option other than to make full use of human intelligence as well as science and technology to manage the safety of nuclear energy. The safety myth of nuclear power generation must be discarded and the collective human intelligence must be applied in pursuit of safer quality and management.

In order to maintain and operate nuclear power plants and use this as a stable energy source, the state and corporations that manage those plants have a tremendous responsibility to make the utmost efforts to ensure that the kind of accidents noted above do not occur. Nuclear safety management implies the entire spectrum of safe operations—the use of plant facilities, materials, management, etc.—as well as various types of preventative measures to minimize the potential for accidents and crisis management measures to localize any damage. In particular, the adoption of the "defense in depth" concept it essential in order to prevent nuclear accidents from occurring and to limit damage should accidents occur. Defense in depth is something that tries to advance the single-layered safety type of plant management by creating multi-tiered crisis management and other systems of plant safety. It is comprised of stress tests at multiple levels and emergency safety measures. Promoting this type of depth of defense of nuclear reactors is the most important measure for nuclear power safety management. But that alone is not sufficient in order to ensure exhaustive nuclear power safety management. It also requires that safety management be promoted in all areas—systems, administration/operation, etc.

Although diverging somewhat from the main text of this report, by considering how to apply nuclear safety management to the objective of preventing accidents at nuclear plants from various relevant perspectives, we can derive the following areas in which measures are needed.

The first is design-based safety management of the nuclear plant (nuclear power plant design, infrastructure). Among the world's nuclear plants, there are boiling water reactors (BWR) and pressurized water reactors (PWR), but the basic issue in either case is improving the reliability of the overall plant design.

The second is the question of risk management of the nuclear plant itself, the operating set-up of the overall system, and the inspection system. This includes the safety management and inspection system of the nuclear power plant's system.

The third is the decision-making process among the national government, local governments, and corporations and the safety management system (legal system, responsibility, jurisdiction). It is crucial that the responsibility and authority for the design, operation, and approval of nuclear energy facilities, and the decision-making process, be both legally and substantively clear. Needless to say, within that context, the most important thing for safety management is the crisis management capability of those in positions of responsibility.

The fourth area is measures to prevent or limit the damage from a nuclear accident, and particularly the issue of countermeasures for radioactive damage. There is currently a great deal of technology about which little is known, and existing measures are inadequate.

The fifth is the regulation, education, and crisis management response of nuclear plant managers and operating personnel. There are also the issues of the technological level and training and retaining of personnel. When one considers that the major accidents to date have occurred as a result of operator mistakes, this is clearly an important point.

The sixth includes protective measures and antiterrorist measures to guard nuclear power and other relevant facilities as well as radioactive materials. This is the core of the nuclear security issue. The legal framework and actual implementation must be consistent on this issue.

The seventh area covers international cooperation, technical cooperation, accident response, and information sharing related to safety management at nuclear plants. These have been lacking in the past and this field requires the utmost attention in the future.

The eighth and final area includes issues of managing, storing, and disposing of nuclear fuel, spent fuel, and nuclear waste. This is a difficult challenge shared by all countries that possess nuclear facilities. Accordingly, focus should be placed on international cooperation in this field.

It is important that the above points regarding nuclear safety management be comprehensively implemented—all are important issues that cannot be overlooked. Among them, however, we would like to focus on two points that are particularly important for the nation to address.

The first point is that we must discard the safety myth. Whether one chooses to abandon nuclear power or promote it, the difficult question remains of nuclear power–related facilities, spent fuel, and radioactive waste materials. No matter what the technology may be, absolute safety is not possible, and we must first meticulously examine the problems and make improvements based on that awareness. When moving down this path, an enormous responsibility falls on the politicians who lead the nation's politics, the engineers who lead the technological innovations, and the administrators who manage the organization and business aspects. Those who try to avoid taking responsibility should not be assigned to those positions. Safety is not an inherent state of being; it requires constant work and attention.

The second point is to clarify who holds responsibility and authority. The recent accident at the Fukushima nuclear plant demonstrated that Japan's crisis management system—from the leadership to the regulatory organizations, and even to the implementation of the private company's crisis management manual—failed to function on many fronts. The way in which governance functioned, including the political leadership, was certainly "unforeseen" in how poor it was. Mistakes in the management of nuclear power plants lead to major crises. As a modern nation, when a crisis occurs, the important point is that those with responsibility and authority are able to make appropriate judgments based on the appropriate information and with the assistance of experts, and that based on consistent orders, they use an effective organization and manage to accurately handle the situation. The creation of such a system is an urgent imperative. Also, from the perspective of crisis management response, there is a great deal to be learned from the SDF, which played a major role through their prompt action in providing relief to the earthquake and tsunami victims and in responding to the nuclear accident, as well as from the response of the United States, which pulled together as a country immediately after the disaster struck to assist Japan.

Naturally, the various measures to address these problems can be divided into two major categories: (1) those measures and efforts that must primarily be undertaken domestically and (2) those measures and efforts that must be undertaken by the international community, and particularly those items that should be adopted as key items for cooperation within the context of the Japan-US alliance.

Within these measures, there are a broad range of fields that are relevant to international cooperation and particularly Japan-US alliance cooperation, but in particular, the issue of nuclear plant safety management, nuclear security, and the management of spent fuel are areas in which Japan must work in close cooperation with the United States and must further strengthen the trust that was created through the joint handling of the Fukushima plant accident. Also, assuming that the peaceful use of nuclear power is going to become increasingly adopted in the Asia Pacific region, then thought should be given to how the Japan-US alliance, either jointly or separately, might assist in addressing future disasters. In this regard, lessons should be derived from the experience of Japan-US cooperation in addressing the Fukushima accident.

At the same time, in terms of international cooperation on nuclear nonproliferation and nuclear power usage, it goes without saying that Japan-US cooperation should be pursued on such issues as (1) global governance (safety regulations, risk management, crisis management); (2) on strengthening the functions of the IAEA and setting global standards on nuclear safety management; and (3) on responses to the major issues currently confronting the field—i.e., cooperation on stopping the development of the nuclear weapons programs and proliferation in Iran and North Korea.

The research for this report placed priority on both nuclear safety management and nuclear security. Narrowly defined, nuclear security includes protection against terrorist attacks and other subversive acts, or against sabotage and other illegal acts targeting nuclear plants and other relevant facilities, as well as safety management and protection for the purpose of preventing malicious acts against the storage, transport or management of radioactive materials, including the illegal transfer, theft, sabotage, unauthorized access, or illegal removal of nuclear fuel, spent fuel, or nuclear waste. In the broader sense of the term, the concept includes the legal systems, guarding and surveillance systems, safety management, information sharing, and international cooperation implemented for that purpose. In other words, nuclear security signifies the measures and policies for the safeguarding, protection, and defense of nuclear power plants and nuclear fuel.

These nuclear security measures include prevention, detection, response, and damage-minimization measures. The preventive measures are crisis management measures intended to stop an accident before it happens, while the damage-minimization measures are intended to limit the damage if an event does occur, mitigate the impact, quickly restore conditions, and prevent a recurrence.

In the recent Fukushima nuclear plant accident, the relevant circumstances did not emerge. However, it was shown that there are vulnerabilities in terms of nuclear security, pointed to the potential for a similar event to occur if the electrical equipment and wiring that feed a nuclear plant sustains significant damage and it becomes impossible to inject coolant into the reactors. The fact that terrorist groups and subversive organizations are now aware of this fact is a major lesson that must be drawn. It is also clear that if a similar incident occurred in neighboring countries, there is absolutely no cooperative system in place. We must apply these lessons and consider policies for the future. Further examination of this issue is needed to strengthen measures for the future.

In the end, when considering domestic policies and measures to promote nuclear security, the first measures that must be implemented by plant licensees and others include (1) improving the personnel system, (2) installing and improving equipment and machinery, (3) reviewing the response manual, and (4) responding to the threat of cyber attacks, etc. At the same time, a response to internal risk is needed, such as mutual surveillance and stricter access management. In addition, measures that should be implemented by the law enforcement agencies (the relevant ministries and agencies) include (1) the state of alert, (2) personnel system, (3) installing and improving equipment and machinery, and (4) strengthening cooperation through training.

On the other hand, in terms of strengthening nuclear security, the IAEA's relevant recommendations indicate the need to specify the institutions for coordinating between the relevant agencies and strengthening cooperation with each institution with regard to the protection measures for nuclear materials and nuclear power–related facilities.

Moreover, in terms of international cooperation to promote nuclear security, first each country needs to solidify its own legal system and, based on that, its protective system for the physical protection and safeguarding of nuclear power plants and nuclear fuel. In Japan's case, the cooperation among the police, Japan Coast Guard, SDF, and local governments was inadequate. In particular, there is no legal basis for the SDF to carry out activities outside their posts for the purpose of protecting critical facilities such as nuclear power plants, and they are in fact unable to carry out such activities. However, in the event that the other party landed and attacked a nuclear facility located close to the shore, then depending on the method of attack and the weapons used, there may be cases where the Coast Guard and police could not respond. A territorial defense law is needed that would allow the SDF to act under such circumstances, but such a law has not yet been put in place. In this way, it is first necessary to spell out the responsibilities and authority for defense and protective measures, establish a practical legal system and mechanisms, and conduct ongoing training.

Moreover, that raises the question of the methods of international cooperation needed to defend against and respond to attacks on nuclear power plants and related facilities, storage facilities for nuclear fuel and spent fuel, and means of transport. Cooperation is also needed with neighboring countries on safety management and the defense and protection of nuclear power–related facilities, on warning/surveillance and information sharing in the sea and air, as well as on dealing with suspicious vessels in the oceans near nuclear power plants and implementing protective measures for vessels transporting nuclear fuel. Another major issue is international cooperation and the activities of the Integrated Support Center with relation to the illicit trade in radioactive materials and the development of technologies related to measurement, detection, and forensics of radioactive materials, as well as to the policing of national borders and ocean areas. The PSI system includes surveillance measures for means of distribution in order to stop the proliferation of weapons of mass destruction, but beyond that there is no framework for international cooperation to prevent attacks on nuclear power plants or nuclear fuel, so this remains an issue for further consideration.

In any case, the Fukushima accident signifies the destruction of the safety myth for the Japanese people. We must take this important and valuable experience and devote ourselves to creating a truly safe society and nation. The Japan-US alliance is also important, but in order for that alliance to function effectively, we must first put our own national system in order. At this moment, that is what we must contemplate and understand.

Appendix 1: Timeline of the accident at the Fukushima Daiichi Nuclear Plant (Units 1–4)

The sequence of events surrounding the accidents that occurred in Units 1–4 as a result of the earthquake and tsunami are shown in the following table. This indicates the events unfolding from March 11 through March 15.

Date	Time	Unit 1	Unit 2	Unit 3	Unit 4
March 11	14:46	Earthquake strikes Auto-shutoff of nuclear reactor External power grid shuts off Emergency diesel generator activated			
	14:47		Earthquake strikes Auto-shutoff of nuclear reactor External power grid shuts off Emergency diesel generator activated	Earthquake strikes Auto-shutoff of nuclear reactor External power grid shuts off Emergency diesel generator activated	
	14:50		Operators start reactor core isolation cooling (RCIC)		
	14:52	Emergency isolation condensers (ICs) start automatically (afterward, valve was manually opened/shut)			
	15:05			Cooling system activates when core meltdown occurs	
	15:37	Tsunami hits Seawater cooling function lost Emergency diesel generator shuts down Direct current (batteries, etc.) power lost Emergency IC functions lost			

		(assumed)			
	15:38				All AC power lost
	15:41		Tsunami hits Seawater cooling function lost Emergency diesel generator shuts down Direct current power lost		
	15:42			Tsunami hits Seawater cooling function lost Emergency diesel generator shuts down	
	abt 17:00	Fuel exposed (assumed) Core meltdown (assumed)			
12	05:46	Fire engine pumps in fresh water			
	11:36			RCIC shuts down	
	12:35			High pressure coolant injection (HPCI) starts automatically	
	14:30	Venting Decrease in containment pressure			
	15:36	Explosion thought to be a hydrogen explosion in the reactor building			
	19:04	Injection of seawater using fire engines			
13	02:42			HPCI system stops	
	abt 08:00			Fuel exposed (assumed) Core meltdown begins (assumed)	
	08:41			Vent opened	
	abt 09:20			Container pressure drops	
	09:25			Injection of	

				seawater using fire pump	
	abt 11:00		Vent opened		
	13:25		RCIC shuts down (assumed)		
	abt 18:00		Reactor decompression Fuel exposed Core meltdown (assumed)		
	19:54		Fire pump injects seawater		
14	04:08				Pool water temperature rises to 84°C
	11:01			Explosion thought to be a hydrogen explosion occurs in reactor building	
15	abt 06:10		Explosive sound heard		Explosive sound heard Damage was sustained around area of reactor building rooftop
	08:11				Damage to reactor building confirmed
	09:38				Fire breaks out on 3rd floor of building
16	05:45				Fire breaks out on 4th floor of building
20	08:21				Injection of water into spent fuel pool begins

Source: The data for this table was drawn from Nuclear Emergency Response Headquarters, "Heisei 23-nen (2011) Tokyo Denryoku (kabu) Fukushima Daiichi • Daini Genshiryoku Hatsudensho jiko (Higashi Nihon Daishinsai) ni tsuite" [On the 2011 TEPCO Fukushima Daiichi/Daini Nuclear Power Plant accident (Great East Japan Earthquake)], July 19, 2011 (8:00 p.m.), http://www.kantei.go.jp/saigai/pdf/201107192000genpatsu.pdf; the Nuclear Emergency Response Headquarters, "Genshiryoku anzen ni kansuru IAEA kakuryo kaigi ni taisuru Nihon-koku seifu no hokokusho—Tokyo Denryoku Fukushima Genshiryoku Hatsudensho no jiko ni tsuite" [Report of the Government of Japan to the IAEA Ministerial Conference on nuclear safety—On the accident at the TEPCO Fukushima Nuclear Power Plant], June 2011, http://www.kantei.go.jp/jp/topics/2011/iaea_houkokusho.html; NISA, "Tokyo Denryoku Kabushiki Kaisha Fukushima Daiichi Genshiryoku Hatsudensho jiko no gijutsuteki chiken ni tsuite chukan torimatome."

Appendix 2: What is nuclear power generation?

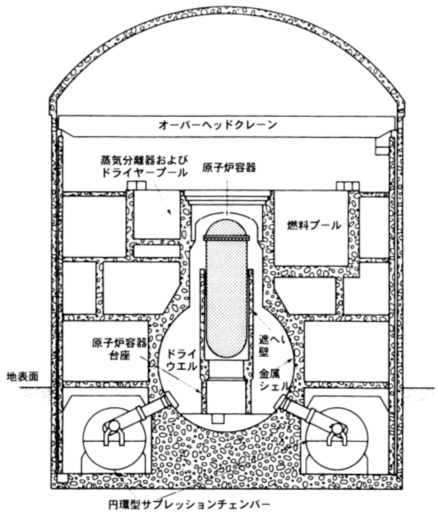
Nuclear power is generated when a nuclear fission reaction occurs in uranium fuel and the energy generated in that process is converted to electricity. The atoms that make up matter are comprised of the atomic nucleus and the surrounding electrons. When an unstable nucleus containing large quantities of protons and neutrons splits under certain conditions, the energy released at that time is called a nuclear fission reaction. Because this reaction releases new neutrons as well, it leads to the nuclear fission of the next material, thus setting off a chain reaction. In a nuclear power plant known as a light water reactor, the number of neutrons is controlled and water is used as an intermediary to convert that to energy, as steam causes turbines to rotate and produce electricity.

Fission products—split off elements within the fuel—include cesium (Cs), iodine (I), strontium (Sr), and plutonium (Pu). Even when the nuclear reaction stops, the decay itself continues, and this process continues to generate decay heat.[187] For that reason, the spent nuclear fuel must be continuously cooled in a storage pool.

Figure A-1 shows an example of the type of boiling water reactor (BWR) that is used in the Fukushima Daiichi Nuclear Power Plant.[188] The fuel assembly[189] is contained in the central nuclear reactor vessel (pressure vessel).

The safeguard against an emergency is known as the emergency core cooling system (ECCS). This includes two types of safeguards: one for high pressure, which allows for the injection of water even if the pressure within the reactor rises above the rated working pressure, and one for low pressure, which allows for the injection of large amounts of coolant after the pressure in the reactor drops.[190] During the accident at Fukushima Daiichi, none of these systems worked.

Figure A-1. BWR similar to that used in the Fukushima Daiichi Nuclear Power Plant



187. Tadahiro Katsuta, "Kakunenryo to sono hoshasei busshitsu" [Nuclear fuel and its radioactive materials], *Kagaku* 81, no. 6 (June 2011):

188. The interior of the central reactor vessel is also called the pressure container. In drywells, there is no water. There is a hollow metal shell, surrounded by concrete. A large duct connects the bottom of the drywell to the torus suppression chamber. Usually this is half-filled with water, and during a loss of coolant accident (LOCA), the steam is released into the drywell, passes through the duct, and is condensed in the torus. That lowers the pressure in the containment vessel and reduces the possibility of radionuclides escaping into the environment. John R. Lamarsh, *Genshikaku kogaku nyumon (ka)* [Introduction to nuclear engineering (part 2)] (Tokyo: Pearson Education Japan, 2005), 164.

189. A fuel assembly is a collection of zircaloy-clad tubes (fuel rods) that contain fuel that has been burned and hardened into pellets.

190. These safeguards are put in place to avoid a LOCA. In terms of high-pressure systems, there is a high-pressure coolant injection system (HPCI) in order to prevent LOCA, maintain the reactor water level, and avoid heating of the fuel, and there is a reactor core isolation cooling system (RCIC) in case the water supply stops for some reason. In addition, in Unit 1, there is an emergency isolation condenser (IC) rather than an RCIC. Fundamentally, the operation of these systems requires an AC generator, but the RCIC drives the turbines with steam, and the IC does not require a driving source. Among low-pressure systems, there is a core spray system (CS). This cools the reactor core by spraying water from the condensate storage tank or pressure suppression pool through a nozzle at the top of the core. There is also a residual heat removal system (RHR) that eliminates decay heat at the time of a shut-down of the reactor or residual heat during reactor core isolation (a stoppage of water supply). NISA, "BWR genshiro reikyo keito setsubi no gaiyo" [Summary of BWR nuclear reactor coolant system equipment], November 25, 2011, http://www.nisa.meti.go.jp/shingikai/800/28/003/3-1.pdf.

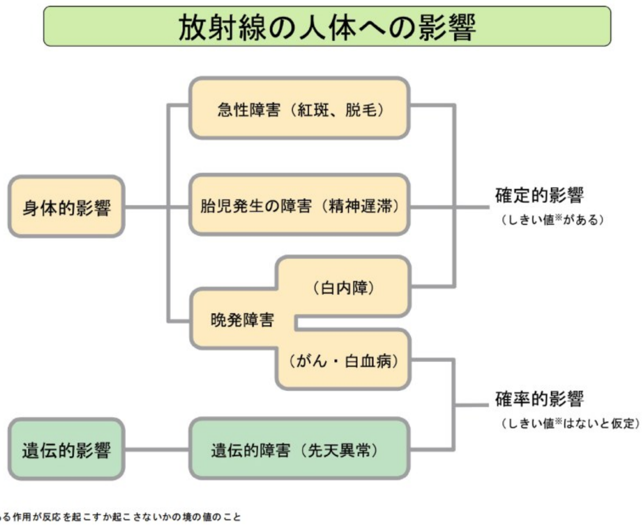
Appendix 3: What are radioactive contamination and radiation exposure?

Radiation exposure includes external exposure, in which radiation is showered on the body from the outside, and internal exposure, which results when radioactive material enters the body internally. There are also two types of impact that such exposure has on the body. The first is a physical effect where the impact of the radiation is apparent in the person’s body, and while it is not transmitted to future generations, there may be acute injuries that appear immediately after exposure as well as delayed effect injuries that may not be apparent until years after the exposure occurs. The other type of impact is the genetic impact that is believed to be transmitted to future generations (see figure A-2).

Also, while high-dose exposure is an issue for workers confronting the accident, the understanding among the general populace about exposure levels of 100 mSv or less—so-called low-dose radiation exposure—is complicating the issue. On November 9, 2011, a Cabinet Office working group on long-term exposure to low-dose radiation began work and completed its report in December of that year.[191] Their report stated that it is best to take the safe approach and consider that even low-dose exposure of 100 mSv or less can directly increase health risks.

In addition, if one looks at the fission products generated in the uranium fuel and inside the reactor that were released into the environment, it has long been known that elements such as strontium, for example, which is similar to calcium and can thus easily accumulate in the bones, or cesium, which is similar to potassium and thus easily accumulates in muscle, have an impact on the body.[192]

Figure A-2. Physical impact of radiation



Source: Federation of Electric Power Companies of Japan, “Genshiryoku-enerugii zumenshu 2011-nenban” [Nuclear power and energy diagrams 2011], http://www.fepc.or.jp/library/publication/pamphlet/nuclear/zumenshu/.

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[191]. Cabinet Secretariat, “Teisenryo hibaku no risuku kanri ni kansuru waakingu guruupu hokokusho” [Report of the working group on risk management for low-dosage exposure to radiation], December 22, 2011, http://www.cas.go.jp/jp/genpatsujiko/info/twg/111222a.pdf.

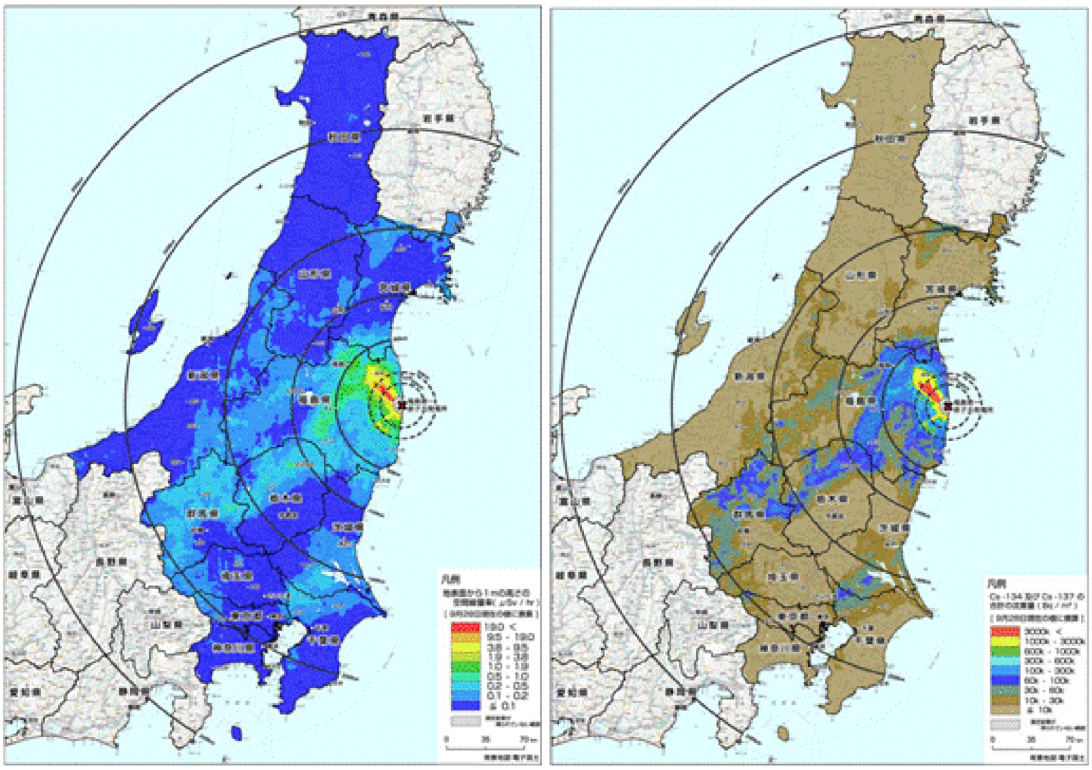
[192]. ^{90}Sr is a nuclide that has a long half-life (27.7 years), and since strontium is an alkali earth metal belonging to the same family as calcium, its behavior in the world of living organisms is similar to that of calcium. In other words, since calcium is one of the main components of human bone, ^{90}Sr also accumulates in the bones. ^{137}Cs also has a long half-life of nearly 30 years, and since its chemical properties are similar to potassium, it behaves in a similar way in living organisms as well. In other words, just like ^{90}Sr, it attaches itself to plants, and is absorbed into the human body through food such as milk and fish, accumulating primarily in the soft tissues such as muscles. In addition, when in the soil, ^{137}Cs possesses properties that make it more easily absorbed by the soil than ^{90}Sr. And while ^{131}I has a relatively short half-life of roughly 8 days and therefore does not accumulate over a long period of time, it becomes an issue as a nuclide that accumulates in the thyroid gland through the food chain (pasture grass → milk → humans, or leafy vegetables → humans) and thereby exposes humans to radiation. Chemical Society of Japan, *Hoshasei busshitsu* [Radioactive materials] (Tokyo: 1976, Maruzen), 18.

Discharged radiation

The impact of discharged radiation as of the end of September 2011 is shown in figure A-3 (at left), which depicts the ambient dose rates detected at a height of 1 meter from the ground. This indicates that within 20–30 kilometers to the northwest of the plant, there are sites that recorded rates above 19 microsieverts per hour (μSv/h), and readings of 0.5 μSv/h were detected at locations more than 150 kilometers away. Surface deposits of ^{134}Cs and ^{137}Cs are shown in figure 1-7 (at right). This indicates that cesium was dispersed over a broad area. In addition, the status of plutonium and strontium dispersion is indicated in figure A-4. Here again, the dispersion was quite widespread (the former has been detected within a 50 km radius, while the latter has been found within an 80 km radius).

On March 22, 2011, ^{131}I and ^{137}Cs were detected in the ocean off the coast by the Fukushima Daiichi Nuclear Power Plant.[193] Tests also found ^{131}I, ^{134}Cs, and ^{137}Cs in marine sediment from the coast of Miyagi Prefecture, Fukushima Prefecture, and Ibaragi Prefecture.[194] On May 3, samples from the seabed more than 15 km from the reactor showed 100 times the normal levels of ^{131}I and more than 1,000 times the normal levels of ^{134}Cs and ^{137}Cs.[195] According to a November 2011 survey by the Japan Agency for Marine-Earth Science and Technology, in which plankton carcasses and sand were collected, roughly one month after the accident, radioactive cesium carried in contaminated water and airborne debris from TEPCO's Fukushima Daiichi plant had reached a location more than 2,000 km from the plant.[196]

Figure A-3. Ambient radiation dose rates 1 meter from the ground (left) and deposits of ^{134}Cs and ^{137}Cs on the ground surface (right)



Source: MEXT.

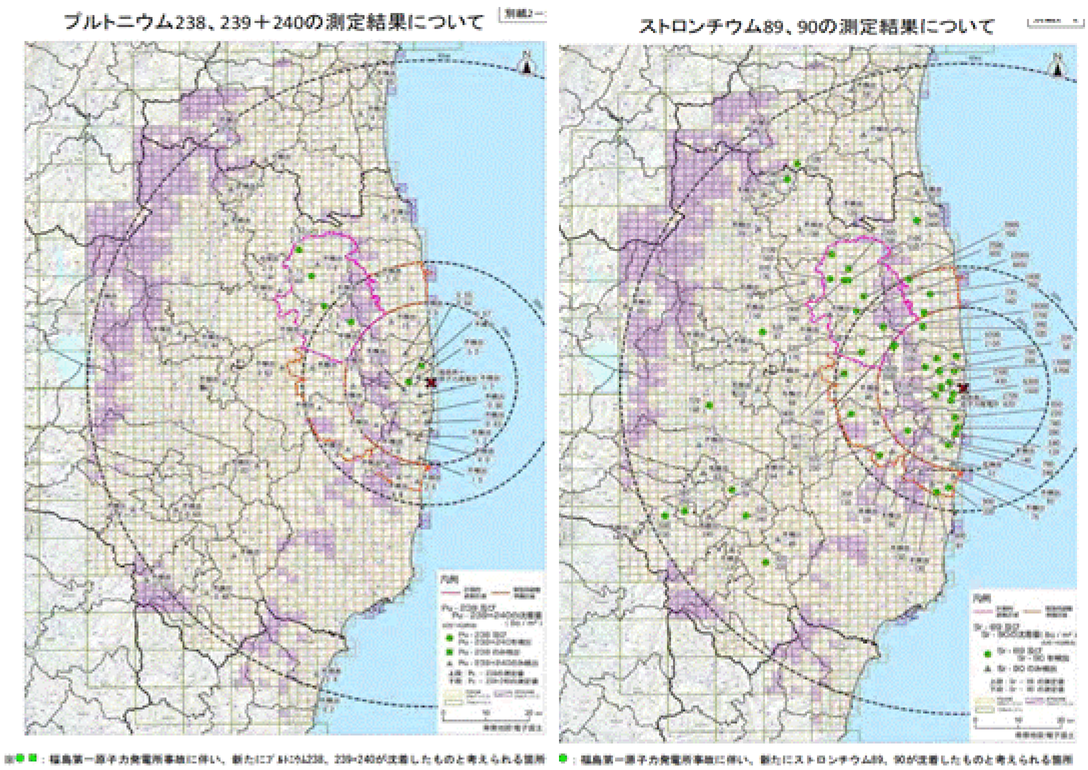
[193]. The highest amounts recorded were 76.8 Bq/L of ^{131}I and 24.1 Bq/L of ^{137}Cs (March 23, 2011). MEXT, "Monitoring Information of Environmental Radioactivity Level," March 24, 2011.

[194]. MEXT, "Monitoring Information on Marine Soil."

[195]. TEPCO, "The Results of Nuclide Analyses of Radioactive Materials in the Ocean Soil off the Coast of Fukushima Daiichi Nuclear Power Station," May 3, 2011, http://www.tepco.co.jp/en/press/corp-com/release/11050305-e.html.

[196]. Japan Agency for Marine Earth Science and Technology, "Fukushima Daiichi Genshiryoku Hatsudensho jiko ikkagetsugo ni okeru seshiumu-134, -137 no seibu Kita Taiheiyo ni okeru kosan jokyo ni tsuite" [Status of spread of cesium-134 and -137 in the western portion of the North Pacific one month after the accident at the Fukushima Daiichi Nuclear Power Plant], November 28, 2011, http://www.jamstec.go.jp/j/jamstec_news/20111128/.

Figure A-4. Findings of nuclide analysis for plutonium (left) and strontium (right), as of September 30, 2011



Source: MEXT, “Monbukagakusho ni yoru, purutoniumu, sutoronchiumu no kakushu bunseki no kekka ni tsuite” [Results of nuclide analysis by MEXT for plutonium and strontium], September 30, 2011.

If we compare this data with the Chernobyl accident (1.8 x 10^{18} becquerels [Bq] of ^{131}I; 85 x 10^{15} Bq of ^{137}Cs)[197], the iodine and cesium released[198] in the case of Fukushima Daiichi were approximately one-tenth the Chernobyl amounts.

The Comprehensive Test Ban Treaty Organization (CTBTO) has been gathering tsunami data and data on radioactive materials from March 11 on.[199] The organization’s research institute in Vienna has been using this data and has calculated that in the three days immediately following the accident, the amount of radioactive iodine released was approximately 20 percent of the amount released over a 10-day period in the Chernobyl accident.[200] The NISA also conducted a comparison of the radiation leak at the Fukushima plant to the atomic bomb that was dropped on Hiroshima,[201] reporting that the amount released was the equivalent to 168 bombs in terms of ^{137}Cs, 2.5 bombs in terms of ^{131}I, and 2.4 bombs in terms of strontium-90 (^{90}Sr).[202] The Meteorological Research Institute announced that the quantity of ^{137}Cs observed in March was approximately 30,000 Bq/m^2, which was more than 50 times the previous high recorded in June 1963, which was the result of nuclear tests conducted at that time (see fig. A-5).

197. Nuclear Security Commission, “Fukushima Daiichi Genshiryoku Hatsudensho kara taikichu e no hoshasei kakushu (yoso 131, seshiumu 137) no hoshutsu soryo no suiteiteki shisanchi ni tsuite” [Preliminary estimate of total amount of radionuclides (iodine-131 and cesium-137) released into the air from the Fukushima Daiichi Nuclear Power Plant], April 12, 2011, http://www.nsc.go.jp/info/20110412.pdf.

198. IAEA, “Environmental Consequences of the Chernobyl Accident and their Remediation: Twenty Years of Experience,” STI/PUB/1239(2006), http://www-pub.iaea.org/mtcd/publications/pdf/pub1239_web.pdf.

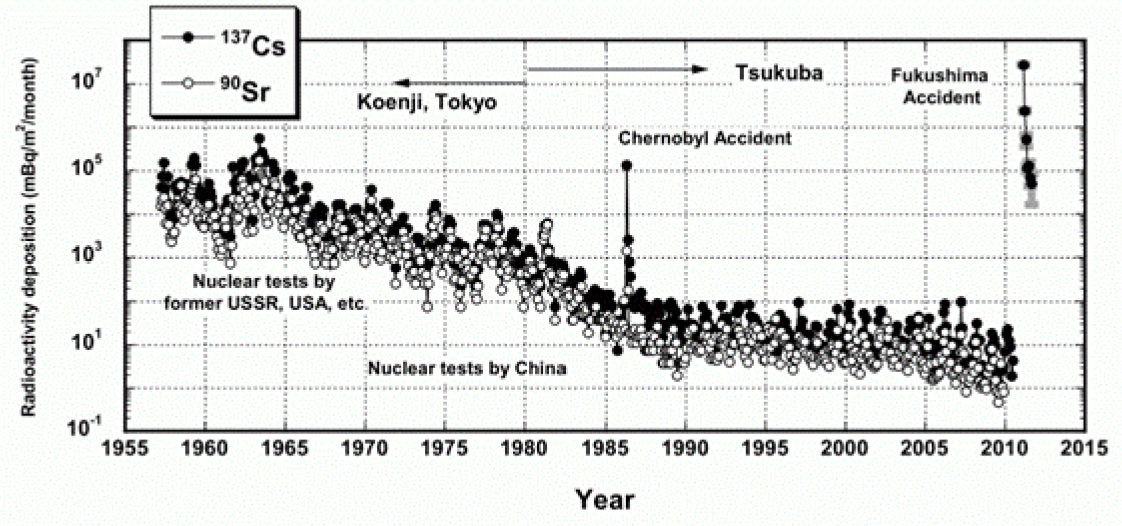
199. CTBTO website, www.ctbto.org.

200. “Hoshasei busshitu hoshutsu, Cherunobuiri 1~2-wari no shisan” [Radioactive material released is estimated to be 10~20% of Chernobyl], *Yomiuri Shimbun*, March 28, 2011.

201. NISA, Nuclear Safety Public Relations and Training Division, “Tokyo Denryoku Kabushiki Kaisha Fukushima Daiichi Genshiryoku Hatsudensho oyobi Hiroshima toka sareta genshi bakudan kara hoshutsu sareta hoshasei busshitsu ni kansuru shisanchi ni tsuite” [On estimates of the radioactive materials released from Fukushima Daiichi Nuclear Power Plant and the atomic bomb dropped on Hiroshima], August 26, 2011, http://www.meti.go.jp/press/2011/08/20110826010/20110826010.html.

202. “Fukushima Daiichi hoshutsu seshiumu 137—Hiroshima genbaku 168-ko-bun” [Cesium-137 released from Fukushima Daiichi equals 168 Hiroshima atomic bombs], *Tokyo Shimbun*, August 25, 2011, http://www.tokyo-np.co.jp/s/article/2011082590070800.html.

Figure A-5. Discharge of cesium and strontium as a result of nuclear tests and of the Fukushima Daiichi Nuclear Power Plant accident



Source: Meteorological Research Institute, "Kankyo ni okeru jinko hoshano no kenkyu 2011 ni tsuite" [On artificial radionuclides in the environment 2011], December 2011, http://www.mri-jma.go.jp/Dep/ge/2011Artifi_Radio_report/index.html.

In terms of the area of contaminated soil, although it depends on the level of contamination, if you look for example at approximately 600 kBq/m^2, the area in the case of Chernobyl was more than 250 times as vast as in the Fukushima case.[203,204]

203. Fumiaki Takahashi, Genshiryoku Gakkai, Clean-Up Subcommittee, "Cherunobuiri hatsudensho jiko ni yoru kankyo shufuku" [Environmental restoration after the Chernobyl nuclear accident].

204. Even though the area of contamination may be smaller than was the case at Chernobyl, that does not mean that the issues created by the accident were also smaller. Both accidents were level 7 events on the INES scale, and it is impossible to make a simple comparison between Chernobyl, which was a runaway nuclear reaction and therefore by nature had a broader area of contamination, and Fukushima, which entailed a loss of core coolant. Also, while the area contaminated with more than 3 million Bq/m^2 of ^{134}Cs and ^{137}Cs spread up to 30 km to the northwest of the plant, reaching as far as the southern portion of Iidatemura, that 3 million Bq/m^2 value is a higher level of contamination than found in the area that was evacuated following the Chernobyl accident. Hisako Sakiyama, "Hoshasei seshiumu osen to kodomono hibaku" [Radioactive cesium contamination and radiation exposure of children], *Kagaku* 81, no. 7 (2011): 695.

Appendix 4: About the project members

Nobumasa AKIYAMA Project Team Chair; Professor, Graduate School of Law, Hitotsubashi University

Dr. AKIYAMA is a professor at the Graduate School of International and Public Policy at Hitotsubashi University and an adjunct research fellow of the Japan Institute of International Affairs (JIIA). Prior to joining Hitotsubashi, he was an assistant professor at the Hiroshima Peace Institute, Hiroshima City University, and a senior research fellow at the Center for the Promotion of Disarmament and Non-Proliferation, JIIA. He was an advisor to the foreign minister on nuclear disarmament and nonproliferation in 2010, serving as a member of Japanese delegation to NPT Review Conferences and their preparatory committees. He holds degrees from Hitotsubashi University and from Cornell University and has written extensively on nuclear nonproliferation, nuclear deterrence, and disarmament in Japanese and English.

Heigo SATO Professor, Institute of World Studies, Takushoku University

Dr. SATO has been a professor at the Institute for World Studies (IWS), Takushoku University, since April 2006. He was a senior research fellow at the National Institute for Defense Studies (NIDS) before moving to IWS. He joined NIDS in 1993 as research fellow. He served as a special advisor to Foreign Minister Katsuya Okada on disarmament and nonproliferation. His many publications include “Strategic Surprise and National Security,” *Kaigai Jijo* (2011) and “The Export Control Reform Initiative of the Obama Administration,” *Kaigai Jijo* (2010), “Reducing the Role of Nuclear Weapons, A Theoretical Essay,” *Kaigai Jijo* (2010). He earned his doctoral degree in international relations from Hitotsubashi University. He received an MA in area studies (United States) from University of Tsukuba and in political science from George Washington University (Fulbright Scholarship). He research interests include international relations, American politics & diplomacy, security studies (traditional and nontraditional), arms control, and nonproliferation.

Kaoru NAITO President, Nuclear Material Control Center

Mr. NAITO is a graduate of University of Tokyo with a Master's degree in nuclear engineering in March 1971. He also obtained a Master of Public Systems Engineering degree from University of Michigan (USA) in May 1976. He joined the Japanese government’s Science and Technology Agency (STA, now merged into MEXT) in April 1971 and worked mainly in the area of nuclear safety, safeguards, and nuclear security regulations. He was a deputy-director general when he left the government in January 2001, after almost 30 years of service. He also served at the IAEA twice, for seven years in total. In addition, he served as a special assistant to the minister of MEXT until March 31, 2010. He has been the vice-president of the Institute of Nuclear Material Management Japan Chapter since 2004. He now chairs the Special Committee on Nuclear Security, Japan Atomic Energy Commission. He holds the current office of president of the Nuclear Materials Control Center since April 2003.

Yosuke NAOI Deputy Director, Integrated Support Center for Nuclear Nonproliferation and Nuclear Security, Japan Atomic Energy Agency (JAEA)

Mr. NAOI is deputy director of the Integrated Support Center for Nuclear Nonproliferation and Nuclear Security, which was established in December 2010 in the JAEA, based on the Japanese statement at the Nuclear Security Summit of April 2010. He was involved in the heavy water reactor development project for a total of 20 years, since 1983. From 1998 to 2000, he was on loan to MOFA as a technical adviser for the KEDO (Korean Peninsula Energy Development Organization) project. He was assigned to research the mechanism of fuel supply assurance based on a contract with the Cabinet Assistance Office of the Japanese government for three years, starting in 2005. From 2010, he was engaged in preparations for the establishment of the Integrated Support Center.

Tadahiro KATSUTA Associate Professor, School of Law, Meiji University

Dr. KATSUTA has a PhD in plasma physics from Hiroshima University (1997). He is currently an associate professor at Meiji University. In 2008–2009, he conducted research on multilateral nuclear fuel cycle systems as a visiting researcher at Princeton University. In 2006–2008, he carried out research at the University of Tokyo on the separated plutonium management problem in Japan caused by the Rokkasho reprocessing plant operation. After the Fukushima Daiichi accident, he was appointed as a member of the NISA review committee conducting a comprehensive assessment of various technical aspects of the accident, including severe accident preparedness and the nuclear fuel cycle. His work focuses on nuclear power engineering, atomic energy policies, and the issue of peaceful use and military use of nuclear atomic energy.

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The Saskawa Peace Foundation

The Nippon Foundation Bldg., 4th Fl., 1-2-2, Akasaka, Minato-ku, Tokyo, 107-8523, Japan

Tel: +81-3-6229-5400 Fax: +81-3-6229-5470

URL: http://www.spf.org/ Email: japan-us@spf.or.jp (Japan-US Exchange Program)

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