Trustworthiness of

Nuclear Energy Questioned:

10 years after the Fukushima Daiichi nuclear accident

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Foreword

This is the final report of the Study of Lessons Learned from Fukushima Daiichi Nuclear Disaster, one of the projects undertaken by the International Peace and Security Department of the Sasakawa Peace Foundation (SPF) in FY2020.

The March 11, 2011, the accident of the Tokyo Electric Power Company's (TEPCO's) Fukushima Daiichi Nuclear Power Station (hereinafter "Fukushima Daiichi nuclear accident") put an end to the myth of nuclear safety. The Japanese government and Diet (parliament) set up bodies to investigate the accident, and so did international organizations, such as the Organisation for Economic Co-operation and Development (OECD) and the International Atomic Energy Agency (IAEA), which have sent a series of fact-finding missions to Japan. These bodies have put forward recommendations on nuclear power plant safety measures and crisis management in the event of an accident. The Fukushima Daiichi nuclear accident also had a profound impact on energy policies in the world, prompting not a few countries to make a policy shift toward phasing out nuclear power. At the same time, however, some other countries—those seeking to continue to use nuclear energy to combat global warming—are looking to international cooperation in addressing challenges inherent in the use of nuclear energy, such as securing the safety of nuclear facilities and finding a solution to the permanent disposal of spent nuclear fuel.

Against the backdrop of these developments, we at the International Peace and Security Department embarked on this project to recapture the lessons learned from the Fukushima Daiichi nuclear accident—including issues not sufficiently covered in reports produced by various investigative bodies mentioned above—and examine how we should proceed with the civilian use of nuclear energy, taking the opportunity of the 10th anniversary of the incident in March 2021.

Specifically, the theme of this report is the loss of legitimacy of the civilian use of nuclear energy in the wake of the Fukushima Daiichi nuclear accident and the loss of public trust in the government and utilities that have been promoting nuclear energy. We conducted research and surveys both in Japan and abroad—including interviews, visits to nuclear facilities, and information collection at relevant international conferences—and identified lessons from the accident and challenges faced in the ongoing decommissioning work at the Fukushima Daiichi NPS to examine the following three perspectives:

- Public trust in the safety of nuclear energy: Risk communication by the Nuclear Regulation Authority (NRA)
- Public trust in regional development programs: Governance of the decommissioning process
- Attempt for democratic control over nuclear energy: Legislative oversight over nuclear administration

In this project, we set up the Study Group on the Fukushima Daiichi Nuclear Accident, a team of four experts on nuclear energy and nuclear non-proliferation as listed below, which has held three rounds of discussions either online or offline to review the research and survey methodologies employed in the project and the content of the resulting report. Also, in carrying out this project, we have received generous cooperation and advice from the nuclear authorities, utilities, and research institutions in Japan, the United States, France, and many other countries using nuclear as a source of energy. We believe that they were all driven by the desire not to waste the lessons of the deadly Great East Japan Earthquake and the Fukushima Daiichi nuclear accident, which together caused extensive damage and casualties. Taking this opportunity, I would like to express my deepest gratitude for their generous support and cooperation, and to offer my sincere condolences and sympathy to the quake victims and those survivors who even today, 10 years after the quake and nuclear disaster, continue to struggle with various difficulties.

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Note: Although this research was carried out as one of the self-directed projects of the SPF's International Peace and Security Department, neither the study group nor the SPF takes any specific stand on the civilian use of nuclear energy. Also, it should be noted that this report does not represent the opinion of any expert who cooperated in carrying out this project.

List of Acronyms and Abbreviations

ALPS	Advanced Liquid Processing System
ANDRA	*Agence nationale pour la gestion des déchets radioactifs* (French national radioactive waste management agency) in France
ASN	*Autorité de Sûreté Nucléaire* (Nuclear Safety Authority) in France
BWR	boiling water reactor
COP3	Third Conference of the Parties to the UN Framework Convention on Climate Change
GE	General Electric
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
INPO	Institute of Nuclear Power Operations
IRRS	Integrated Regulatory Review Service
kPa	Kilopascal
LNG	liquefied natural gas
mSv	millisievert
NRC	Nuclear Regulatory Commission in the United States
OECD	Organisation for Economic Co-operation and Development
OPECST	*Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques* (Parliamentary Office for the Evaluation of Scientific and Technological Choices) in France
PWR	pressurized water reactor
TMI	Three Mile Island Nuclear Generating Station
UPZ	urgent protective action planning zone
WH	Westinghouse Electric Company LLC
WHO	World Health Organization

Introductory Chapter: Purpose of This Report

The accident at the Fukushima Daiichi Nuclear Power Station (NPS)[1] on March 11, 2011, was a compound disaster, in which natural disasters, namely an enormous earthquake and tsunami, and a nuclear reactor crisis occurred in quick succession.

The electric power supply from outside was lost as utility poles were toppled and power lines were damaged by the earthquake. In addition, most of the emergency power supply systems installed in the basement of reactor buildings were submerged in seawater and became disabled when the tsunami hit. As a result, it became impossible to supply water to the reactors to keep them cool, nuclear fuel melted down from its own heat. A large amount of hydrogen gas was generated in the process. The hydrogen gas leaked out of the containers, filled the reactor buildings and the spent fuel pools adjacent to reactors, and exploded.[2] This severe accident was far beyond the ability of Tokyo Electric Power Company (TEPCO), the operator of the Fukushima Daiichi NPS, and had to be dealt with by mobilizing national efforts and seeking cooperation from other countries including the United States and France. Although Japan managed to stave off a massive release of radioactive substances that would have made the Tokyo metropolitan area inhabitable, the incident made people across the world clearly recognize the fact that a nuclear power plant brings about a serious situation when it goes out of control.

Taking the opportunity of the 10th anniversary of the Fukushima Daiichi nuclear accident, this chapter reflects on the lessons thereof in preparation for exploring how we can make good use of the lessons.

(1) Lessons of the Fukushima Daiichi nuclear accident

1) Concept of resilience

Prior to the Fukushima Daiichi nuclear accident, neither the utilities operating nuclear power plants nor the regulatory body responsible for safety inspections of nuclear power plants had assumed the possibility of a total loss of power supply or a reactor cooling system failure lasting for many hours. The concept of defense in depth (IAEA, 1996), which is to ensure preparedness for an emergency, had not been practiced properly, and hence, the emergency response in the wake of the occurrence of the unexpected was total chaos.

That is, neither the on-site emergency response organization, i.e., the Fukushima Daiichi NPS where the accident occurred, nor any of the off-site emergency response organizations, including the central and local governments as well as the head office of TEPCO, was not properly prepared in terms of both preventing accidents and mitigating the consequences in the event of an accident. Thus, taking a lesson from this accident, experts began to advocate the concept of resilience.[3]

The term "resilience" was originally used in the field of psychology and medicine, meaning the

1 See Appendix 2 at the end of this report for a general description of the Fukushima Daiichi NPS.

2 See Appendix 3 at the end of this report for the detailed progression of the Fukushima Daiichi nuclear accident.

3 Ahn, J., Carson, C., Jensen, M., Juraku, K., Nagasaki, S., Tanaka, S., 2014. Reflections on the Fukushima Daiichi Nuclear Accident: Toward Social-Scientific Literacy and Engineering Resilience, Springer Open, pp.435-454

ability of individuals to restore and recover from a severe mental shock such as trauma. In the field of safety engineering, resilience is a concept encompassing not only the emergency response and subsequent recovery in the event of an accident but also the learning of lessons from past accidents to prevent accidents and mitigate the consequences of accidents in the future, and the term is defined as system safety improvement composed of four elements: prevention, anticipation, response, and learning (Hollnagel, 2006). Based on this definition, Japan's nuclear safety regulation prior to the Fukushima Daiichi nuclear accident was inadequate as various investigative bodies noted in their respective reports, failing to satisfy the four elements of resilience.

Efforts and preparations on the part of companies and individuals concerned are not enough in responding to unexpected events and emergencies. Response cannot be successful unless the government takes the lead and provide a basic policy, by incorporating the concept of resilience, to guide the efforts of all parties involved in the emergency response. The government needs to explicitly define a mechanism by which to prevent the occurrence of severe accidents and a system that can mitigate the damage in the event of an accident by bringing the accident under control before it evolves into a severe accident. That is one of the prerequisites for restoring public trust in nuclear energy.

2) Relationship between society and scientific technology

The lessons of the Fukushima Daiichi nuclear accident go beyond just improving resilience for proper system safety management.

Today's social and economic activities are supported by various scientific and technological systems. At the same time, however, science and technology have an inherent risk of causing an adverse event. Furthermore, when multiple risks are involved, they may set off a chain reaction, leading to an adverse event of a far greater magnitude. Risk is a concept that refers to the degree of uncertainty regarding the occurrence of undesirable events and the severity of their consequences.[4] Thus, when deciding on the introduction of a certain scientific technology to society, there needs to be an adjustment mechanism in which the utility seeking to introduce the technology, the government having the authority to give approval for the technology, and representatives of the general public who would be the user of the technology exchange opinions on what precautions should be taken to properly manage risks so as to maximize the benefits and minimize the potential risks of the technology. Only after going through this adjustment process, would the use of the technology be justified in society.[5]

Regarding the civilian use of nuclear energy in Japan, it was after the oil crisis in the 1970s that Japan entered the stage of nuclear power development, embarking on the construction of a series of nuclear reactors. The expectation that nuclear power plants would support the economic growth of Japan, a country scarce in natural resources, by serving as a stable power supply system was justified, leading to an expansion in the use of nuclear energy. After 2000, nuclear energy was given another definition as a critical tool to prevent global warming. Meanwhile, among the various risks inherent

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4 Tomio Kinoshita, 2016, *Risuku Komyunikeshon no Shiso to Gijutsu: Kyoko to Shinrai no Giho [Philosophy and Technology of Risk Communication: Techniques for co-thinking and trust]*, p.7, Nakanishiya Shuppan.

5 Euratom, "The TRUSTNET Framework: A New Perspective on Risk Governance," EUR 19136 EN, European Commission, 2000

in nuclear energy, the risk of the occurrence of a severe accident, such as one resulting in a massive leakage of radioactive substances, had been underestimated. Besides, communication among experts from different disciplines—geologists, safety engineering researchers, nuclear engineers, etc.—was not sufficient regarding the risks natural disasters pose to the safety of nuclear power plants, despite Japan being one of the most quake-prone countries in the world.

Experts tend to focus solely on risks in their respective areas of expertise and hence they are apt to lack sufficient awareness of how risks in other areas may affect those in their areas of expertise. This insufficiency of communication is often attributed to differences in the framework for thinking across different areas of expertise.[6]

The Fukushima Daiichi nuclear accident revealed shortcomings in various aspects, i.e., inadequate assessment of technology risks associated with the use of nuclear energy and the risks they pose to society and the environment, a lack of sufficient cross-disciplinary communication on risk management, and an absence of an efficient social mechanism for adjustments.

One of the lessons of the Fukushima Daiichi nuclear accident is the need to recognize that people have different ways of perceiving problems depending on where they stand and, based on that recognition, create a mechanism in which all parties concerned share the same framework of risks that need to be addressed and communicate actively on how they should address these risks.

3) Risk communication: Co-thinking and trust

Risk communication is one mechanism that has evolved from an attempt to overcome differences in the framework for thinking and gaps in risk information among parties concerned.

The concept of risk communication was developed in the United States in the 1970s through the 1980s. Back then in the United States, consumers were reaping the benefits of advancement in science and technology. At the same time, however, they became aware that new uncertainty and risks associated with the advancement of science and technology, as demonstrated by the Three Mile Island (TMI) accident in 1979, could jeopardize their livelihoods. This prompted the widespread adoption of risk management—a conceptual framework on how to identify risks that affect people's livelihoods and how to mitigate such risks, for instance, by implementing regulations—in industry as well as in public administration. And as a prerequisite for that, it was necessary to equip business operators and public administrators with communication techniques to accurately inform people of potential risks and win their understanding, and such communication came to be referred to as "risk communication."[7]

However, in the early stage of its introduction in the United States and elsewhere, risk communication was primarily about how professionals, i.e., government officials and private-sector experts, should communicate to and persuade non-professionals, i.e., ordinary people, about risks and methods to be employed to address them as perceived by the professionals, and how to contain opposition. In other words, it was

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6 Hideaki Shiroyama, 2015, *Daishinsai ni Manabu Shakai Kagaku vol. 3: Fukushima Genpatsu Jiko to Fukugo Risuku Gabanansu [Social Science Learned from the Great East Japan Earthquake vol. 3: Fukushima nuclear accident and complex risk governance]*, p.8, *Toyo Keizai Inc.*

7 Kinoshita, T., 2016, *Risuku Komyunikeshon no Shiso to Gijutsu: Kyoko to Shinrai no Giho [Philosophy and Technology of Risk Communication: Techniques for co-thinking and trust]*, p.23

defined as a technique used by professionals to enlighten passive people, those without information and knowledge. From 2000 onward, the concept of risk communication has changed with the emergence of new concepts, such as the right to live in peace and environmental rights as fundamental human rights, and as more information has become available. Using the term "*kyoko*," a coined Japanese word that literally translates as "co-thinking," Tomio Kinoshita attempted to define risk communication as "philosophy and technology for exploring a path leading to a solution by disclosing as much information as possible on the risk posed by the object concerned to the individuals concerned and thereby co-thinking with them."[8] It is a process to eliminate information gaps among people involved in or affected by risks through information sharing, not through one-way communication from a company or a government agency, and to search for a solution through co-thinking. As mentioned above, even those who are called "scientists" or "specialists" are non-specialists and cannot fully absorb information and knowledge when it comes to things outside their respective areas of expertise. Thus, the concept of co-thinking, which is to eliminate information gaps, is important as a tool for cross-disciplinary communication.

This change in the definition of risk communication, i.e., from one-way communication from professionals to co-thinking, means that communication on whether certain risks should be accepted or not by society takes place in three stages. The first stage is risk assessment. Here it is necessary to define in law how and under whose responsibility the risk assessment must be performed. The second stage is to identify, based on the results of the assessment, whether the risks are manageable, and if they are, who should manage them and how. Lastly, in the third stage, information on the risks is disclosed to the members of society to determine, through a society-wide consultation, whether the risks are acceptable or not. According to the U.S. National Research Council, given the definition of risk communication as an interactive process of the exchange of information and opinions among individuals, groups, and institutions, an enhanced level of understanding and trust among stakeholders is proof of successful communication.[9]

Trust, which is defined as proof of successful communication, is indispensable to the effective operation of institutions and society at large, and it is widely recognized by experts of various disciplines—ranging from psychologists to economists and political scientists—that trust plays a critical role in social relationships including political and economic activities.[10]

In considering the relationship between society and scientific technology, we need to understand the two types of trust.[11]

One trust is expectations about the competence of others. In the context of the use of nuclear energy, people are more confident when they determine that the government and operators have the competence to ensure the safe operation of nuclear power plants and the proper management of risks involved. The other trust is expectations about the intent of others. In the context of the use of nuclear energy, people's trust deepens when utilities and the government have the intent to serve for the development of social

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8 *Id.* p.27

9 *Id.* p.25

10 Toshio Yamagishi and Hisashi Komiyama, "*Shinrai no Imi to Kozo: Shinrai to Komittomento Kankei ni kansuru Rironteki/Jisshoteki Kenkyu* [Significance and the Structure of Trust: Theoretical and Empirical Research on Trust and Commitment Relations]," *INSS Journal 2 1995*, p.1

11 *Id.* p.4

and economic activities, such as ensuring the stable supply of electricity, and spare no effort to share information on risks that need to be addressed. On the other hand, even when they have the competence to operate nuclear power safely, people's confidence cannot be gained if utilities and politicians are suspected of pursuing personal interests and withholding information inconvenient to them.

(2) About this report

1) Fukushima Daiichi nuclear accident through the lens of risks and trust

Considering how, in the wake of the Fukushima Daiichi nuclear accident, public trust in the use of nuclear energy fell apart in Japan, which had seemingly secured both types of trust, we have no choice but to conclude that prior to the Fukushima disaster, communication concerning the use of nuclear energy had been utterly insufficient. This fact indicates that the mutual "trust" among the government, utilities, and the general public that existed prior to the accident was not trust as defined above but had been built on the myth of nuclear safety, i.e., the belief—without scientific evidence—that Japanese nuclear power plants are free from severe accidents.

Prior to the Fukushima Daiichi nuclear accident, Japanese utilities had been in frequent communication with host community residents. However, in what was meant to be a forum for dialogue, utilities typically kept on emphasizing the safety of nuclear energy. Regarding the fact that discussions on risks had been suppressed by the myth of nuclear safety, the Nuclear Safety Reform Plan (2013), compiled by TEPCO following the Fukushima Daiichi nuclear accident, notes that the company was unable to disclose risk information because of the preconceived belief that the revelation of newly identified risks would invite demands from host communities and the regulatory body for excessive measures and could make it inevitable to shut down reactors for an extended period of time.

Today, 10 years since the Fukushima Daiichi nuclear accident, utilities and the government are still not seen in Japanese society as having the competence to ensure the safety of nuclear power plant operations by implementing proper risk management. They have neither won public trust in their intent to continue to use nuclear energy as means to tackle global warming and secure the stable supply of electricity. A new regulatory agency was established and new safety standards introduced after the accident, but these developments have not yet led to the recovery of trust.

When we look at the world, we see that a total of 437 nuclear reactors were in operation as of January 1, 2020, with 59 under construction in China, Russia, and elsewhere, and 82 more planned. It has been emphasized that nuclear power plants have a series of advantages such as producing an enormous amount of electricity from a small amount of uranium fuel, having low carbon dioxide emissions, and contributing to the slowing of global warming. However, the capacity of nuclear power plants in operation worldwide, which had been on the rise since 2013, dropped to 411,924 MW in 2020, as the Fukushima disaster prompted some countries to shift away from nuclear, in particular, with Germany seeking to entirely phase out nuclear by 2022.[12] As such, the Fukushima Daiichi

12 Japan Atomic Industrial Forum, Inc., "*Sekai no Genshiryoku Hatsuden Kaihatsu no Doko 2020-nenban wo kanko* [World Nuclear Power Development Trend 2020 to Be Released]," *JAIF Press Release*, June 25, 2020 (https://www.jaif.or.jp/cms_admin/wp-content/uploads/2020/06/doukou2020-press_release.pdf)

nuclear accident presented a serious problem not only to Japan but to the international community.

Taking the opportunity of the 10th anniversary of the Fukushima Daiichi nuclear accident, this report attempts to answer the question of how we should grapple with the civilian use of nuclear based on the discussions to date on the lessons learned from the accident as well as on the current state of the decommissioning work underway at the Fukushima Daiichi NPS, the site of the accident, focusing on the loss of trust in nuclear energy as an underpinning theme.

2) How this report is structured

In Chapter 1, we will examine how the Nuclear Regulation Authority (NRA) implements risk communication. The NRA was established as a new regulatory authority in the wake of the Fukushima Daiichi nuclear accident. While it formulated new nuclear safety standards and is trying to change the way it communicates with electric power companies and residents, we will consider the current situation in which the public has not necessarily trusted the ability of the government and operators to safely drive nuclear power generation and their intention to continue using nuclear power generation. We will analyze the process of establishment of new safety standards after the Fukushima Daiichi nuclear accident and the interaction between the regulatory authority and electric power companies, and compare safety regulations in Japan with them in France, which have the highest ratio of nuclear power supply in the world. In addition, the formulation of a regional disaster prevention plan that is deeply related to confidence for nuclear power generation among local residents where nuclear power plants are located will be examined by comparing the differences between regulatory authorities in Japan and in the U.S.A, which have the largest number of nuclear reactors operating in the world.

Chapter 2 is entitled "Governance of the Decommissioning Process." In proceeding with the decommissioning work at the Fukushima Daiichi NPS, it is essential for TEPCO and the government to communicate to affected residents on the risks involved, including those associated with the permanent disposal of the contaminated water that resulted from the accident and responses thereto as well as with the removal of melted nuclear fuel (debris). However, people's distrust in TEPCO and the government is so deep and the gulf of disagreement between the two—i.e., affected residents on one side and TEPCO and the government on the other—are so wide that it is almost impossible to have any meaningful communication. Against this backdrop, we will examine what is happening at the site of the decommissioning work and whether there is any path leading to a solution.

In Chapter 3, which is entitled "Legislative Oversight over Nuclear Administration," we will explore how the Diet (Japanese parliament) should supervise nuclear administration and government policy for the use of nuclear energy by drawing on examples from other countries, in a bid to set the stage for all people from all walks of life to think about the use of nuclear energy, instead of regarding it as a problem confined to those living in the areas hosting or located near nuclear power plants. Examples from other countries are the cases of the USA, France and Finland, which is the first in the world to construct a final disposal site to landfill spent nuclear fuel in strata.

Chapter 1: Risk Communication by the NRA

This chapter examines how the NRA, a new regulatory body, implements safety regulations for nuclear power plants that have been revised to reflect the lessons learned from the Fukushima Daiichi nuclear accident, and how the NRA is seeking to build communication and relationships with utilities and host community residents. Whether the NRA can establish good communication with other stakeholders is the crucial question that determines the success or failure of efforts to restore people's trust in the safety of nuclear energy.

The Fukushima Daiichi nuclear accident revealed the ill-preparedness for the risk of severe accidents on the part of the operator and a lack of supervisory competence on the part of the regulatory body that had been unable to point out the flaw. This led to the reform of government agencies, and hence to the establishment of the NRA in September 2012. And then, in 2013, a new set of safety regulations, which take into account the need to respond to unexpected events, were introduced.[13] In a bid to cast off the regulatory administration system of the pre-Fukushima era, the NRA has pledged to safeguard the independence and transparency of nuclear administration, making the records of its communication with utilities accessible to the public.

However, even after 10 years since the accident, people still remain skeptical of the capability of the NRA and utilities to address risks, taking a harsh view of their efforts to enhance the safety of nuclear power plants.

The Japan Atomic Energy Relations Organization's (JAERO's) latest public opinion survey on nuclear energy (2020),[14] a cross-sectional survey that has been conducted annually since 2006, found that 29.7% of respondents responded negatively to the question asking whether they think it is possible to secure the safety of nuclear power plants in the future, while 21.3% responded positively. Meanwhile, asked whether they think emergency response plans to protect communities surrounding nuclear power plants are properly in place, negative responses accounted for 32.8%, compared to only 10.7% who responded positively.

The establishment of the NRA and the introduction of a new set of safety regulations for nuclear power plants have not led to the restoration of public trust in the safety of nuclear energy. Why is that?

(1) Establishment of a new regulatory body and changes in the way of communicating with utilities

A series of reports compiled by various accident investigation bodies harshly criticized the nuclear safety measures and policies that had been put in place by the Tokyo Electric Power Company (TEPCO) and the regulatory body prior to the Fukushima Daiichi nuclear accident and proposed measures to rectify the situation.

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13 See Appendix 4 at the end of this report for changes in the administrative system for nuclear safety regulation before and after the Fukushima Daiichi nuclear accident.

14 According to the JAERO, the 2020 public opinion survey on nuclear energy was conducted from October 2 through October 14, 2020 over 1,200 people (592 males and 608 females) across Japan, aged 15 to 79.

The final report of the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations (ICANPS)[15], an accident investigation body established by a decision of the Cabinet of then-Prime Minister Naoto Kan, which dealt with the accident, pointed to the urgent need to reform the nuclear regulatory administration, noting that preparedness for severe accidents was insufficient because of:

1) Limitation of measures implemented by utilities; and

2) Lack of capability on the part of the regulatory body.[16]

Meanwhile, the final report of the Fukushima Nuclear Accident Independent Investigation Commission (NAIIC)[17], an investigative body established by the Diet, compared the safety regulations that had been in place in Japan prior to the accident with those implemented in other countries, and based on the findings thereof, called for requiring a new regulatory body to satisfy the following five criteria[18]:

1) Complete independence: Maintain independence from the utilities and government agency promoting the use of nuclear energy
2) Transparency: Disclose the decision-making process and report to the Diet on the process in which decisions are made and the decision-makers involved.
3) Professional competence and commitment to duties: Develop and train professionals specialized in the areas to be regulated and apply the "no-return rule."
4) Unified control: Establish a unified control system for nuclear regulation to enable quick information sharing and decision-making in emergency.
5) Capability for self-improvement: Work constantly to review and make necessary changes to the existing regulations and organizational arrangements by incorporating the latest knowledge and expertise.

The NAIIC's final report is the only one that proposed specific criteria that should be satisfied by a then-planned new nuclear regulatory body. Thus, in this section, we examine whether the lessons of the Fukushima Daiichi nuclear accident have been reflected in the new safety regulations with the establishment of the NRA, using the above criteria as reference.

However, it is not easy to verify whether the NRA satisfies the above criteria because the definitions of the terms "independence" and "transparency" lack clarity. So, we first examine whether the independence of the NRA is ensured by law as compared to its counterparts of the USA and France, and then, analyze how the communication between the regulatory body and utilities changed before and after the Fukushima Daiichi nuclear accident, using some specific examples.

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15 The official name of the committee is the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of the Tokyo Electric Power Company (ICANPS). It was established on May 24, 2011 by a Cabinet decision.

16 The final report of the ICANPS, July 2012, pp.397-405

17 The Fukushima Nuclear Accident Independent Investigation Commissions (NAIIC) was established by the Diet, the legislature of Japan, on December 8, 2011 to conduct an investigation into the accident from an independent standpoint, separately from the one carried out by the Cabinet.

18 The final report of the NAIIC, 2012, pp.21-22

1) Establishment and independence of the NRA

One cannot conclude that the NRA has its independence and transparency secured and can fully demonstrate its capability to manage risks posed by nuclear facilities and their operators, solely based on the fact that the nuclear regulatory body is separated from the Ministry of Economy, Trade and Industry (METI), a government agency promoting the civilian use of nuclear energy.[19] First, we need to understand the NRA's status under law and examine how its independence and transparency, as defined and secured by law, differ from those of its counterparts in these countries.

The NRA is an administrative organ popularly referred to as an "Article 3 commission."

Established under Article 3 of the National Government Organization Act, an Article 3 commission is authorized to determine and announce the national will and the authority to give permission rests with the head of each commission. More specifically, an Article 3 commission has the authority to make a ruling or conduct mediation in disputes and to regulate private-sector organizations. Examples of Article 3 commissions include the Japan Fair Trade Commission (JFTC), an antimonopoly watchdog overseeing business practices to ensure fair and free competition in the market, and the National Public Safety Commission (NPSC), which is responsible for implementing democratic control over police and security duties.[20] In performing their duties, these commissions must be free from the influence of a shift in political speculation resulting from a change of government or pressure from specific government agency and the NRA has been given a status defined as such by law. It is without question that the regulatory body's independence from politics and the government agency promoting nuclear energy has been enhanced compared to prior to the Fukushima Daiichi nuclear accident when the Nuclear and Industrial Safety Agency (NISA), the nuclear safety regulator at the time, was an extraordinary organ of the Agency for Natural Resources and Energy (ANRE).

However, when compared to its counterparts overseas in the scope of authority and status under law, it is highly debatable whether the NRA is sufficiently independent.

In France, which moved ahead of Japan to separate the regulatory function from the government agency promoting the use of nuclear energy, the Nuclear Safety Authority (ASN: *Autorité de Sûreté Nucléaire*), an independent administrative body established in 2006, defines its independence as:

- Independence from politics and other government agencies; and
- Authority over budget, personnel matters, and approval resting on the head of the regulatory body.[21]

Concerning budgetary matters, the French ASN is subject to review by the legislature, not the cabinet, and the same holds true for the U.S. Nuclear Regulatory Commission (NRC). This means that once an overall budget request is approved by the legislature, it is left for the head of the regulatory body to decide the allocation and execution of the budget. As for personnel matters, the head of the regulatory body has the authority to decide the distribution of personnel for the secretariat

19 For the changes in the nuclear safety regulation system implemented after the Fukushima Daiichi nuclear accident, see Appendix 4 at the end of this report.

20 Explanatory material prepared by the Ministry of Health, Labour and Welfare (MHLW) of Japan, (https://www.mhlw.go.jp/stf/shingi/2r98520000034j5w-att/2r98520000034j8m.pdf), accessed on February 24, 2020.

21 ASN follow-up seminar held on November 22, 2017, in Paris.

and local branches. And it goes without saying that the regulatory body is free from intervention from the president or any other government agencies in its decision-making over whether to give permission, for instance, for the installation and operation of nuclear facilities.

The NRA does not satisfy the criteria provided above because it is subject to control by the Ministry of the Environment, which holds jurisdiction over the Secretariat to the Nuclear Regulation Authority (NRA Secretariat), and the Minister of the Environment regarding budget and the appointment of personnel for the NRA Secretariat. Also, there are certain circumstances unique to Japan that the NRA faces in securing its independence from other government agencies.

In launching the NRA, the so-called "no-return rule" was introduced to prohibit, in principle, the exchange of personnel between the regulatory body (i.e., the NRA and the NRA Secretariat) and other government agencies or divisions promoting the civilian use of nuclear energy. However, the initial staff for the NRA had to be mobilized from various government agencies, selecting personnel with expertise on nuclear energy. And for this reason, the Act for Establishment of the Nuclear Regulation Authority included an exception clause, i.e., Article 6 of the Supplementary Provisions, which provides that the no-return rule "shall not apply in cases within five years after the enforcement of this Act where unavoidable grounds are found," thereby creating a loophole for those assigned to the NRA Secretariat to return to government agencies they originate from, including those promoting the use of nuclear energy.

The fact that the law provided for an exception to the application of the no-return rule, albeit limited to the initial five years, cannot be ignored in considering the independence of the NRA, particularly because the U.S. NRC emphasizes the need to have *technical independence*, i.e., non-reliance on others in making technical judgments on the safety of nuclear energy, in addition to the ASN-defined criteria for independence above.[22]

In countries using nuclear energy for civilian purposes, private-sector organizations formed by utilities and nuclear reactor builders, such as the Institute of Nuclear Power Operations (INPO) in the United States, are engaging in voluntary safety enhancement initiatives, setting their own standards for nuclear safety. The regulatory body must have the technical capability to respond to matters pointed out by such private-sector organizations and various requests made through government agencies promoting the use of nuclear energy. Otherwise, whatever safety regulations implemented by the regulatory body may be rendered toothless.

Indeed, in Japan, there has been a case in which it appears that such safety regulations were made ineffectual.

Prior to the Fukushima Daiichi nuclear accident, the Japan Nuclear Energy Safety Organization (JNES), a now-defunct NISA-affiliated incorporated administrative agency (integrated into the NRA Secretariat in March 2014), supported inspecting the safety of nuclear power plants conducted by the NISA. However, it was revealed six months after the accident that the JNES had been conducting inspections using an inspection checklist almost identical to the one prepared by utilities beforehand

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22 Tatsujiro Suzuki, Hideaki Shiroyama, and Setsuo Takei, "*Anzen Kisei ni okeru 'Dokuritsusei' to Shakaiteki Shinrai: Beikoku Genshiryoku Kisei Iinkai o Sozai toshite* [Independence and Social Trust in Safety Regulation: The case of the Nuclear Regulatory Commission and its implication]," *Shakai Gijutsu Kenkyu Ronbunshu* [Collection of Research Papers on Social Technology], vol. 4, December 2006, pp.163-164.

upon instruction by the JNES. Many employees at the JNES were former employees of utilities or nuclear reactor builders, from which we can surmise how, through such a network of personal contact, items for inclusion in the safety checklist had been selected to serve in favor of utilities.[23]

As a result, pre-accident nuclear safety inspections in Japan were serving as a mechanism for utilities to exclude unwanted inspection items from the safety checklist and delay the timing to take costly safety measures. Here lies the reason why it is important that the regulatory body work on the capacity building of its staff to secure its independence in technical decision-making, in addition to its independence from politics.

In the IAEA's Integrated Regulatory Review Service (IRRS), a peer review service conducted in countries using nuclear energy for civilian purposes, the degree of independence of the NRA and the technical capability of its staff have been focused on as priority areas of assessment to determine whether Japan's new regulatory body has overcome the challenges in regulating nuclear safety that existed prior to the Fukushima Daiichi nuclear accident.

In a review conducted in 2016, the IRRS mission made a rigorous assessment of the NRA's activities to regulate nuclear safety and provided critical feedback on the NRA's independence and the competence of NRA inspectors, pointing to the problem of the legal framework for inspection falling short of assuring NRA inspectors free access to nuclear facilities and challenges faced in improving the technical capability of NRA inspectors.

In response to those points made, the NRA implemented a series of improvement measure, including sending its staff to the U.S. NRC for training and launching staff education and training programs. After concluding a follow-up mission in January 2020, which was to review the actions taken since the initial IRRS mission in 2016, an IAEA team of experts acknowledge that NRA inspectors are now receiving appropriate training, appreciating the progress made[24] and underlining the importance of human resource development for nuclear safety regulation in Japan.

Utilities, i.e., those being regulated, are also aware of improvement in the competence of NRA inspectors. A senior official of TEPCO's nuclear power business division said, "As a result of training at the U.S. NRC and other efforts, regulatory inspectors' competence has improved significantly compared to prior to the Fukushima Daiichi nuclear accident. Specifically, they are more astute in pointing out what sort of accident could occur upon taking one look at facilities, and it is becoming imperative on our part as utilities to improve the competence of our staff conducting self-inspections."[25]

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23 "*Gyosha ga Gen'an: Kiban Kiko, Maru-Utsushi Jotaika* [Draft Prepared by Power Plant Operators: JNES copied the draft word-for-word as a matter of normal practice]," *Mainichi Shimbun,* November 2, 2011.

24 "*IAEA Sogo Kisei Hyoka Sabisu Nittei Shuryo, Kisei-I ni Sangyokai tono Komyunikeshon o Shiteki* [IAEA's IRRS Team Concludes a Mission, Calling on the NRA to Enhance Communication with utilities and other industry stakeholders]," *Genshiryoku Shimbun*, January 21, 2020, (https://www.jaif.or.jp/journal/japan/1676.html), accessed on March 4, 2020.

25 Interview with a senior official of TEPCO's nuclear power business division conducted on July 4, 2020.

The U.S. and French cases show that an evaluation on the independence of a regulatory body is not made solely on the grounds of legislative and administrative changes to that effect. In the next sub-section, we will examine whether the NRA is competent to communicate based on its own technical knowledge and whether it is making such communication accessible to the public to maintain transparency in the nuclear regulatory administration.

2) Communication between the regulatory body and utilities

Reflecting upon the problem of opaque communication between regulators (government) and those regulated (utilities), as was the case prior to the Fukushima Daiichi nuclear accident, the NRA has established internal rules requiring that any meeting with a utility be attended by at least two commissioners, and that any such meeting lasting five minutes or more be video-recorded and minutes taken. Video recordings of meetings between NRA commissioners and utilities are available on the NRA website.

However, ensuring transparency does not end with just keeping video recordings and minutes and making them available to the public. By ensuring transparency, the NRA must aim to contribute to enhancing the safety of nuclear energy through public discussion between the regulator and those regulated And by demonstrating such openness to the public, it must seek to build public understanding and trust in the civilian use of nuclear energy.

Here, we attempt to compare and analyze how communication between the regulatory body and utilities changed before and after the Fukushima Daiichi nuclear accident by looking at the following instance of communication:

- Communication concerning the establishment of facilities equipped to withstand specific serious accidents (hereinafter "safeguarded facilities"), which is to play a crucial role in addressing the risk of terror attacks

■ Controversies concerning facilities equipped to withstand specific serious accidents

Safeguarded facilities are defined as those equipped to control nuclear reactors remotely in the event of emergency, such as a terror attack, even if the central control room, from which nuclear reactors are operated and controlled, is taken over or destroyed by the terrorists, and the like. The construction of such facilities was included in the new safety standards set in 2013 and thus became one of the duties utilities need to fulfill to operate nuclear power plants. Since such facilities cannot be constructed immediately, the NRA had provided a five-year grace period for utilities to fulfill this requirement. However, when the grace period was about to expire, one utility after another asked for its extension. Thus, from 2019 onward, the NRA had to hear the demands of utilities and determine whether to allow an extension.

In fact, the deadline for installation of safeguarded facilities had been changed once before.

Initially, the NRA required all utilities to set up such facilities within five years from the date of enforcement of the new safety regulations (July 8, 2013), reckoning that the installation of facilities equipped to withstand specific serious accidents is a backup measure that is integral to enhancing the reliability of the main facilities of nuclear power plants. However, in January 2016, the grace period was changed to "five years from the date a construction plan is approved" on the ground that it takes time to apply for and obtain construction permit.[26] Based on this revised rule, safeguarded facility installation deadlines for nuclear power plants approved for restart (including those already restarted) are as shown in Table 1.

Table 1: Deadlines for installation of safeguarded facilities (Listed by date of application)

Nuclear power plant and reactor unit No.	Deadline
Kyushu Electric Power's Sendai NPS Unit 1 reactor	March 17, 2020
Kyushu Electric Power's Sendai NPS Unit 2 reactor	May 21, 2020
KEPCO's Takahama NPS Unit 3 reactor	August 3, 2020
KEPCO's Takahama NPS Unit 4 reactor	October 8, 2020
Shikoku Electric Power's Ikata NPS Unit 3 reactor	March 21, 2021
KEPCO's Takahama NPS Unit 1 reactor	June 9, 2021
KEPCO's Takahama NPS Unit 2 reactor	June 9, 2021
KEPCO's Mihama NPS Unit 3 reactor	October 25, 2021
KEPCO's Ohi NPS Unit 3 reactor	August 24, 2022
KEPCO's Ohi NPS Unit 4 reactor	August 24, 2022

Source: Created by authors based on the NRA's "*Mihama, Ohi, Takahama Hatsudensho ni kakaru Genshiryoku Kisei Iinkai no Taio Jokyo ni tsuite* [Status of the Nuclear Regulation Authority's Responses regarding the Mihama, Ohi, and Takahama Nuclear Power Stations]."

By the end of June 2019, the NRA responded as follows to the requests from utilities for another extension of the grace period:

- One of the biggest lessons learned from the accident at Fukushima Daiichi nuclear accident is that TEPCO, the operator, lacked a sense of responsibility to make persistent efforts to improve safety. Unnecessarily postponing the deadlines would undermine such persistent efforts for improvement and the NRA cannot overlook situations not in conformity with the standards. Thus, the NRA confirmed its policy to demand the shutdown of reactors[27].

In other words, the NRA made it clear that it would not extend the deadlines shown in Table 1 for whatever reasons.

In response, utilities decided one after another to shut down their nuclear reactors in operation. Kyushu Electric Power Company shut down the Unit 1 and Unit 2 reactors of the Sendai NPS in Kagoshima Prefecture respectively in March and May 2020. In October of the same year, Kansai Electric Power Company (KEPCO) shut down the Unit 4 reactor of the Takahama NPS in Fukui Prefecture. Meanwhile, Shikoku Electric Power's Ikata NPS in Ehime Prefecture had to postpone the

26 NRA, "*Mihama, Ohi, Takahama Hatsudensho ni kakaru Genshiryoku Kisei Iinkai no Taio Jokyo ni tsuite* [Status of the Nuclear Regulation Authority's Responses regarding the Mihama, Ohi, and Takahama Nuclear Power Stations]," August 8, 2019

27 See Footnote 26.

resumption of operation by about one year due to a delay in the construction of the safeguarded facility. Consequently, as of March 11, 2021, exactly 10 years after the Fukushima Daiichi nuclear accident, only four nuclear reactors, including those undergoing adjustments, were in operation in Japan.

The shutdown of these reactors has a direct impact on the business performance of the utilities, which have been hoping to improve profitability by bringing more nuclear reactors back online. This also means a decreased diversity of power sources, which could threaten the stability of electricity supply when demand surges in summers and winters.[28] Considering these points, utilities should have estimated the scale of construction work and the time required beforehand. As it turned out, however, utilities are found to have been too optimistic in their estimates, calling into question the degree of their awareness of the need to address the threat of terrorism and commitment to safety.

■ Change of mindset required of both regulators and regulated utilities

Undeniably, both the regulatory body and utilities have undertaken significant efforts to strengthen nuclear safety, implementing organizational reforms based on the lessons learned from the Fukushima Daiichi nuclear accident. The NRA has taken steps to secure its independence from politics and the government agency promoting the use of nuclear energy and worked to ensure transparency through open discussions. Meanwhile, utilities have been putting a great deal of efforts to instill safety culture within their respective organizations. For instance, TEPCO has established new senior managerial positions, which are independent from the managers in charge, to periodically provide advice and recommendations on the ways of conducting business in five key areas of safety management such as nuclear reactor operations and facility maintenance, following the advice of Charles Casto, a former U.S. NRC official who led the NRC's on-site operations in Japan in dealing with the Fukushima Daiichi nuclear accident.[29]

However, analysis of communication between the regulatory body and utilities concerning matters linked directly to nuclear safety reveals various problems as seen in the instance discussed earlier. We would like to consider how we can pave the way for these safety enhancement initiatives to lead to the restoration of public trust in nuclear energy based on the view of the IAEA.

To begin with, when it comes to ensuring nuclear safety, simply securing compliance with the regulatory safety standards is not enough and it is indispensable to work continuously to check and make improvements when deemed necessary.

The IAEA emphasized the role of communication and proposed a set of recommendations concerning the nuclear regulatory administration in Japan. After conducting the IRRS follow-up mission in January 2020, the leader of the IAEA team of experts emphasized that communication

28 In early January 2021, Japan faced a very tight supply of electricity across the country as the cold wave hit and electricity for heating demand soared, in particular in the area served by KEPCO with the demand-to-capacity ratio reaching 99% and the possibility of a large-scale blackout looming. The tight power supply was the result of multiple factors, such as a shortage of liquefied natural gas (LNG) due to logistics disruptions across the world caused by the COVID-19 pandemic, etc., a decrease in solar power output due to unfavorable weather conditions, and the continuing closure of nuclear power plants. "*Denryoku Jukyu Hippaku: Antei Kyokyu e Kensho, Hosaku Shimese* [Power Supply Strained: Government needs to look into the root cause and present measures for ensuring a stable supply of electricity]," *Fukui Shimbun*, February 25, 2021 (https://www.fukuishimbun.co.jp/articles/-/1266930).

29 Interview with a senior official of TEPCO's nuclear power business division conducted on July 4, 2020.

with members of the regulated industry contributes to nuclear safety although the independence of the regulatory body must not be compromised.[30]

The IAEA's recommendations, which were made in light of specific examples of other countries, have been implemented as part of measures to break the ongoing impasse in Japan. Other countries using nuclear energy for civilian purposes have already established, either by changing existing laws concerning the independence and transparency of nuclear administration or creating new ones, systems for public communication between the regulator and regulated utilities to discuss matters relating to nuclear safety and jointly work out better ways to regulate.

One such example is the case in France. Nuclear Rapid Action Force (FARN: *Force d'Action Rapide Nucléaire*) in France. In subsequent discussions among the ASN, the Radioprotection and Nuclear Safety Institute (IRSN: *Institut de Radioprotection et de Sûreté Nucléaire*), a public body comprising nuclear experts, and EDF after the Fukushima Daiichi nuclear accident, the nuclear safety standards are newly established. The ASN is working to establish the new regulatory standards in three phases as shown below to enhance the safety of nuclear facilities.

- **Phase 1: Implement stricter safety standards for nuclear facilities (2011-2015)**
  Reinforcement of facilities as appropriate based on the conditions of each facility (e.g., number of years in operation, geographical conditions, population distribution in the vicinity), deployment of power supply vehicles and fire engines, construction of water reservoirs, etc.
- **Phase 2: Strengthen back-up systems (2015-2020)**
  Establishment of a system capable of rapidly responding to an emergency at a nuclear power plant, supplying necessary materials and equipment within 24 hours to put the situation under control
- **Phase 3: Address risks that have not been dealt with in the earlier phases (2020 onward)**
  Measures to address newly emerging threats to nuclear facilities, such as cyberattacks and terrorism

Dominique Martineau of the ASN explained that these developments concerning the newly established nuclear safety standards are attributable to French efforts undertaken from 2006 onward to reform the nuclear regulatory administration. In France, regulatory functions were separated from the government agency promoting nuclear, i.e., the Ministry of Economy, Finance and Industry, way ahead of Japan, under the Nuclear Transparency and Safety Law of June 13, 2006, known as the TSN law. In implementing the nuclear regulatory administration, the ASN, an organ responsible for safety inspections, seeks advice from the IRSN, a body of experts, with a great deal of emphasis placed on an "open dialogue among the three organizations including EDF to discuss better ways to regulate".[31]

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30 "*IAEA Sogo Kisei Hyoka Sabisu Nittei Shuryo, Kisei-I ni Sangyokai tono Komyunikeshon wo Shiteki* [IAEA's IRRS Team Concludes a Mission, Calling on the NRA to Enhance Communication with utilities and other industry stakeholders]," *Genshiryoku Shimbun*, January 21, 2020, (https://www.jaif.or.jp/journal/japan/1676.html), accessed on January 30, 2020.

31 Interview with Dominique Martineau of the ASN conducted on November 22, 2017, in Paris.

In the case of Japan, the NRA seems to have been prioritizing its independence as a regulatory body by keeping its distance from utilities, instead of communicating with them, in view that its predecessor which was in service before the Fukushima Daiichi nuclear accident, was criticized for having been seduced by the logic of utilities. Regarding the installment of safeguarded facilities, the NRA would have been able to obtain third-party opinions and things could have gone more effectively, had it communicated with utilities in public to discuss the length of time required for constructing such facilities and construction methodologies to be employed before making it a regulatory requirement.

The fact that there are fewer opportunities in Japan for exchanging opinions on nuclear safety than in other countries means fewer opportunities for people to learn about the regulatory body and utilities as to whether they have competence to execute their responsibilities and what intent they have. This is also one of the factors making it difficult to restore people's trust in the civilian use of nuclear energy.

(2) Communication between the regulatory body and host community residents

Our comparative analysis of the Japanese and overseas nuclear regulatory administration has revealed that more distinct differences are observed in the relationship between the regulatory body and host communities—i.e., local governments and residents—than in the communication between the regulatory body and utilities. Following the Fukushima Daiichi nuclear accident, a new set of nuclear regulatory standards were established in Japan. However, while these standards are applicable to utilities operating nuclear power plants, the nuclear safety management system remains unchanged in that the local governments and residents in host communities have no legal rights to get involved in the process. As a result, the NRA has no part to play when local governments develop their emergency preparedness plans or conduct nuclear accident drills in accordance with the plans, and residents in host communities have fewer opportunities to communicate with the regulatory body than their counterparts in other countries. This is linked directly to the results of the JAERO's public opinion survey on nuclear energy cited at the outset of this chapter, which showed that many people are skeptical about the viability of local emergency preparedness plans. Another survey, conducted jointly by local newspapers based in 13 prefectures hosting nuclear power plants to mark the 10th year since the Fukushima Daiichi nuclear accident, also found similar tendencies, with more than 60% of respondents living in Fukui Prefecture, which is home to 13 commercial nuclear reactors (including those to be decommissioned), expressed skepticism about the viability of the emergency preparedness plan.[32]

In what follows, we will analyze characteristic uniquely observed in Japan regarding the relationship between the regulatory body and local communities hosting nuclear power plants and explore ways to gain the trust of residents in the civilian use of nuclear energy.

1) Development of local emergency preparedness plans and the NRA

Japan has a unique way of developing local emergency preparedness plans.

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32 "*Hinan Keikaku ni Jikkosei 'Muzukashii' 6-wari-cho* [Over 60% of Respondents Find It 'Difficult' to Believe the Evacuation Plan Is Viable]," *Fukui Shimbun*, March 1, 2021, (https://www.fukuishimbun.co.jp/articles/-/1269150).

Following the Fukushima Daiichi nuclear accident, a new secretariat was established within the Cabinet Office, headed by the Minister of State for Nuclear Emergency Preparedness and staffed by a director general and some 50 officials to work on a full-time basis for ensuring emergency preparedness such as evacuation plans in the event of a nuclear disaster. In contrast, in the United States, emergency preparedness plans, including evacuation plans for local communities, are subject to review by the regulatory body as part of its unified control.

■ Rethinking of evacuation plans for local communities

At the time of the Fukushima disaster, the emergency preparedness plans that had been put in place did not work as shown by the failure to issue evacuation orders to residents in a timely manner and to secure shelters for evacuees while the scope of radioactive contamination continued to widen. One reason for this lies in the nuclear safety regulation in place prior to the accident, which did not envisage the possibility of a severe accident. Areas within a radius of 8-10 km of a nuclear power plant were defined as designated areas covered by nuclear emergency preparedness requirements. However, in the wake of the Fukushima Daiichi nuclear accident, the evacuation zone was expanded to a radius of 20 km of the plant, and it was not possible to communicate evacuation orders to the public and secure means of transportation for them in short order.

After the Fukushima Daiichi nuclear accident, it was determined to designate areas within a radius of 30 km from nuclear power plants as "urgent protective action planning zone (UPZ)." As a result, some municipalities, which were previously not required to have an evacuation plan, are now required to do so.

Municipalities within the UPZ are responsible for developing their respective evacuation plans by taking into consideration the characteristics of the nuclear plant and related facilities in their vicinity, following the Nuclear Emergency Response Guidelines set by the NRA, while the director general and staff for nuclear emergency preparedness at the Cabinet Office provide them with necessary assistance.

However, the NRA neither assess those municipality-level evacuation plans nor review the effectiveness of evacuation drills organized by respective municipalities. In other words, in Japan, nuclear emergency preparedness plans developed by host and nearby municipalities are outside the regulatory purview of the NRA.

■ Factors behind the differences between Japan and the USA

The difference between Japan and the United States as to whether local emergency preparedness plans should be within or outside the purview of the nuclear regulatory body is related to the overall progress of how Japan has handled the Fukushima Daiichi nuclear accident.

The emergency response system, which was in place in 2011 when the Fukushima Daiichi nuclear accident occurred, called for the establishment of the Nuclear Emergency Response Headquarters (NERHQ) within the Prime Minister's Office and a Local Nuclear Emergency Response Headquarters (Local NERHQ; headed by the State Minister of Economy, Trade and Industry) within an off-site center in a municipality in the vicinity of the nuclear power plant concerned upon declaration by the Prime Minister of a nuclear emergency situation under the Act on Special Measures Concerning Nuclear Emergency Preparedness (The off-site center for the Fukushima NPS was located in Okuma Town, Fukushima Prefecture). The Secretariat to the NERHQ was placed in the emergency response center inside the NISA, the regulatory body at the time, fully equipped with a teleconference system that allowed the sharing of critical information such as on the conditions of the reactors sent real time from the nuclear power plant. Based on such information, the Local NERHQ was to take control of emergency response measures such as the evacuation of the public.

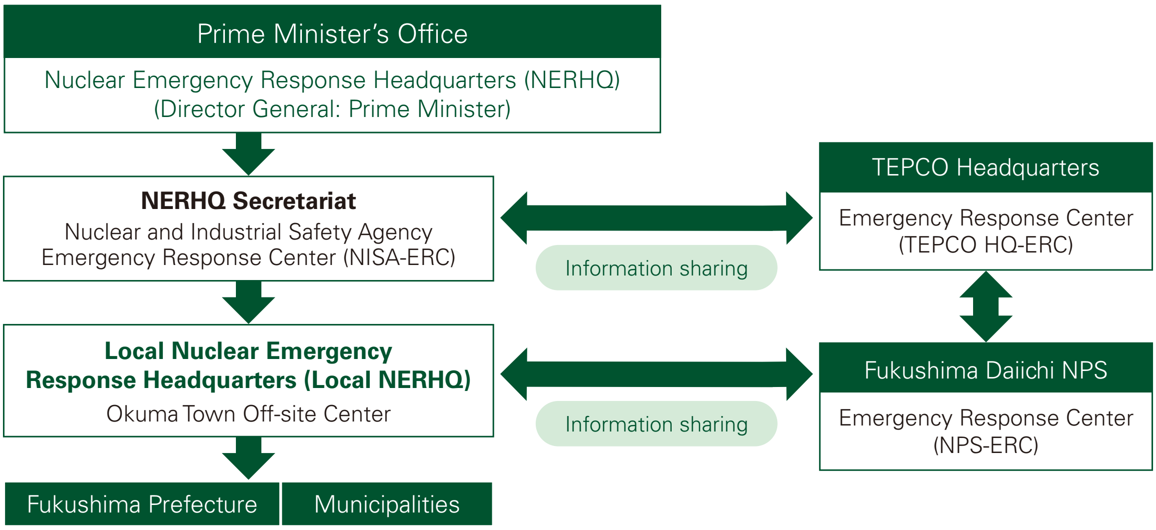

Fig. 1: Organizational arrangements for response to the Fukushima Daiichi nuclear accident

Source: Created by authors based on the interim report of the ICANPS (Investigation Committee on the Accident at the Fukushima Nuclear Power Stations) published in December 2011.

However, the emergency response arrangements in place at the time of the Fukushima Daiichi nuclear accident had been developed based on the premise that infrastructure, including telecommunications and transportation networks, would function properly just as in normal times, without envisaging the possibility of a compound disaster (earthquake, tsunami, and nuclear meltdown). Hence, real-time information on the conditions of the nuclear reactors was not available at the NISA-ERC because of damage to telecommunication facilities. Also, the NISA, which was serving as the NERHQ Secretariat, was busy collecting information on the progression of the accident at the Fukushima Daiichi NPS and unable to coordinate work across multiple government agencies concerned in securing means of transportation for evacuation and setting evacuation procedures. As such, the government's response to the accident was in chaos.

A new, post-Fukushima emergency response system was developed based on the lessons learned from the failed response to the Fukushima Daiichi nuclear accident.

As a result, it was determined that the NRA should, along with the NRA Secretariat, concentrate on supporting the on-site response to a nuclear emergency, and the Cabinet Office should be responsible for the off-site response.

As shown in Fig. 2, when the NERHQ is set up, the Cabinet Office—not the government agency responsible for regulating nuclear power plants—is to serve as the secretariat. The director general for nuclear emergency preparedness, supported by a staff of some 50 full-time officials, is to coordinate work across multiple government agencies concerned to enable rapid emergency response. A former director general for nuclear emergency preparedness of the Cabinet Office explains as follows: "It is difficult for the NRA, which is just one of regulatory agencies, and its secretariat (NRA Secretariat) to manage the entire scope of work for nuclear emergency preparedness. We can better secure the effectiveness of emergency response operations by having the Cabinet Office, which is good at coordinating with other government agencies, play the leading role."[33] While the on-site response requires knowledge and expertise in nuclear engineering, the off-site response involves a great deal of coordination across various agencies within the central government as well as with local governments concerned, for instance, in securing means of transportation for evacuation and shelters for evacuees. The new arrangements are designed to facilitate expeditious coordination, quickening up the process that took so much time in dealing with the Fukushima Daiichi nuclear accident.

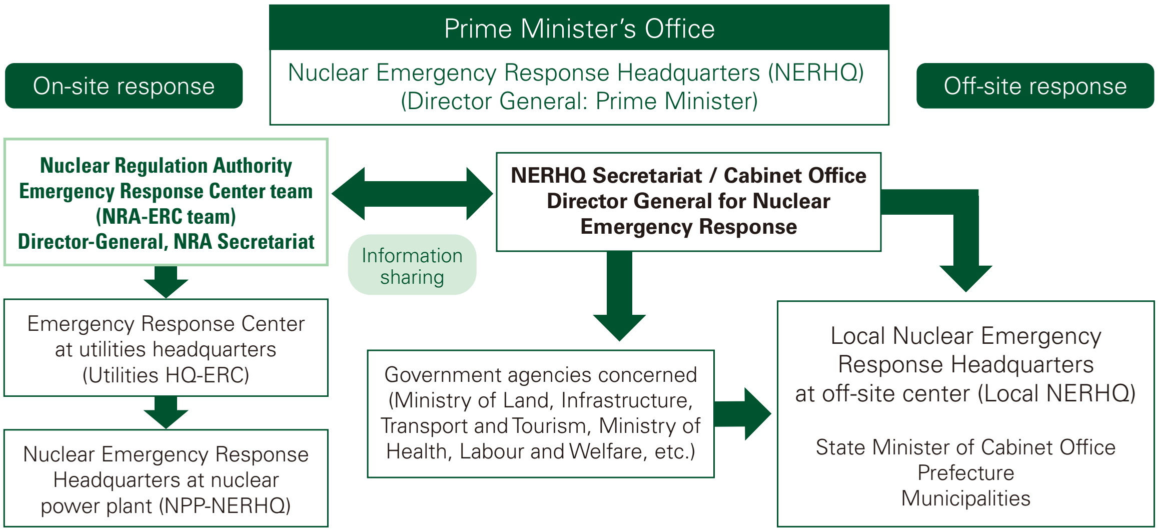

Fig. 2: Organizational arrangements for post-Fukushima nuclear emergency response

Source: Created by authors based on the "White Paper on Disaster Management 2018," Cabinet Office.

As such, Japan's nuclear emergency response system is characterized by its two-track structure, in which the on-site response such as providing support to emergency workers at the site of accident and the off-site response such as assisting with local emergency preparedness and organizing evacuation are managed by two separate government agencies.

33 Interview with a former director general for nuclear emergency of the Cabinet Office conducted in November 2019.

■ Two-track structure

As shown in the above-cited comment of a former director general for nuclear emergency preparedness of the Cabinet Office, the two-track structure has been designed as such to enable speedier nuclear emergency response, particularly by facilitating expeditious coordination across multiple government agencies. However, it is worthwhile examining the difference with the United States, where the basis of policy is to put nuclear regulatory administration under unified control, in a bid to develop more effective nuclear emergency preparedness plans.

In the United States, which experienced a nuclear meltdown in the Three Mile Island Nuclear Generating Station (TMI) in 1979, the U.S. NRC, a regulatory agency, has unified control over nuclear regulation including local emergency preparedness plans.[34]

The U.S. regulatory process for the operation of nuclear facilities proceeds as follows. First, the U.S. NRC sets out standards for emergency response plans applicable to each nuclear facility according to its size and the population distribution in its vicinity. Then, based on the standards, the facility operator and the host municipality develop their emergency response manuals and evacuation plans for residents, and so does the state government to be prepared for the possibility of widespread damage. Up to this point, it looks pretty much the same as the Japanese regulatory process for requiring the development of local emergency preparedness plans. However, in the United States, plans developed by the operator and the municipality are both subject to examination by the NRC, which would not permit the operation of the nuclear facility if either one of them is found to be failing to satisfy the standards.

We cannot make a simple comparison between the NRA, which has a staff of only about 1,000 including inspectors, and the U.S. NRC, which has a staff of nearly 4,000, in the scope of their roles and responsibilities. However, is it possible to enhance nuclear safety when the regulatory agency, which is responsible for reviewing the safety of nuclear facilities, has little—if any—involvement in the development of local emergency preparedness plans?

For instance, Shikoku Electric Power's Ikata NPS is located at the tip of the Sadamisaki Peninsula in Ehime Prefecture, and the regional evacuation plan developed by the prefecture in 2013 stipulates that affected residents be evacuated not only by land but also by sea to Oita Prefecture in the event of emergency. Being premised on cooperation with another prefecture, the evacuation plan is inevitably complex as it involves securing the means of transportation and shelters, posing significant challenges in terms of maintaining the viability of the plan.

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34 Muneyuki Shindo, 2017, *Genshiryoku Kisei Iinkai: Dokuritsu/Churitsu toiu Genso [Nuclear Regulation Authority: An illusion of independence and neutrality]*, pp.162-163, Iwanami Shinsho

Fig. 3: Location of Shikoku Electric Power's Ikata NPS

Source: Created by authors.

On October 23, 2020, the Ehime Prefectural Government organized a nuclear emergency preparedness drill. Taking the lessons of the Fukushima Daiichi nuclear accident, a compound disaster—nuclear accident and earthquake—was assumed and measures against infectious diseases were incorporated in the scenario to test the evacuation procedures.

However, the scenario did not assume the possibility of traffic congestion despite the likelihood that many people would try to flee by car in the event of actual emergency as was the case at the time of the Fukushima Daiichi nuclear accident. The Ehime Shimbun, a local newspaper, published an editorial critical of the current state of emergency preparedness. "Good communication by the central and local governments to publicize the evacuation plan in advance and keep residents updated with relevant information is key to successful evacuation in the event of a nuclear accident, but one cannot help but feel insecure of how things stand today," it says. "There were persistent concerns about the viability of the evacuation plan even before the Ikata Unit 3 reactor was brought back to operation. We should be aware that putting the operation of nuclear reactors on hold is a viable option if safe evacuation cannot be ensured in the face of increasingly severe conceivable situations in which an accident could occur, i.e., a compound disaster amid the COVID-19 pandemic."[35]

Some members of the judiciary also raise questions about the current system in which the NRA is not involved in the development of evacuation plans for communities.

The ruling on March 9, 2016, by the Otsu District Court that upheld a petition seeking a temporary injunction against the operation of Units 3 and 4 reactors of KEPCO's Takahama NPS was the first-ever judicial decision that ordered the shutdown of a nuclear reactor in operation. Along

35 "*Ken Genshiryoku Bosai Kunren: Hinan Keikaku no Jikkosei Kibishiku Kensho wo* [Nuclear Emergency Preparedness Drill Organized by the Prefectural Government: Viability of the evacuation plan must be tested strictly]," *Ehime Shimbun,* October 24, 2020, (https://www.ehime-np.co.jp/article/news202010240010)

with the seismic resistance standards under the new safety requirements set after the Fukushima disaster, the viability of evacuation plans developed by the local governments was the point at issue. Pointing to the "urgent need to develop a concrete and visible evacuation plan under the leadership of the central government," the presiding judge of the district court was quoted as saying as follows: "There should be broad-based regulatory standards that would include local evacuation plans. After having gone through a severe accident, I would say it is not just a hope but the duty of good faith and fair dealing the government owes to the public that it should develop such standards."[36]

Also, in another case concerning the Tokai No.2 Power Station in Tokai Village, Ibaraki Prefecture, which had been filed by a group of residents pointing to problems with safety measures taken by its operator, JAPC, the Mito District Court ruled on March 18, 2021, that JAPC should not be allowed to resume the operation of the nuclear power plant, noting that "one cannot conclude that the level of protection is sufficient to ensure the safety in the event of a serious accident unless evacuation plans for residents living within a radius of 30 km from the nuclear power plant and other necessary arrangements are properly in place."[37]

This is not to say that it is wrong for the Cabinet Office, one that is considered good at coordinating across government agencies, to serve as the secretariat to the NERHQ, or that the current system in which the Cabinet Office provides support to local governments in developing their respective emergency preparedness plans is inadequate. However, given the problems pointed out concerning the emergency preparedness drill in Ehime Prefecture, the temporary injunction granted by the Otsu District Court, and the ruling by the Mito District Court discussed above, it is worthwhile to consider making emergency preparedness plans subject to examination by the NRA as part of regulatory requirements and creating a mechanism for assessing the viability of such plans.

With the NRA having little involvement with local emergency preparedness plans as things stand today, host community residents are effectively deprived of opportunities to be informed about the competence and intent of the regulatory body regarding the safety management of nuclear facilities and to judge whether it is worthy of trust. The result of this is the widespread public skepticism about the viability of emergency preparedness plans, as observed in the results of the JAERO's public opinion survey on nuclear energy cited earlier.

In view of this situation, the NRA in 2017 set forth a basic policy regarding on-site inspections by NRA commissioners and the exchange of opinions with the local parties concerned to enhance dialogue with local governments in host communities.[38] However, these efforts are voluntary efforts, not regulatory requirements, and have yet to set up a forum for regulators, local governments, and local residents to exchange views based on the law.

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36 "*Takahama Genpatsu, 'Unten Sashitome Karishobun' no Omoi Imi: Saibansho ga Anzen Taisaku to Hinan Keikaku wo Futatabi Mondaishi* [Weighty Meaning of the 'Temporary Injunction Ordering the Suspension of Operation' of the Takahama NPS: The court again questions safety measures and evacuation plans]," *Toyo Keizai Online*, March 10, 2016, (https://toyokeizai.net/articles/-/108804?page=2), accessed on March 16, 2020.

37 "*Tokai Daini Genpatsu Saikado Mitomenai Hanketsu Mito Chisai* [Mito District Court Disallows the Restart of the Tokai No.2 Power Stations]," *NHK*, March 18, 2021, (https://www3.nhk.or.jp/news/html/20210318/k10012921701000.html)

38 NRA, "*Genshiryoku Kisei Iinkai no Torikumi no Kohyo (3.11 Hokoku) ni tsuite (An)* [Disclosure of Activities Undertaken by the Nuclear Regulation Authority (3.11 Report) (Draft)]," March 3, 2021, pp.9-10.

2) Nuclear safety agreements

In Japan, authority over nuclear safety regulation rests solely with the central government with no legal authority given to local governments. Against this backdrop, nuclear safety agreements (NSAs) between utilities and local governments have been filling the institutional vacuum left under the current system and operated in a way to allow for a degree of local government involvement in nuclear safety management. Enabling local governments to get involved in nuclear power plant operation in various forms, NSAs have been considered instrumental to confirming the trust between utilities and host local governments.

The first-ever NSA was concluded in April 1969, when the Unit 1 reactor of the Fukushima Daiichi NPS was under construction, between TEPCO and the Fukushima Prefectural Government upon request from the prefectural government. In April 1976, the two municipalities co-hosting the nuclear power plant—i.e., Futaba and Okuma Towns—joined as parties to the agreement. At the time, Japan was in its high economic growth period and the agreement was defined as equivalent to a pollution control agreement. Although consultations with host communities for the development of nuclear power plants and the construction of additional nuclear reactors tended to hit a snag, the NSA provided a sense of assurance to host community residents and TEPCO managed to be recognized as a socially responsible contributor to the local community, prompting other utilities to follow suit in Fukui and Ibaraki Prefectures.

NSAs do not have any legal basis or biding power. However, in de-facto terms, they have been binding on utilities as shown below:

- Information sharing with the local community: Utilities are not required by law to inform the local governments concerned regarding accidents below the level subject to the Act on Special Measures Concerning Nuclear Emergency Preparedness. However, they are required to do so under NSAs.
- Added reliability through local government involvement: Local governments conduct and disclose the results of environmental monitoring, establish their own nuclear safety review committees, and make on-site inspections of nuclear facilities.
- De-facto social decision making by the heads of local governments: The heads of local governments are entitled to participate in decision making concerning the loading of fresh nuclear fuel into a reactor and plans for building additional reactors as per the prior consent provisions of NSAs.

As such, NSAs have been instrumental to bringing a focus on the consensus building with local governments in host communities as a key process required when utilities seek to expand nuclear power plants such as building additional reactors. Thus, the operation of such agreements has been given a degree of legitimacy.

However, the current system—in which host local governments effectively have part of decision-making authority over nuclear safety and the construction of new and additional nuclear facilities without any legal grounds—is unique to Japan and may run counter to the rule of law, a fundamental principle of democracy. Also, it has been pointed out that the current system is putting the transparency of the nuclear-related decision-making process at risk by providing leeway for local governments to make the arbitrary selection of members for their nuclear safety review committees and/or to permit the construction of new or additional facilities in exchange for regional development programs. It is questionable whether the current system has helped build trust between utilities and host communities.[39]

Regarding those legal ambiguities embedded in NSAs, local governments have begun to call for a review. In February 2021, Mayor Masahiro Sakurai of Kashiwazaki City, Niigata Prefecture, which is home to TEPCO's Kashiwazaki-Kariwa NPS, expressed his intention to seek consultations with the central government and other parties concerned to look into the possibility of turning its NSA with TEPCO into a legally binding agreement.[40]

Today, 10 years after the Fukushima Daiichi nuclear accident, communities hosting nuclear power plants are beginning to show growing interest in seeking legal grounds for communication opportunities between the NRA and stakeholders, i.e., utilities, host local governments, and residents in host communities, making it an issue subject to discussion.

(3) Summary

In this chapter, we analyzed the current state of risk communication by the NRA, a new regulatory body established after the Fukushima Daiichi nuclear accident, to consider whether it is helping restore public trust in the civilian use of nuclear energy.

Our analysis of the NRA's communication with utilities, concerning the new requirement of constructing safeguard facilities, found that the NRA is concerned more with ensuring its independence than with ensuring good communication with utilities, wary of the criticism that the collusive relationship between the regulatory body and utilities prior to the Fukushima Daiichi nuclear accident led to the opacity of the regulatory administration for nuclear safety.

Nuclear safety cannot be ensured simply by setting and complying with regulatory standards. It requires persistent efforts by both the regulatory body and utilities to make improvements to enhance safety. Going forward, the NRA and utilities should seek to regain public trust in the civilian use of nuclear energy by continuing public discussion on nuclear safety in a way visible to the public, drawing on successful examples of other countries.

A comparison with the practices of regulatory administration for nuclear safety in the United States showed that opportunities for local governments and residents to communicate with the regulatory body are far more limited in Japan.

In the U.S, evacuation plans, which are instrumental to mitigating the consequences of a nuclear accident, are subject to review by the regulatory body, which is also responsible for reviewing the safety of nuclear facilities under an integrated regulatory framework. In contrast, in Japan, the

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39 Shiroyama, H., 2015, *Daishinsai ni Manabu Shakai Kagaku vol. 3: Fukushima Genpatsu Jiko to Fukugo Risuku Gabanansu [Social Science Learned from the Great East Japan Earthquake vol. 3: Fukushima nuclear accident and complex risk governance]*, pp.91-115, *Toyo Keizai Inc.*

40 "*Kashiwazaki Shicho Anzen Kyotei Minaoshi ni Genkyu* [Kashiwazaki Mayor Refers to the Need to Review the Nuclear Safety Agreement]," *Niigata Nippo*, February 26, 2021, (https://www.niigata-nippo.co.jp/news/national/20210226601058.html).

development of evacuation plans is a responsibility of local governments. Although Cabinet Office officials in charge of emergency preparedness provide support, the NRA has not part to play in the process. Also, nuclear emergency preparedness drills organized by host prefectural governments are not subject to regulation. As such, the NRA has no chance to evaluate the viability of evacuation plans or exchange opinions with local governments and residents.

Going forward, efforts should be made to define by law opportunities for communication between the NRA and local stakeholders, i.e., local governments and residents, concerning the viability of local emergency preparedness plans, because such communication is linked directly to building trust in the civilian use of nuclear energy.

Chapter 2: Governance of the Decommissioning Process

In this chapter, we analyze the communication between and among the TEPCO, the central government, and residents in the local community concerning the decommissioning (i.e., dismantlement and decontamination) of the Fukushima Daiichi NPS and examine what challenges faced in winning the trust of residents in the local community and Japanese people in the decommissioning process.

The decommissioning of the Fukushima Daiichi NPS is a post-accident process undertaken in the aftermath of a severe accident, in which the operator, TEPCO, failed to manage risks inherent in nuclear power generation and extensive damage was done. Following the definition of the term "trust" in the Introductory Chapter, this means that the decommissioning process had to start from where the operator lost the trust of residents in the host community as it lacked the "competence" to manage risks. "Intent," another definition of trust, also comes under strict scrutiny. People who were living in the vicinities of the Fukushima Daiichi NPS are hoping to see their cities, towns, and villages restored in a way to bring back the vibrance they had prior to the accident. Do TEPCO and the central government have the intent to make such wishes come true? Even if they do, they may encounter technical problems that would make it difficult to have radioactive waste entirely moved out of Fukushima Prefecture within the several decades as specified in the decommissioning implementation plan. If that happens, what would they do? All these questions need to be examined.

The decommissioning of the Fukushima Daiichi NPS involves—and thus can proceed only in tandem with—the development of new technologies, for which the best available scientific knowledge must be mobilized. Seen in light of the above-discussed perspective, it is also a social challenge that involves persistent efforts to communicate with and seek the understanding of affected residents as a concurrent process. We will consider the following two case examples to examine this challenge.

First, we will take a look at the permanent disposal of contaminated water, an urgent issue as of spring 2021. More precisely, it is about problems surrounding the ocean release of treated, radioactively contaminated water, i.e., the water used to cool melted nuclear fuel in the aftermath of the accident and subsequently treated using purifying equipment. Because of TEPCO's poor competence in risk management and attitude toward information disclosure, people have lost trust in the ocean discharge plan and there is little progress in communication for the implementation of the plan.

Second, we will consider how communication with residents affected by the accident should be pursued regarding the end state of the Fukushima Daiichi NPS, including the use of the site after the completion of the decommissioning process. The end state is linked closely with the restoration of the affected areas. However, there is a gulf of difference between what is considered achievable based on the current level of science and technology and what the affected residents hope to see as the end state. This has made it extremely difficult to have any communication concerning the end state, and it has now become necessary to create a new framework, in which a third party would provide an objective analysis of the current state and present possible options rather than relying solely on the existing framework between TEPCO and the central government on one side and the affected residents on the other, in order to find a way out of the current impasse.

By analyzing such communication regarding the decommissioning of the Fukushima Daiichi NPS, we can expect to derive some suggestions to help future efforts to build consensus and establish communication on matters that would involve scientific and technical risk management over a long period of time, such as the selection of potential sites for a deep geological repository for spent nuclear fuel. This is an issue of universal relevance, having implications not only to the people who were living in the vicinity of the Fukushima Daiichi NPS at the time of the accident but also to the entire Japanese society as well as to the global community.

(1) Problems surrounding contaminated water disposal and communication

In April 2021, 10 years after the Fukushima Daiichi nuclear accident, the central government decided to release treated water into the ocean. Treated water is injected to cool nuclear fuel and contaminated, finally purified with a dedicated device. The decision was due to a situation in which tanks storing treated water could fill the site in the nuclear power plant, affecting the overall decommissioning work.

The treated water contains tritium, which is one of the radioactive substances, but cannot be removed even with a dedicated device. Since tritium is known to affect the human body, such as a decrease in blood cell components, nuclear facilities around the world dilute it and release it after nuclear fuel cooling to the ocean and other natural worlds. The Japanese government wants to start releasing treated water at the Fukushima Daiichi NPS into the ocean by 2023, diluting it to 1/40 level of the national standard and dispose of it over several decades.

The International Atomic Energy Agency (IAEA) rated the Japanese government's decision as "based on scientific evidence," but local fishermen who have suffered reputational damage, but also neighboring countries and regions such as China and South Korea have opposed the Japanese government's decision, citing adverse effects on the marine environment.

In this section, we will verify how TEPCO and the government have tackled the issue of treated water after the Fukushima Daiichi nuclear power plant accident, and consider measures to gain trust in releasing treated water into the ocean.

1) Measures taken for disposal of contaminated water

In the Fukushima Daiichi nuclear accident, the supply of cooling water to the reactors stopped due to the loss of electrical power. As the water level fell, nuclear fuel became exposed to air, began to melt in its own heat, and fell off onto the bottom of the reactor in the form of debris. Some of the fuel debris penetrated the bottom of the reactor to the containment vessel, a structure designed to shield a reactor. Even after becoming debris, nuclear fuel continues to generate enormous heat. Unless it is cooled properly, fuel debris can penetrate even through the containment vessel and deep into the ground.

Water injected for cooling was exposed to nuclear fuel debris and turned into highly radioactive contaminated water. Not only the reactors but also the bottoms of their containment vessels were damaged extensively by heat from debris. Thus, contaminated water leaked from the containment vessels to spread inside the reactor buildings and even came in contact with natural groundwater flowing underneath the reactor buildings, creating a vicious circle in which the more water injected to cool debris, the more contaminated water generated.

Table 4 provides a summary of how things developed on measures for disposal of contaminated water.

From the table, we can see that the disposal of contaminated water emerged as a serious problem immediately after the outset of the accident. It also shows how TEPCO lost residents' trust in its competence and intent; each attempt to do something new—whether new equipment or a measure—was ensued by the occurrence of an inconvenient event, and each time, it had failed to properly disclose information. As a result, the central government became deeply involved in this process.

Table 2: Measures taken for contaminated water disposal and related developments

Month/Date/Year	Measures and related developments	Purpose and results
April 4-10, 2011	TEPCO discharges groundwater contaminated with low-level radioactivity into the ocean.	Low-level radioactive water was released into the ocean in order to make room for and prevent the leakage of more severely contaminated water. This invited criticism not only from the residents in the affected community but also from neighboring countries as TEPCO did not properly inform the public beforehand.
March 2013	The Advanced Liquid Processing System (ALPS), a multi-nuclide removal system, is brought into operation.	It was touted that the ALPS would be able to remove all radioactive substances except for tritium. However, it has been found that some nuclides other than tritium were contained in some of ALPS-treated water.
May 13, 2013	The Fukushima Prefectural Federation of Fisheries Co-operative Associations expresses opposition to TEPCO's proposed method in which a groundwater bypass was created to pump up groundwater for discharge into the ocean.	The federation asked for the central government's involvement, saying that its member associations would not trust TEPCO. Thereafter, communication with local stakeholders has been undertaken jointly by the Ministry of Economy, Trade and Industry (Agency for Natural Resources and Energy) and TEPCO.
November 2016	The Ministry of Economy, Trade and Industry sets up a Subcommittee on Handling of the ALPS Treated Water, a 15-member advisory body composed of scientists, scholars, and representatives of not-for-profit organizations (NPOs).	After discussing various options from a third-party point of view, the subcommittee produced a report in February 2020, citing discharge into the ocean as the most promising option to solve the problem of contaminated water.
November 2017	A frozen soil underground wall encircling the reactor buildings has been installed.	The frozen soil wall was built to prevent groundwater from seeping into the ground underneath the reactor buildings. However, it has been pointed out that the shielding effect of the wall is limited.
September 2018	It is announced that the ALPS has failed to remove some nuclides other than tritium, including those with radioactivity above regulatory limits, contradicting TEPCO's previous explanation that the equipment is capable of removing all nuclides except for tritium.	TEPCO initially released this information only on its website, inviting criticism for its attitude toward information disclosure.
August 2019	TEPCO says that it expects to run out of space in the Fukushima Daiichi NPS to accommodate storage tanks holding treated contaminated water by around the summer of 2022.	It became imperative to find way to permanently dispose of ALPS treated water.

Source: Created by authors based on information provided on TEPCO's website, etc.

TEPCO's first action against contaminated water, which came about a month after the accident, was to discharge low-level radioactive water into the ocean to make room for storing highly radioactive water to prevent its leakage to the ocean. Water contaminated with low-level radioactivity was discharged for one week from April 4, 2011. This invited criticism not only from residents in the local community but also from neighboring countries as TEPCO had not informed the public properly beforehand. As it turned out, this action led to the loss of public trust in measures against contaminated water, making it difficult to build consensus on any steps taken in the future.[41]

The next step was to build a shield to block off the flow of groundwater from entering the reactor buildings and to upgrade water purification facilities.

The construction of the shield was necessary because otherwise groundwater would continue to seep into the reactor buildings and generate a massive amount of contaminated water.

One of the methods employed to achieve this end was to install wells (subdrains) upstream to pump up groundwater before it enters the reactor buildings and discharge the groundwater into the ocean. A groundwater bypass was also constructed for this purpose. Pumped up before reaching the area surrounding the reactor buildings, groundwater from the bypass does not contain any radioactive substances. However, there have been multiple cases in which highly contaminated water leaked into supposedly non-contaminated groundwater prior to its discharge, giving rise to suspicion that radioactive water might have been released to the ocean. As a result, TEPCO's dialogue with local fishermen to seek their consent to the discharge of groundwater became bogged down.[42] As shown in Table 4, the revelation of those problems concerning the groundwater bypass led to greater involvement of the Ministry of Economy, Trade and Industry (METI) as local fishermen began to question TEPCO's ability to cope with the situation.

Another method was the construction of a frozen soil walls, which began in March 2016. It was expected that the 1.5 km long, 30 m deep wall encircling the ground underneath the reactor buildings would block groundwater inflow. It was nearly complete in November 2017. However, many people questioned the effectiveness of the in-ground barrier, and the Board of Audit urged the central government and TEPCO to "properly show the effect of the frozen soil wall," noting that the ultimate cost of the structure would amount to 56.2 billion yen including the portion financed from the national treasury.[43] In March 2018, TEPCO announced that the frozen soil wall reduced groundwater inflow to the reactor buildings by 95 metric tons per day, while noting that the amount of water—including rainwater and groundwater—seeping into the reactor buildings decreased from some 490 metric tons per day prior to the installation of the wall to 110 metric tons.[44] Based on this explanation, more than 70% of the reduction is attributable to other measures such as subdrains. The question about the cost effectiveness of the frozen soil wall remains unresolved.

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41 Shiroyama, H., 2015, *Daishinsai ni Manabu Shakai Kagaku vol. 3: Fukushima Genpatsu Jiko to Fukugo Risuku Gabanansu [Social Science Learned from the Great East Japan Earthquake vol. 3: Fukushima nuclear accident and complex risk governance]*, pp.171-177, *Toyo Keizai Inc.*

42 *Id.*

43 "*Genpatsu Jiko kara 8-nen, Osensui ga Imamo Okina Kadai ni* [Eight Years since the Nuclear Accident, Contaminated Water Remains a Major Problem]," *NHK*, March 11, 2018, (https://www3.nhk.or.jp/news/genpatsu-fukushima/20190311/osensui.html), accessed on March 7, 2020.

44 "*Todoheki no Koka, Towareru Hiyo-tai-Koka* [Effect of the Frozen Soil Wall: Cost effectiveness questioned]," *Sankei Shimbun*, March 1, 2018, (https://www.sankei.com/life/news/180301/lif1803010035-n1.html), accessed on March 7, 2020.

In dealing with contaminated water being generated day to day, TEPCO initially relied on decontamination systems built by Areva of France and Kurion of the United States. Subsequently, Japanese makers continued efforts to improve the performance of their products, and the Advanced Liquid Processing System (ALPS), a multi-nuclide removal system developed by Toshiba and Hitachi was introduced in March 2013. The ALPS is designed to remove a total of 62 nuclides excluding tritium. As it turns out, however, the ALPS has been suffering from one flaw after another ever since it was brought into full operation, forced to operate at only about 30% of its capacity in some months. Having gone through a great deal of trial and error, treatment of contaminated water using the ALPS is continuing today.

In September 2018, TEPCO announced that about 84% of the ALPS-treated water in storage at the time—i.e., 750,000 metric tons out of 890,000 metric tons—was found to contain above-limit levels of radioactive substances that the system had failed to adequately remove, contradicting its earlier claim that the ALPS is capable of removing 62 nuclides, that is, all the radioactive substances contained in the water except for tritium.[45] From treated water in some tanks, Strontium-90 and other radioactive nuclides were detected in concentrations as high as 20,000 times the allowable limits set by the government. Although these results were disclosed on TEPCO's website and thus known to some people, TEPCO came under fierce criticism from international environmental organizations and others for its failure to proactively publicize the information and explain why things turned out to be different from what the company had explained.[46] It seemed that TEPCO was reluctant to release information inconvenient to the company, and this has made it all the more difficult to foster the trust of local residents in its treatment of contaminated water and build consensus on the ocean discharge of treated water.

The central government—the NRA in particular—is also accountable for this problem.

It is the NRA that issued a certificate confirming that the ALPS had passed the pre-service test at the time of its introduction and again at the time of installing additional facilities. Speaking at a regular news conference on August 22, 2018, NRA Chairman Toyoshi Fuketa acknowledged that the NRA was aware that the ALPS is not capable of fully removing nuclides other than tritium. He continued to explain as follows: "Keeping the sum of the ratios of measured concentrations of all nuclides contained to their respective concentration limits specified in the NRA's public notice below the target level is to satisfy the requirement for discharge. Therefore, as I said earlier, what we require them to do is [to discharge in a way of satisfying the regulatory requirements, and] our stance is that so far as the requirements are satisfied, we do not expect any impact whatsoever, whether on the environment or human health."[47] That is, the NRA holds the view that as a regulatory body, it has never required as a condition of the pre-service test, the ALPS to be capable of removing all the nuclides except for tritium and

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45 "*Osensui, Jokago mo Kijun 2-manbai no Hoshasei Busshitsu* [Contaminated Water Found to Contain Radioactive Substances in Concentrations as High as 20,000 Times the Threshold Levels Even After Treatment]," *Asahi Shimbun*, September 28, 2018, (https://www.asahi.com/articles/ASL9X6HQ3L9XULBJ014.html), accessed on April 1, 2020.

46 e.g., GreenPeace, "*Toden ga Osensui wo Umi ni Nagashitewa Ikenai 4-tsu no Riyu* [Four Reasons Why TEPCO Must Not Discharge Contaminated Water into the Ocean]," July 2019, (https://www.greenpeace.org/japan/sustainable/story/2019/07/23/9618/), accessed on April 1, 2020.

47 Transcript of Regular News Conference by the NRA on August 22, 2018, (https://www.nsr.go.jp/data/000243171.pdf), accessed on August 6, 2020.

that it determined that it would not cause any problem to discharge ALPS-treated water after diluting it enough to keep the sum of the ratios of measured concentrations to limits below the target level.

Even if the NRA chairman's explanation is correct from a scientific viewpoint, it is difficult to convince those residents who had been told that all the nuclides other than tritium would be removed. With little time left before all the space in the Fukushima Daiichi NPS is filled with tanks, the situation remains extremely difficult as TEPCO and the central government must start anew to rebuild trust with residents in the local community.

2) What is tritium?

Tritium, a type of hydrogen, was not generated by the meltdown. It occurs in the normal process of operating nuclear reactors. It behaves just like normal hydrogen and is soluble in water. Therefore, it is not easy to separate and remove water molecules containing tritium. The use of electrolysis has been proposed. However, only16 grams of tritium is contained in more than 1.25 million tons of contaminated water currently held in storage and it is estimated to cost several tens of billions of yens to remove such a small amount of tritium by means of electrolysis. Meanwhile, tritium has a relatively short half-life of 12.33 years, meaning that it decays to half the original amount in 12.33 years. Thus, in all countries using nuclear energy for civilian purposes, tritiated water is released to the environment such as the ocean after it is diluted to reduce the concentration of tritium below the designated level considered having no impact on the human body and the environment.

Japan is no exception. For more than 40 years since it started using nuclear energy for civilian purposes, tritium generated by nuclear power plants—including those that have resumed operation after the Fukushima Daiichi nuclear accident—has been discharged into the ocean. Coastal waters near nuclear facilities are regularly monitored to check the levels of tritium concentration and it has been confirmed that they are kept below 10,000 Bq/L[48], which is the limit set by the World Health Organization (WHO) for tritium in drinking water.

3) Permanent disposal of treated water emerging as a matter of urgency

Despite this track record of having disposed of treated tritiated water by way of discharge into the ocean, TEPCO has made little headway in its efforts to permanently dispose of treated contaminated water from the Fukushima Daiichi NPS. This fact symbolizes residents' distrust in the handling of contaminated water and the decommissioning process.

As of March 2021, the permanent disposal of treated water was becoming a matter of urgency. In August 2019, TEPCO announced the prospect that it would run out of space in the Fukushima Daiichi NPS to accommodate storage tanks holding treated contaminated water by around the summer of 2022.[49]

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48 Bq stands for Becquerel, a unit measuring the amount of radiation emitted by radioactive substances, whereas the effect of radiation on the human body is measured by a unit called the sievert (Sv). Hokuriku Electric Power Company's website (http://www.rikuden.co.jp/housyasennokoto/tani.html), accessed on March 7, 2020.

49 "*Osensui Tanku Ato 3-nen de Manpai* [Storage Tanks for Contaminated Water Will Be Full in Three Years]," *Asahi Shimbun,* August 8, 2019, (https://www.asahi.com/articles/ASM873SMCM87ULBJ005.html), accessed on March 7, 2020.

Photo 1: Fukushima Daiichi NPS filled with ever-increasing number of tanks holding ALPS-treated water

Source: (C) Maxar Technologies, Inc. (November 2020)

The problem of permanent disposal of contaminated water is raising difficult questions that must be addressed in considering ways forward in the overall decommissioning process.

When the premises of the Fukushima Daiichi NPS are filled with tanks, it will affect the entire decommissioning work, for instance, by making it difficult to find space to put equipment for removing fuel debris. Also, if any of those tanks is damaged by a typhoon or an earthquake, it may cause a random leakage of treated water and hence the spread of tritium in the nearby environment. However, the reality on the other side is that TEPCO has been pleading for permission to discharge treated water into the ocean, insisting that the concentration of tritium is below the designated level, but it remains unable to win back the trust of local fishermen and residents.

Against this backdrop, in November 2016, the METI set up a 15-member advisory panel composed of scientists, scholars, and NPO representatives, to discuss ways to solve the problem of contaminated water. The Subcommittee on Handling of the ALPS Treated Water (ALPS Subcommittee) was headed by Ichiro Yamamoto, vice principal of the Nagoya University of Arts and Sciences.

According to its final report published in February 2020, the ALPS Subcommittee was presented with the following five methods considered feasible from the scientific and technical points of view: geosphere injection, hydrogen release, underground burial, evaporation, and discharge into the ocean. However, the first three were deemed impractical for immediate implementation, given the lack of precedents for their use anywhere in the world as a means to dispose of tritium, the need to secure a new location, and the legislative action involved to establish environmental standards. Thus, evaporation and discharge into the ocean, for both of which precedents exist, were discussed as practical options. Advantages and disadvantages of these two methods are summarized in Table 5.

Evaporation, a method in which the treated water would be evaporated into the environment, was used as a means to permanently dispose of the treated water generated by the 1979 Three Mile Island (TMI) accident in the United States. However, a disposal method involving the liquid-to-vapor transition of radioactive substances has never been applied in Japan. Meanwhile, as discussed earlier, discharge into the ocean is a method that has been employed by Japanese utilities operating nuclear power plants, and TEPCO is no exception.

Based on these observations, the final report of the ALPS Subcommittee highlights the technical advantage of discharge into the ocean over other methods, while pointing to the need to give special consideration to local fishermen.[50]

Table 3: Overview of evaporation and ocean discharge

	Evaporation	Ocean discharge
Precedent	Yes (Employed in disposing of contaminated water after the TMI accident, etc.)	Yes (Employed extensively by utilities operating nuclear facilities)
Advantage	Some of the radioactive substances contained in the treated water would be solidified and remain as dry residue, thereby reducing the volume of radioactive substances released into the environment.	Existing discharge facilities can be used and there is an established method to monitor the level of radioactive concentration.
Disadvantage	• Radioactive substances left in the form of solidified dry residue need to be disposed of separately. • Regional differences in the level of radioactive concentration may widen depending on climate conditions such as the direction of the wind and the amount of rainfall. • More people and industries would be affected than in the case of discharge into the ocean.	• Reputational damage may occur. Particularly, the local fisheries industry, which is already suffering serious damage due to the Fukushima Daiichi nuclear accident, may suffer yet another blow.

Source: Created by authors based on information provided in the final report of the Subcommittee on Handling of the ALPS Treated Water.

The mention of the need to give consideration to local fishermen in the ALPS Subcommittee's report is related to the characteristics unique to the Hamadori region of Fukushima Prefecture, where the Fukushima Daiichi NPS is located. Before the accident, fisheries and tourism were the key industries of this region, and hence, the recovery of these two industries is linked closely to the restoration of the region. Concerns are being raised that the discharge of treated water into the ocean may cause reputational damage.

Fukushima Prefecture has a 167 km-long coastline with a continental shelf, an area of relatively shallow water of less than 200 m deep, extending some 60 km off the northern part of the prefecture and 30 km off the southern part. It is a major trawl fishing ground for flatfish such as turbot and sole. Also, an area off the coast of Fukushima Prefecture is a meeting point of the Kuroshio

50 Report of the Subcommittee on Handling of the ALPS Treated Water, February 2020, pp.25-27.

warm current and the Oyashio cold current, and full of migratory fish such as sauries and tunas.[51] The quantity of fish catch from the waters of Fukushima Prefecture (fishing has been carried out on an experimental basis after the Fukushima Daiichi nuclear accident) dropped sharply and remains below 20% of the level prior to March 2011 (see Fig. 4), with many ports and fishing boats destroyed by the earthquake and tsunami, and because of the halting of fishing in inshore waters due to radioactive leakage from the damaged nuclear power plant. The Fukushima Prefectural Federation of Fisheries Co-operative Associations has announced its plan to shift to "expanded operation" from April 2021.[52]

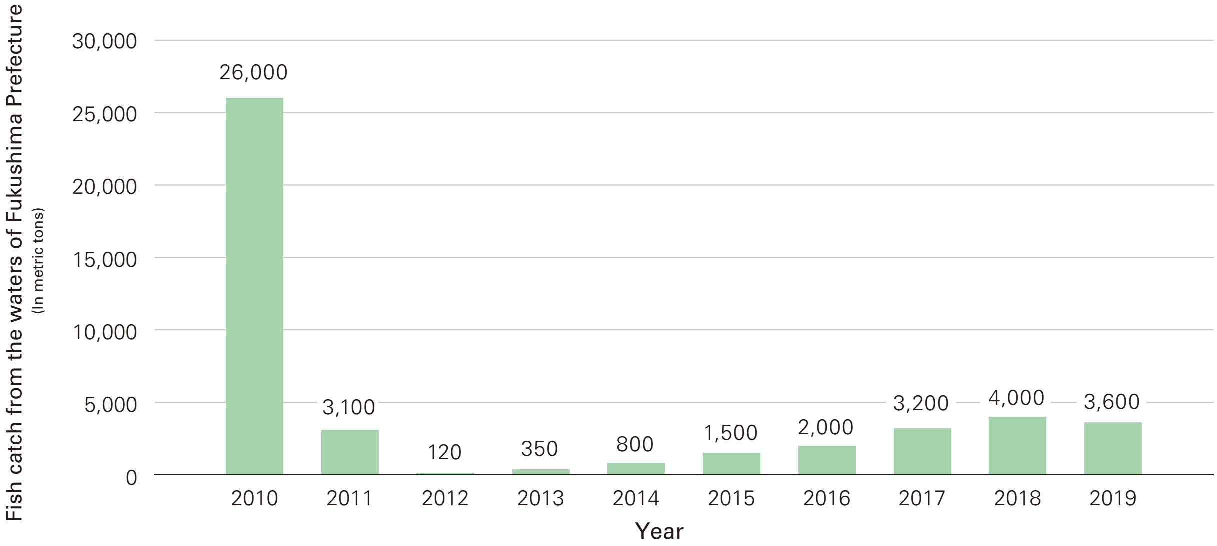

Fig. 4: Fish catch from the waters of Fukushima Prefecture before and after the Great East Japan Earthquake

Source: Created by authors based on materials provided by the Fukushima Prefectural Federation of Fisheries Co-operative Associations.

Partly due to these circumstances, the permanent disposal of tritiated water from the Fukushima Daiichi NPS has been often cited by the media and research organizations—both domestic and foreign ones—as a specific case example to consider how scientific technology and associated risks are accepted in society and what sort of information disclosure and communication should be made to have them accepted in society.[53] Also from the same perspective, relevant international organizations such as the IAEA have been discussing the disposal of tritiated water.

From November 5 to 13, 2018, an IAEA review team visited Japan to evaluate the decommissioning of the Fukushima Daiichi NPS from an international viewpoint. In its final report, the

51 National Diet Library, Japan, "*Fukushima-ken ni okeru Gyogyo no Shiken Sogyo no Genjo* [Current Status of Experimental Fishing in the Waters of Fukushima Prefecture]," August 31, 2017, (https://dl.ndl.go.jp/view/download/digidepo_10950741_po_0974.pdf?contentNo=1), accessed on March 31, 2020.

52 "'*Honkaku Sogyo' Meisho no Henko Teian e* [Replacement of the Term 'Full-fledged Operation' to be Proposed]," *NHK*, February 17, 2021, (https://www3.nhk.or.jp/lnews/fukushima/20210217/6050013471.html).

53 For instance, "*Hoshasei Busshitsu wo Fukumu Mizu no Shobun wa 'Anzen, Demo Zero Risuku wa Nai': Sono Kotoba no Shin'i* [Disposing of Water Containing Radioactive Substances Considered "Safe But Not Zero Risk": What does that mean?]," *BuzzFeed Japan*, December 14, 2019, (https://news.yahoo.co.jp/articles/0e7f86a69d06d85b3a746faf3a68adbf8986405d?page=2), accessed on April 1, 2020.

IAEA review team pointed out that "a decision on the disposition path for the stored ALPS treated water … must be taken urgently, engaging all stakeholders, to ensure the sustainability of the decommissioning activities and of the safe and effective implementation of other risk reduction measures." As a premise for taking the decision and implementing the path chosen, the report says, it is essential that TEPCO, as the operator, obtain public trust, highlighting the importance of compliance and information disclosure in this regard. "After the decision on the disposition path is made, TEPCO should prepare and submit to the Nuclear Regulation Authority (NRA) for authorization, a comprehensive proposal for its implementation in conformity with laws and regulations, supported by such items as a safety assessment and analysis of the environmental impacts," the report says. To facilitate the smooth implementation of the chosen disposition path, it encourages efforts to go beyond just complying with laws and regulations but to develop a "robust comprehensive monitoring program" and a "communication plan ensuring a proactive and timely dissemination of information to stakeholders and general public." [54]

In April 2021, the government decided on a policy of disposing of treated water into the ocean, however it is difficult to say that timely communication to stakeholders and residents as pointed out by the IAEA research team is being implemented. There is no trace of the government's efforts to explain the discussions at the subcommittee to local fishermen or to seek understanding from neighboring countries before announced the decision of disposing of treated water into the ocean. If this decision is to be carried out in two years, it is necessary to establish a transparent monitoring system and publish information to obtain the understanding of not only fishermen and local residents, but also neighboring countries.

(2) End state of the Fukushima Daiichi NPS and communication

What constitutes the completion of decommissioning and what will be the end state of the Fukushima Daiichi NPS?

These are critical questions to ask when considering regional restoration from the unprecedented nuclear accident. However, our interviews with various stakeholder groups—nuclear engineers and decommissioning specialists, central government officials, TEPCO officials, decommissioning workers, and residents in the local community—found that there are significant perception gaps among them. As noted in the Introductory Chapter, they need to first recognize that they have different perceptions of the problem depending on where they stand and then, based on that recognition, create a common framework of risks that need to be addressed.

A decade after the accident, a method for removing fuel debris, which is perceived to be the most challenging part of the decommissioning work, has yet to be developed. Based on this fact, nuclear engineers and decommissioning specialists insist that it is too early to present the end state. Meanwhile, residents in the local community tend to believe that the decommissioning process is considered completed only when all the radioactive waste including fuel debris is taken out of their

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54 IAEA, "IAEA International Peer Review Mission on Mid-and-Long Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station," January 2019, pp.8-9.

area. Indeed, municipalities hosting or located near the Fukushima Daiichi NPS have made a request to TEPCO and the government to move all the radioactive waste out of Fukushima Prefecture. As for the Roadmap set by the government and TEPCO, the fifth revised edition was released in December 2019. While the latest edition includes a plan to start removing fuel debris from the Unit 2 reactor, the timing for completing the overall decommissioning process is not set specifically but defined in a range between 2041 and 2051. It also falls short of providing a clear picture of what the end state will look like after completing the decommissioning process.

In this section, we first provide an overview of basic knowledge concerning decommissioning and then examine whether there is any way to probe for possible paths to a solution.

1) Challenges associated with decommissioning

■ What is decommissioning?

In countries using nuclear energy for civilian use, decommissioning work is underway on experimental and commercial nuclear reactors launched in the 1960s and 1970s, but there are very few completed cases.[55] It is only after 2000 that the IAEA officially presented the definition of decommissioning to its member states. When it comes to decommissioning accident-damaged nuclear reactors, it is almost like entering into an uncharted water. We will have to grope around in the dark to find ways to remove and permanently dispose of nuclear fuel debris.

In a bid to encourage countries using nuclear energy for civilian purposes to properly dismantle their out-of-service nuclear facilities, the IAEA in 1999 set the definition of decommissioning of nuclear reactors (which was officially presented to its member states in 2006) as follows: "The term decommissioning refers to administrative and technical actions taken to allow removal of some or all of the regulatory controls from a nuclear facility. These actions involve decontamination, dismantling and removal of radioactive materials, waste, components and structures. They are carried out to achieve a progressive and systematic reduction in radiological hazards and are taken on the basis of preplanning and assessment to ensure safety during decommissioning operations."[56]

In Japan, following the IAEA recommendation of 1999, the Nuclear and Industrial Safety Agency (NISA), which was the regulatory body at the time, compiled a report on its policy in 2004 and notified it to utilities and relevant research institutions. In the report, decommissioning is defined as "a set of measures—including transfer of nuclear fuel material, elimination of contamination caused by nuclear fuel material, and disposal of nuclear material or material contaminated thereof—taken after the completion of primary activities relating to the approved or designated business or nuclear reactors till the time the facility concerned ceases to be subject to regulation under the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and

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55 According to the Japan Atomic Industrial Forum, Inc. (JAIF), a total of 170 nuclear reactors in the world were set to be decommissioned as of January 2019. In Japan, apart from those in the Fukushima Daiichi NPS, a total of 12 nuclear reactors—including the Units 1 and 2 reactors in Chubu Electric Power Company's Hamaoka NPS—have stopped operations and are set to be decommissioned, but decommissioning work has not been completed on any one of them. (https://www.jaif.or.jp/cms_admin/wp-ontent/uploads/2019/03/world-npp-development201903.pdf), accessed on April 3, 2020.

56 IAEA, "Decommissioning of Nuclear Power Plants and Research Reactors," IAEA Safety Standards Series, Safety Guide No. WS-G-2.1, 1999; and IAEA Safety Standards Series, Safety Requirements No. WS-R-5, 2006.

Reactors."[57] The law referred to in the foregoing statement provides that decommissioning is considered completed when the following four conditions are satisfied:

- Transfer of all the nuclear fuel material possessed
- Decontamination of the facility and premises
- Disposal of radioactive waste
- Surrender of radiation management records

Each of the above conditions is crucial to restoring the former sites of nuclear facilities to a state where residents can use them without being exposed to radiation after the regulation under the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors is removed.

■ Decommissioning strategies

In addition to setting the definition of decommissioning, the IAEA provides decommissioning options that satisfy the definition. Since the length of time and the amount of manpower to complete decommissioning differ depending on the size of the facility, the amount of nuclear fuel left, and the degree of contamination, the IAEA sets out three types of strategies, namely, immediate dismantling, deferred dismantling, and entombment.[58]

Immediate dismantling involves removing, in principle, all the equipment, structures, and parts of a facility containing radioactive contaminants, and decontaminating the entire premises to reduce the radioactivity to the permissible level set by the regulatory body. In this case, the decommissioning process begins shortly after the permanent cessation of reactor operations and all radioactive waste is moved out of the premises to another facility for disposal.

Deferred dismantling is no different from immediate dismantling in that it involves decontaminating the entire premises to reduce the radioactivity to the permissible level set by the regulatory body. However, it takes a longer period because parts of a facility containing radioactive contaminants are maintained until a technique for safe dismantling is established. Eventually, all parts of the dismantled facility and radioactive waste will be moved out of the premises to another location.

Unlike the above two strategies, entombment is to dispose of parts of a facility containing radioactive contaminants and radioactive waste in situ after applying appropriate safety measures to ensure that no harm is made to the surrounding environment. Contaminated facility parts and radioactive waste are encased in a structurally long-lived material, and the release of the site for use must wait till radioactivity decays to the permissible level set by the regulatory body.

Whichever option is taken; two points need to be considered. First, a decommissioning plan must be developed based on a detailed survey of characteristics of the facility, such as the amount of

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57 NISA Decommissioning Safety Subcommittee, "*Genshiryoku Shisetsu no Haishi Sochi Kisei no Arikata ni tsuite* [Regarding the Way of Regulating the Decommissioning of Nuclear Facilities]," December 2004.

58 Atomic Energy Society of Japan's (AESJ's) 1F Decommissioning Committee, "*Kokusai Hyojun kara Mita Haikibutsu Kanri* [Waste Management in Light of International Standards]," July 2020, pp.6-7.

nuclear fuel left and the extent of contamination at the facility. Second, the end state of the facility must be presented.[59] These two points are inextricably linked with each other. There is no envisioning the future use of the site without a clear decommissioning plan in place, while the choice of a decommissioning strategy—immediate dismantling or deferred dismantling in tandem with the development of safety-ensuring techniques—varies depending on how the site will be used. In the case of the decommissioning of the Fukushima Daiichi NPS, the Roadmap has been revised five times, whereby the way to proceed with decommissioning and techniques to be employed have been gradually brought into shape. However, there has been little discussion on the end state.

■ Consideration of the end state and the removal of nuclear fuel

Removing fuel debris is the most challenging part of decommissioning work.

In the case of the Fukushima Daiichi NPS, where the accident occurred, there are two types of nuclear fuel. One type is spent nuclear fuel, which had been used in ordinary operations and were kept in spent fuel pools at the time of the accident, and the other is fuel debris resulting from the meltdown of the Units 1, 2, and 3 reactors.

Spent fuel rods stored in cooling pools are moved to a safe storage place after they are cooled down sufficiently. The Fukushima Daiichi NPS had been in commercial operation for 40 years at the time of the accident and the method for handling spent nuclear fuel rods is well established. However, the explosions that occurred during the accident have made it impossible to take them out of the cooling pools in the ordinary procedure. Numerous pieces of rubble scattered inside and around the pools must be removed first.

Fuel debris is posing more difficult challenges. As noted earlier, nuclear fuel continues to generate heat even after becoming debris, and at the same time, emits highly concentrated radiation that would eventually kill a human who was exposed for several minutes. Fuel debris needs to be cooled down with water for a long period of time, causing the generation of contaminated water. Meanwhile, investigation of the conditions inside the reactors and containment vessels, an attempt to understand the state of fuel debris, has been making little progress. However, it is considered almost certain that in each of the reactor, melted fuel penetrated the reactor bottom and fell to the bottom of the containment vessel. The removal of fuel debris is expected to be extremely difficult and a technique for enabling this has yet to be established.

Dividing the decommissioning process into three phases, the Roadmap lays out plans on the timescale of several decades. The fifth revised edition released in December 2019 defines the decommissioning process as shown below:

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59 *Id.*

- **Phase 1: December 2011 – November 2013**
  Start removing spent fuel from spent fuel pools.
- **Phase 2: November 2013 – no later than the end of 2021**
  Complete the removal of spent fuel from spent fuel pools; Determine the order and method for removing fuel debris based on the findings from the investigation of the inside of the containment vessels, etc. and start removing fuel debris.
- **Phase 3: 2021 – 2041 (target) or the end of 2051 at the latest**
  Complete the decommissioning process including the removal of fuel debris.

As indicated by the fact that the Roadmap has already been revised five times, a technique for removing fuel debris is extremely difficult to establish. In December 2020, TEPCO said it would postpone the start of work to remove fuel debris by about one year. The company attributed the delay to the spread of COVID-19, explaining that the test run and training for a robotic arm to be used in removing fuel debris, which had been planned to take place in overseas, could not take place due to the pandemic.[60]

Robots and other remote equipment are not the only challenges.

To insert a robot into a reactor, it is necessary to make holes in the walls of the reactor and containment vessel and install pipes, and this must be done manually. A team of decommissioning workers, known as *kosenryo butai* or radiation hot zone team within those working in the Fukushima Daiichi NPS, is the one undertaking this challenging task. In November 2019, the Sasakawa Peace Foundation conducted an interview survey on the state of decommissioning work and preparatory work for the removal of fuel debris, visiting those engaging in the task at their dormitory.

The work being carried out by the team includes draining the huge quantities of contaminated water out of the reactor buildings and constructing walls to block radioactive "hot spots," i.e., highly radioactive zones with scattered rubble from the explosions of the buildings. The contaminated water left inside the reactor buildings was generated when water was injected into the buildings by deploying fire engines and high-pressure cement pumps in the initial effort to cool down the reactors and nuclear fuel pools shortly after the accident. Highly appreciated for their ability to quickly carry out their tasks under a highly radioactive environment, those on the team have also been assigned to engage in the task of sending a camera robot into the containment vessels to investigate the shape of fuel debris.

In addition to carrying out decommissioning work at the Fukushima Daiichi NPS, they have been receiving practical skill training several times a month at the Fukushima Daini NPS and a Hitachi plant in Ibaraki Prefecture, where they would practice making holes and installing pipes for the insertion of robots using a full-size replica of the containment vessels that suffered meltdown during the accident. According to J.E., a worker from Miyagi Prefecture, what is crucially important in the robot insertion task is that a welder who makes a hole in the containment vessel, pipe

60 "*Nenryo Deburi Toridashi wo Enki* [Removal of Fuel Debris Postponed]," *NHK*, December 24, 2020, (https://www3.nhk.or.jp/lnews/fukushima/20201224/6050012819.html).

fitters who install pipes, and general workers who build scaffolding work in tune with each other, and the procedure is checked and confirmed several times during the training. As areas around the reactors that melted down are highly radioactive, each worker can work for only 30 minutes to one hour. Therefore, he said, "We always measure the time and repeat practicing until we can finish within the designated time."[61]

However, work in preparation for the removal of fuel debris has never been free from challenges. In October 2019, an attempt was made to send a camera robot into the Unit 1 reactor of the Fukushima Daiichi NPS to take photos of the inside of the containment vessel as part of the ongoing efforts to develop a technique for removing fuel debris. However, the moment the hole was drilled through the wall of the containment vessel, a plume of dust rose and readings on the radiation counters shot up, and thus the work had to be stopped immediately. Fortunately, none of the workers were injured or exposed to high levels of radiation. One of the workers we interviewed is a site foreman of a second-tier subcontractor, a native of Fukushima Prefecture, who can directly talk to employees of first-tier subcontractors for the decommissioning work, such as Hitachi and major construction companies. Regarding this incident, he said, "Probably, they tried to make a hole in a section relatively close to the bottom where fuel debris is believed to lie and ended up raising the highly radioactive dust."[62]

This incident made the workers upset. Ryuichi Fuse said, "When radioactive dust rises, the level of radiation goes up so high that you can't stay there more than 10 minutes. At least the Unit 1 reactor is concerned, I think it is impossible to start removing fuel debris within 2021."

Given what we heard from those who are working on site, it is uncertain whether work for removing fuel debris can start after a one-year postponement. In the Roadmap, the requirements for Phases 1 and 2 to be considered completed are to "start removing" spent fuel and fuel debris respectively, and there is no mention of the length of time required to the removal of fuel debris. Quite possibly, there will arise new challenges and the removal of fuel debris will turn out to be a much lengthier process than assumed. In light of the definition of and strategies for decommissioning set out by the IAEA, immediate dismantling—which calls for moving all the radioactive materials out of the area in short order within a few decades—is not necessarily achievable. There is no ruling out the possibility of entombment, in which case radioactive waste including fuel debris would be kept within the premises of the Fukushima Daiichi NPS for several centuries.

On the other hand, local municipalities and residents want to see all the radioactive waste moved out of their areas. In August 2016, the governor of Fukushima Prefecture and the mayors of 13 local municipalities hosting or located near the Fukushima Daiichi NPS, including Futaba and Okuma Towns, jointly submitted a letter of request to then METI Minister Hiroshige Seko. The letter reads as follows:

"The accident at TEPCO's Fukushima Daiichi Nuclear Power Station caused serious and exten-

61 Interview with a decommissioning worker conducted in November 2019 at Hirono Town, Fukushima Prefecture.

62 Interview with a decommissioning worker conducted in November 2019 at Hirono Town, Fukushima Prefecture.

sive damage to the people of Fukushima Prefecture, particularly those living near the power plant. Even today, many people are still being forced to live away from their hometowns, while many others live with anxiety over invisible radiation and decommissioning work. They are also suffering reputational damage. The reconstruction and revitalization of Fukushima Prefecture are making steady progress and evacuees are gradually coming home. Against this backdrop, in order not to impose any more burdens on the future of Fukushima Prefecture, we ask the government to:

- ensure the safe and secure removal of fuel debris by mobilizing the best available knowledge and expertise from around the world; and
- discuss methods for disposing of radioactive waste, including fuel debris and spent fuel, and properly dispose of them outside Fukushima Prefecture under the responsibility of the government that has been promoting nuclear energy policy."[63]

As such, there is significant difference among parties concerned in terms of what they believe constitutes the completion of decommissioning as well as how the site should be used and what the local community should be like in the future. What approach should be taken to start discussion on the end state?

2) Exploring ways to launch a dialogue to discuss the decommissioning of the Fukushima Daiichi NPS and regional revitalization

■ Common understanding as a basis for launching a dialogue

How to proceed with the decommissioning and what end state to envision for the Fukushima Daiichi NPS are linked directly to the return of those who were living in the vicinity of the nuclear power plant before the accident and the future of the local community.

As a prerequisite to launching a dialogue among the government, local municipalities, TEPCO, and people in the local community on the difficult challenges involved in the decommissioning process as discussed above, "the government and TEPCO should explain that it is difficult to fully release the premises in several decades, because safety must be given the highest priority in proceeding with the decommissioning work," says member of the Atomic Energy Society of Japan's (AESJ's) 1F Decommissioning Committee.[64]

Indeed, when we look at the decommissioning of nuclear facilities overseas, it is extremely rare to envision the release of entire premises as the end state, although there is one case in the United States in which a visitors center was put in place on a piece of land within the premises of a former nuclear facility.[65] In most cases, a certain portion of premises is used as a radioactive waste disposal

63 "*Hoshasei Haikibutsu no Kengai Shobun ni kakaru Moshiire* [Requests Regarding the Disposal of Radioactive Waste Outside Fukushima Prefecture]," Fukushima Prefectural Government website, August 29, 2016, (https://www.pref.fukushima.lg.jp/sec/16025c/genan413.html), accessed on November 20, 2020.

64 Interview with a member of the AESJ's 1F Decommissioning Committee conducted in November 2020.

65 The Fernald site in the U.S. state of Ohio, where uranium metal production began in the 1950s, also produced plutonium for nuclear weapons. Decommissioning started in full gear in 1991 and ended in 2006. Although a visitors center was opened on a piece of land within the premises, the most part of the premises was designated as a controlled area and is not accessible to the public. AESJ's 1F Decommissioning Committee, "*Kokusai Hyojun kara Mita Haikibutsu Kanri: Haikibutsu Kento Bunkakai Chukan Hokoku* [Waste Management in Light of International Standards: Interim Report of the Waste Subcommittee]," July 2020, p.40.

site and managed as a controlled area, which is not accessible to the public. The United States has a system in place, under which the Department of Energy develops an environmental management program for each site and decides on the end state of the premises after consulting with residents in the local community on decommissioning. The establishment of the visitors center is an example of decisions taken in this way.

At the site of the former Chernobyl nuclear power plant, a new structure for enclosing the accident-damaged reactor and thereby safely confining radioactive materials for 100 years was nearly completed in November 2016. In Japan, this new structure is called "*sekkan*" (sarcophagus) almost without exception. However, in official documents such as those released by the IAEA, "sarcophagus" refers to the emergency covering structure that was completed six months after the accident, and the new structure is referred to as a "shelter" or a "new safe confinement." Satoshi Yanagihara, a specially-assigned professor at the University of Fukui who is on the AESJ's 1F Decommissioning Committee says, "When you call it 'sarcophagus,' it gives the impression that the accident-damaged reactor is just covered and abandoned. However, when it is impractical to remove all the radioactive materials, covering troubled reactors with a safe confinement structure to prevent the leakage of radioactive materials is one form of decommissioning." This may as well be assumed as a possible scenario for the Fukushima Daiichi NPS, that is, it may be difficult to remove all the fuel debris, in which case the potion left unremoved would have to be confined within the premises over a long period of time.

Hiroshi Miyano, who chairs the AESJ's 1F Decommissioning Committee, says, "The end state of the Fukushima Daiichi NPS must be discussed by all parties concerned. The challenges involved in the decommissioning process must be explained straightforwardly. It is necessary to create a permanent discussion forum for all parties concerned drawing on initiatives undertaken by the U.S. Department of Energy."[66]

■ Significance of having a third-party organization

Regarding how decommissioning should be carried out, what the end state should be, and how the affected regions should be restored, there are diverse opinions among utilities, the central government, experts, local municipalities, and residents. People have different frameworks for thinking and different ways of looking at problems depending on where they stand. And based on that premise, we need to seek to build mutual trust among parties concerned and promote dialogue by clarifying the issues at stake.

Establishing an independent third-party organization is one way to address this difficult challenge. Equipped with technical knowledge and expertise on the risks in question as well as with the ability to communicate with all parties concerned, such a third-party organization is to evaluate the risks and coordinate different opinions by presenting ways to manage the risks.

In other countries where the concept of risk communication developed earlier than in Japan,

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66 Interview with Hiroshi Miyano on August 18, 2020.

the importance of third-party involvement is well recognized. Countries such as the United Kingdom, Canada, and Sweden have in place a third-party organization, which is independent from the government and utilities, to play a coordinating role to help decision-making on the permanent disposal of spent nuclear fuel, which is considered the most difficult to build consensus on among various tasks involved in civil use of nuclear energy.

Such a third-party organization is typically composed of scientists with in-depth knowledge on waste control and those with experience and know-how in communicating and reconciling differences with citizens concerning public policies. While giving due consideration to scientific uncertainty, it seeks to reflect the opinions of citizens and local community interests in a well-balanced way by collecting information on waste disposal projects and regularly implementing initiatives to share the information with citizens. To achieve that end, it gives advice to utilities to implement their initiatives in a transparent and sound manner, and provide its opinion to the government, which has authority to grant a license for business.[67]

Also in Japan, the March 2011 disaster—the Great East Japan Earthquake and the Fukushima Daiichi nuclear accident—prompted a discussion on the ways of reconciling different opinions and building consensus in due consideration of risks inherent in scientific technology. The establishment of an independent third-party organization designated to reconcile different opinions among parties concerned and provide appropriate advice to utilities and the government is a necessity not only in dealing with decommissioning but also in discussing issue related to the geological disposal of spent fuel, and the same system can be applied to other problems associated with risks inherent to science and technology. Thus, it should be discussed as a challenge that has universal implications.

(3) Summary

Decommissioning is a technical challenge that requires scientific expertise and the development of new technologies. At the same time, it is a social challenge that involves winning understanding from residents in the local community through numerous conversations, because the process includes dismantling facilities containing high-level radioactive materials and removing nuclear fuel, and it is necessary to ensure that there will be no harm to the nearby environment. In this chapter, we examined whether the decommissioning process for the Fukushima Daiichi NPS has been able to win the trust of residents in the local community and the Japanese people by analyzing two case examples.

One is about the permanent disposal of contaminated water, an urgent piece of work among various tasks in the decommissioning process. TEPCO, the utility responsible for the decommissioning process, has been unable to build a trusting relationship with other parties, which is a prerequisite to communication, because of its inappropriate behavior, namely, a discharge of low-level radioactive water into the ocean without proper notice to the public at the initial stage and the poor disclosure of information that invited suspicion from residents in the local community.

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67 Japan Atomic Energy Commission, "*Kongo no Ko-Reberu Hoshasei Haikibutsu no Chiso Shobun ni kakaru Torikumi nit suite* [Future Efforts on the Geological Disposal of High-Level Radioactive Waste]," December 2012.

The other is about the end state of the Fukushima Daiichi NPS upon completion of the decommissioning process. People in the local community want to see all the radioactive waste, including fuel debris, moved out of Fukushima Prefecture. However, 10 years after the accident, those involved in the decommissioning process have yet to establish a technique for removing debris. Because of this, the government and TEPCO have been unable to make explicit reference to the end state in the Roadmap for decommissioning. Given that radioactive material could cause enormous harm to the environment, safety must be given the highest priority in proceeding with the decommissioning work. As a result, it may not be possible to remove all the fuel debris and some of the radioactive waste may have to be kept within the premises of the Fukushima Daiichi NPS for generations to come.

Regarding such decommissioning risks arising from the limitations of scientific technology, it is necessary to share information among parties concerned so that they can together explore viable solutions. However, they are greatly divided in their opinions. To set up a forum for discussion, we must start by establishing an independent third-party organization and creating a mechanism for assessing risks in an easy-to-understand manner and reflecting various opinions of various parties concerned in decision-making. If such a third-party organization manages to play its role to some extent in the exchange of opinions on the decommissioning of the Fukushima Daiichi NPS, it will also be able to help facilitate communication among TEPCO, the government, and residents in the local community on the termination of the designation as a “difficult-to-return” exclusion zone as well as on other issues involving risks inherent in scientific technology and consensus building in society, such as the selection of potential sites for a deep geological repository for spent nuclear fuel.

Chapter 3: Legislative Oversight over Nuclear Administration

Trust in the safety of nuclear energy and the decommissioning process of nuclear facilities examined in Chapters 1 and 2 is mainly about communication between residents in the local community—i.e., municipalities hosting or located near nuclear power plants—on one side and the central government and utilities operating the nuclear power plants on the other. However, an attempt needs to be made to create a mechanism for democratic oversight, one in which people at all levels of society participate more extensively in discussion on nuclear safety regulation and policy, to restore public trust in the civilian use of nuclear energy. Such a mechanism is considered necessary because our examination thus far has revealed that the current communication efforts—i.e., the Nuclear Regulation Authority's (NRA's) disclosure of records of its internal meetings and NRA commissioners' meetings with outside parties, and the dissemination of decommissioning information by utilities and the central government—have not led to a situation where a broad spectrum of people would be informed properly to examine and make judgements about the current and future states of nuclear energy.

When we look at practices in other countries, it is typically the case that the legislature, formed of representatives of the public, undertakes the function of oversight over nuclear administration, thereby preventing the regulatory body from giving up the transparency of decision making, and arousing public interest in nuclear energy.

In Japan, the final report of the Fukushima Nuclear Accident Independent Investigation Commission (NAIIC), an investigative body set up by the Diet in the wake of the accident, called for establishing a standing committee in the Diet to oversee and evaluate the performance of nuclear regulatory administration, whereby the legislature would be involved in regulatory administration for nuclear safety on a continuous basis. However, even today, 10 years after the accident, such a permanent committee is not yet in place, with legislators busying themselves with inter-party conflicts, and as nuclear energy has been lowered in priority as an issue subject to deliberation at the Diet.

In this Chapter, we will first provide an overview of practices in other countries: to how the legislature oversees nuclear regulatory administration and policy implementation, and then, examine the possibility of establishing a system in Japan in which the legislature oversees regulatory administration for nuclear safety and promotes democratic control over nuclear energy.

(1) Legislature's roles in overseeing nuclear safety regulation and policy: Overseas examples

In Chapter 1, we mentioned that after the Fukushima Daiichi nuclear accident, it became a requirement for the NRA to disclose to the public any meeting with a utility lasting five minutes or more. For the NRA, launched with the mission of ensuring the transparency of decision-making process and tasked to implement safety regulation free from intervention from utilities, politics, or any government agency promoting nuclear energy, this practice has been serving as a precious occasion to demonstrate its commitment to the public.

However, in terms of making people more interested in its work and nuclear policy, the NRA needs to make more efforts to further increase the transparency of its decision-making process and engage in more active communication with the public. For instance, although the NRA invites public comments on standards for safety regulation and other matters, it is not required to respond to them. In contrast, the U.S. Nuclear Regulatory Commission (NRC) has the duty to respond to inquiries from the public.

Furthermore, some other countries using nuclear energy for civilian use, are implementing democratic control over nuclear energy by having the legislature oversee nuclear administration, thereby preventing the regulatory body from failing to fulfill its duty to ensure the transparency of its decision-making process and engage in communication with the public. We believe that analyzing these examples from other countries provides new suggestions to Japan. In this section, we will introduce the roles and authority of the legislature in the United States, Finland, and France.

1) United States: Nuclear regulatory administration subject to oversight by the House and the Senate based on their respective authority

Among nuclear regulatory bodies in other countries, the U.S. NRC is the one that Japan looked to most as a model in establishing the NRA, a new regulatory body, after the Fukushima Daiichi nuclear accident, and we discussed in Chapter 1 that the U.S. NRC is upholding its independence not only in terms of being free from political intervention and having autonomy over personnel decisions but also in terms of having the ability to make technical decision on its own, and that it is putting a great deal of efforts into training inspectors so as to ensure that its safety reviews are not influenced by industry lobbying. At the same time, another characteristic of the United States is that it has a congressional oversight system, under which the U.S. Congress oversees the activities of the NRC to prevent it from becoming self-serving.[68]

The oversight authority rests with the Senate Committee on Environment and Public Works and the House Committee on Energy and Commerce. In addition, the NRC is required to submit its activity reports to the House and Senate Budget Committees on a semi-annual basis for review of its budget execution.

One case in which the U.S. Congress rendered its opinion and advice on the NRC's regulatory administration after the Fukushima Daiichi nuclear accident is about the installation of filtered containment venting systems, over which the NRC and utilities had disagreement as to whether make it subject to the new safety regulation.

A filtered containment venting system is an exhaust system designed to reduce the pressure and temperature inside to prevent damage to the reactor containment vessel in the event of a severe accident, such as one that would cause a fuel meltdown, by venting the vapors into the atmosphere while minimizing the release of radioactive substance.[69] Radioactive steam taken in via the pipe

68 National Diet Library, Japan, "*Amerika no Genshiryoku Anzen Kisei Kikan: Genshiryoku Kisei Iinkai (NRC)* [Nuclear Safety Regulatory Body in the United States: Nuclear Regulation Commission (NRC)]," June 2010. (https://dl.ndl.go.jp/view/download/digidepo_3050508_po_024404.pdf?contentNo=1), accessed on August 6, 2020.

69 Japan Atomic Energy Relations Organization's (JAERO's) Energy Encyclopedia, "*Firuta-tsuki Bento Setsubi wa Donna Mono?* [What Is a Filtered Containment Venting System?]," (https://www.ene100.jp/commentary/2269), accessed on October 30, 2020.

from the container vessel goes through a tank filled with a chemical solution and a metal filter which adsorbs radioactive substances. As a result of this process, the amount of radioactive substance contained in the steam is reduced to 1/1000-1/10000 of the original amount before its release to the atmosphere. In Japan, filtered containment venting systems are put in place at all nuclear power plants as utilities are required to install such systems as one of their obligations under the new safety standards established after the Fukushima Daiichi nuclear accident.

Likewise, in the United States, the NRC started discussions in March 2012 on whether it should introduce a new regulatory rule requiring utilities to install filtered vents on containment vessels for nuclear reactors of the same type as those that suffered meltdown during the Fukushima Daiichi nuclear accident. However, utilities found it questionable that filtered vents would provide benefits commensurate with the cost of their installation amounting to nearly 2 billion yen, and feared that should it become a requirement, some of the existing reactors would have to be decommissioned earlier than planned because they would not be able to afford the investment. Pointing to these concerns, utilities asked the NRC to consider alternative ways to secure safety.

The NRC, which had initially planned to finalize its policy by the end of July 2012, postponed its decision as its discussion with utilities went awry. Having been observing the interactions between the two sides, a group of 21 legislators on the House Committee on Energy and Commerce led by its chairman, sent a letter to the NRC chairman on January 15, 2013, based on congressional authority to oversee nuclear regulatory administration. An outline of the letter is as follows:

- The House Committee on Energy and Commerce's concerns stem from the NRC's failure to conduct rigorous technical and cost-benefit analysis. The NRC appears to be failing to consider the cumulative effects of safety measures that have already been implemented and those to be taken. It must not ignore the serious risk that piecemeal consideration of safety measures on an independent basis may yield unintended consequences.
- It is natural that the regulatory requirements imposed in the United States are different from those in Japan. In trying to answer the question of whether an accident like the one in Fukushima can happen in the United States, it is important to know what protections and gaps in the protections existed in the Fukushima Daiichi NPS, and identify whether those gaps exist in the United States. To have a sound basis for regulatory changes, it is essential to conduct a comparative evaluation of U.S. and Japanese regulatory requirements. Without such an international comparison of nuclear regulations, it is impossible to make sensible regulatory changes and public confidence in the NRC will be undermined.
- A piecemeal approach of deciding the filtered vent issue in isolation, which would potentially erode the adequate protection standard, is not appropriate. The committee urges the NRC to take the time necessary to thoroughly consider the matter.

Partly persuaded by these suggestions from the Congress, the NRC on March 19, 2013, voted against immediately issuing an order requiring the installation of filtered vents, and instead decided to consider developing a comprehensive set of rules including other measures.[70]

Although the Congress made suggestions seemingly in favor of utilities in this example, on another occasion prior to the Fukushima Daiichi nuclear accident, the Congress ordered the NRC to require utilities to take more robust safety measures in light of lessons from the terror attacks of September 11, 2001.[71]

Being composed of representatives elected by the public, the Congress is in a position to receive requests and demands from various stakeholder groups outside the Congress, including the nuclear industry and non-governmental organizations (NGOs) present in local communities hosting nuclear power plants. As such, the NRC implements nuclear safety regulation by developing its regulatory policy on its own and makes changes when needed, while being checked by people at all levels of society through the congressional power to oversee nuclear regulatory administration.[72]

2) Finland: Decision-in-Principle system and the roles of the parliament

Finland has a Decision-in-Principle (DiP) system as a process for national decision-making on nuclear projects such as the construction of nuclear power plants and the selection of final (geological) disposal sites for spent nuclear fuel. The term "decision-in-principle" refers to a document adopted by the government as grounds for implementing policy decisions made by the government or relevant government agencies and the act of giving approval to the content thereof, and a decision-in-principle becomes an official national decision only after it is examined and ratified by *Eduskunta* (Finnish parliament). The procedure is unique to Finland.[73]

In 1987, one year after the Chernobyl nuclear accident in the former Soviet Union, a neighboring country, Finland overhauled its nuclear energy law to make the DiP procedure a statutory requirement in introducing a new nuclear facility. The procedure is initiated by a utility submitting a nuclear-related project plan to the relevant government agency. Then, the government reviews the adequacy of the project from the viewpoint of whether it is beneficial to the local community and the country as well as whether there is any adverse impact such as damage to the environment. Upon approval by the government, the project plan is granted a decision-in-principle, and the government submits it in writing to the parliament. At the parliament, the DiP document is first deliberated by a relevant committee (or committees) and then at the plenary session to decide on its ratification. When ratified, the project plan becomes an official national decision. In granting a

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70 Federation of Electric Power Companies of Japan (FEPC), "*Beikoku ni okeru Genshiryoku Kisei to Renpo Gikai ni yoru Kanshi Kino* [Nuclear Regulation and Congressional Oversight in the United States]," (https://www.fepc.or.jp/library/kaigai/kaigai_kaisetsu/1227866_4141.html), accessed on October 26, 2020.

71 Tatsujiro Suzuki, Hideaki Shiroyama, and Setsuo Takei, "*Anzen Kisei ni okeru 'Dokuritsusei' to Shakaiteki Shinrai: Beikoku Genshiryoku Kisei Iinkai wo Sozai toshite* [Independence and Social Trust in Safety Regulation: The case of the Nuclear Regulatory Commission and its implication]," *Shakai Gijutsu Kenkyu Ronbunshu* [Collection of Research Papers on Social Technology], vol. 4, December 2006, p.165

72 *Id.* p.164

73 Radioactive Waste Management Funding and Research Center (RWMC), "*Finrando ni okeru Chiso Shobun no Gaiyo* [Overview of Geological Disposal in Finland]," (http://www2.rwmc.or.jp/pub/hlwkj201102ed-2.pdf), accessed on November 4, 2020.

decision-in-principle, the government is required to obtain consent in writing from the host municipality for a proposed nuclear facility. T. Mika of Teollisuuden Voima Oy (TVO), a private-sector utility operating the Olkiluoto nuclear power plant, explains that when it comes to nuclear-related projects, it is necessary to obtain understanding not only from the local municipality and residents concerned but also from all the people of the country.[74]

The DiP system, which provides the parliament with authority to get involved in nuclear-related projects, was established in response to growing public anxiety over the civilian use of nuclear energy and the rise of anti-nuclear sentiment in the aftermath of the Chernobyl nuclear disaster. Following the introduction of the system in 1987, Finland made a significant change to its nuclear policy, not only strengthening the safety regulation but also abandoning the idea of pursuing a closed nuclear fuel cycle, which involves extracting plutonium from spent fuel for reuse. In 1994, another set of amendments were made to the nuclear energy law to prohibit the export and import of spent nuclear fuel, which had previously been transported to Russia, and requires all the spent nuclear fuel to be disposed of permanently within the country.[75]

Regarding the permanent disposal of spent nuclear fuel, Finland is the only country among those using nuclear energy for civilian use that has a state-approved plan underway to construct a deep geological repository for high-level radioactive waste, i.e., a deep underground facility in an extremely hard bedrock to bury spent nuclear fuel for long-term storage, with an eye on commencing operations as early as in 2025.

Approval for this project was obtained through the DiP procedure. The site selection process began in 1983 but it proceeded only with a great deal of difficulty as some of the potential host municipalities exercised the right to veto. It took more than 15 years before the project was granted a decision-in-principle from the government in 2000. Then, in 2001, it was ratified by the parliament with approval given by the relevant committees and the plenary session to turn the decision-in-principle into an official national decision.

According to Mika, legislative oversight in Finland has the following two characteristics: 1) the DiP system is serving as a mechanism of democratic supervision, and 2) the relatively high public interest in nuclear energy and the government's energy policy in general is making the system workable.

The first characteristic works to better prevent utilities from engaging in fraudulent activities, such as bribing officials of potential host municipalities for nuclear facilities, by placing them under the supervision not only of the government but also of the parliament. The second characteristic is attributable to the state of electricity supply in Finland. As shown in Fig. 5, nuclear energy is the largest source of electricity in Finland, providing 25% of total supply, but the country relies just as much on electricity imports from Russia, which accounts for 23%.

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74 Interview with the TVO official in charge of nuclear business conducted as part of the SPF's fact-finding mission to the Olkiluoto nuclear power plant and the site for the Onkalo spent nuclear fuel repository on October 6, 2019.

75 *Id.*

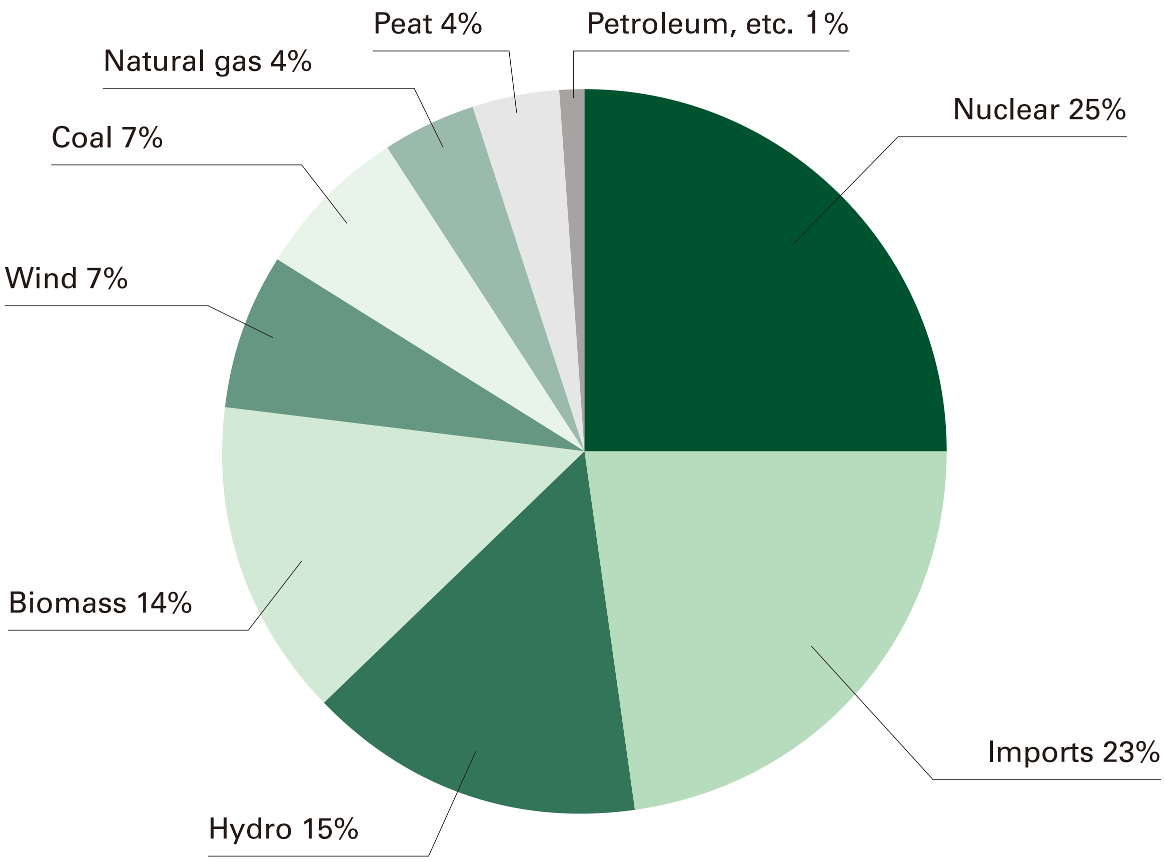

Fig. 5: Electric power mix in Finland (2018)

Source: Created by authors based on explanatory materials provided by TVO during the fact-finding mission to the Olkiluoto nuclear plant and the site for the Onkalo spent nuclear fuel repository on October 6, 2019.

Finland used to be part of the Russian empire. Even after its independence in 1917, Finland was threatened by the Soviet Union during Second World War II. More recently, Russia annexed Crimea in 2014 and has since been conducting large-scale military exercises in the Baltic Sea in a seemingly threatening move, raising security concerns among people in Finland.[76] The level of public interest in the parliamentary debate on energy policy is high and they are in favor of reducing electricity imports from Russia. As a result, Mika says, people living in areas other than those hosting nuclear facilities are just as much interested in decisions-in-principle for nuclear projects and relevant deliberation at the parliament.

3) France: Democratic control over nuclear administration via the OPECST

The Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST: *Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques*), an organ of the French parliament, examines and evaluate scientific and technological policy decisions and the adequacy of the choice of policies in social projects, and is composed jointly of members of the National Assem-

76 "*Dokuritsu 100-nen Mukaeru Finrando, Rosia no Yokoyari Keikai* [Finland Sees Propaganda Attack from Former Master Russia]," October 23, 2016, (https://jp.reuters.com/article/finland-independence-russia-idJPKCN12L0V7), *Reuters*, accessed on October 10, 2019.

bly (equivalent to the House of Representatives in Japan) and the Senate[77] (upper house). It is not entirely dedicated to assessing nuclear administration, but its establishment was prompted by public concern over the uncertainty of nuclear technology.

In the early 1980s, France experienced a series of serious incidents associated with the development and test operation of fast breeder reactors (FBRs), a key component of the nationally promoted nuclear fuel cycle program. The occurrence of such incidents—which included the leakage of sodium, a reactor coolant, which could have easily turned into a severe accident—led to growing public calls for parliamentary involvement in national projects and policy programs in the field of science and technology, instead of leaving them all to relevant experts and government agencies, in order to achieve greater information disclosure and ensure the transparency of policymaking process concerning the choice of technologies. In 1983, the OPECST came into being with the bill for its establishment approved by both chambers of the parliament.[78]

As an organ of the parliament, the OPECST submits reports on its studies and investigations to the parliament and is designated as a standing committee. It is composed of 36 members, 18 each from the National Assembly and the Senate. The OPECST is independent from the executive branch of the government and free from interference from external parties. Its assessment is focused on scientific and technological policy decisions that affect the environment and people's health, with those in the areas of nuclear energy and bioengineering such as genetic modification being the primary targets.

According to the Engineering Academy of Japan (EAJ), which sent a research team to the OPECST in 2019, parliament members are increasingly taking it upon themselves to analyze and develop reports, instead of outsourcing the task to external think-tanks, a tendency that has been observed in recent years in response to the criticism that many of OPECST reports were no more than summaries of interviews with experts.[79]

Subjects for study are set at the request of various parliamentary committees, political parties, or individual legislators, followed by the appointment of OPECST members in charge. Study programs are carried out under the responsibility of those legislators in charge. Although they can set up working groups and/or employ experts, they play the leading role in conducting studies. In the process, public hearings are organized to hear opinions of various stakeholders such as business operators, experts, and environmental NGOs. The number of participants often exceeds 100.

One often-cited example as a model case of democratic oversight over nuclear-related matters is the one in which the selection of potential sites for a high-level radioactive waste disposal facility was halted.

In France, the Atomic Energy Commission (CEA: *Commissariat à l'énergie atomique*), which was in place at the time, embarked on geological surveys in four potential sites for nuclear waste disposal in the 1980s, in line with its basic policy to bury high-level radioactive waste in stable bedrock for

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77 Members of the Senate are elected not directly by voters, but through indirect elections with local assembly members serving as electors. As such, the results of nationwide local elections are directly reflected in the composition of the Senate.

78 "*Présentation de l'Office Parlementaire d'Évaluation des Choix Scientifiques et Technologiques (OPECST)* [The Parliamentary Office for Scientific and Technological Assessment – Presentation]," French Senate website, (http://www.senat.fr/opecst/presentation.html), accessed on September 10, 2020.

79 Interview with Hiroshi Nagano of the Engineering Academy of Japan (EAJ) on September 19, 2019.

final disposal, but was forced to halt its efforts in the face of fierce opposition from residents in the local communities. The OPECST investigated into the reasons behind the massive protests and for any defects in the relevant government agency's procedures and communication with residents in the local communities, and then, reported its findings to the parliament. This led to the establishment of the 1991 Law on Radioactive Waste Management Research (Law No. 91-1381 of December 30, 1991), under which the CEA was required to carry out research over the next 15 years to look into the following three options, without limiting the choice to geological burial.

- Conversion of long-lived radioactive nuclides into short-lived nuclides
- Reversible or irreversible deep geological disposal in a stable bedrock
- Long-term interim storage above ground

The law also required the government to report annually to the parliament on the progress made in the above research activities and to present by 2006 a conclusion summarizing the entire research and an evaluation of findings thereof.

Thus, under the leadership of the implementing body, the National Radioactive Waste Management Agency (ANDRA: *Agence Nationale pour la gestion des Déchets Radioactifs*), and the CEA, research was carried out on the three options as provided for under the law, and a final report on research findings was submitted to the parliament in 2005. The report was reviewed by the OPECST, leading to the establishment of the Law on the Sustainable Management of Radioactive Materials and Waste (Law No. 2006-739 of June 28, 2006)[80] that calls for promoting the permanent disposal of high-level radioactive waste primarily by means of reversible deep geological disposal[81] to allow for undoing in the event of any problem in the future.

The OPECST is unique in that legislators are directly involved in research activities, a practice not observed in other countries, which would be like the legislature in Japan exercising their right to investigate at all times. Also, public hearings serve as an occasion to encourage participation of people at all levels of society and attract media attention, thereby having the effect of engaging the public in the process of making scientific and technological policy decisions including those on nuclear energy. Because of such a track record, the OPESCT is attracting much attention from other countries as a model practice for implementing democratic oversight over scientific and technological policy decisions.

(2) Legislative oversight over nuclear administration in Japan

From the examples introduced above, we can see that legislative oversight over nuclear administration and policy is playing a role complementary to the public's right to know by preventing the relevant government agencies and experts from becoming self-serving in decision-making in the highly technical field of nuclear energy. In fact, there was a recommendation after the Fukushima

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80 Radioactive Waste Management Funding and Research Center, "*Furansu ni okeru Ko-Reberu Hoshasei Haikibutsu no Shobun ni tsuite* [Disposal of High-Level Radioactive Waste in France]," (https://www2.rwmc.or.jp/pub/HLWKJ-201202ed-hd-FR.pdf), accessed on November 4, 2020.

81 Reversibility in the context of geological disposal refers to the situation in which spent nuclear fuel buried in a bedrock for disposal can be retrieved in the event of any environmental damage.

Daiichi nuclear accident that Japan should follow suit and institutionalize legislative oversite over the nuclear regulatory body. In what follows, we will first examine the background to this recommendation and the current situation, and then consider the possibility of implementing democratic oversight over nuclear administration in Japan.

1) NAIIC's recommendation

In its final report, the NAIIC recommended that a standing committee responsible for oversight and evaluation of the nuclear regulatory administration be established within the Diet and the legislature continuously play a role in enhancing nuclear safety. The recommendation was made by reflecting on the problematic nature of the previous nuclear regulatory administration, one that had been in place before the Fukushima Daiichi NPS and failed to prevent the severe accident. It has been pointed out that nuclear safety inspections conducted by the previous regulatory body were rendered toothless through mutual backscratching and behind-the-scenes consultations between the regulatory body and utilities, which has been cited as one factor behind the Tokyo Electric Power Company's (TEPCO's) failure to mitigate the situation before things got out of control.

In the NAIIC's final report, the above proposal is presented as "Recommendation 1" at the top of the list of recommendations. From this we can see that the NAIIC, an investigative commission empowered by the legislature, was putting a great deal of emphasis on the legislature's function as a check on the administrative branch of the government and urging both chambers of the Diet to implement democratic oversight over nuclear administration, which is technical and difficult to make understandable to the public. The content of the recommendation is as follows:

■ Recommendation 1: Diet's oversight over the nuclear regulatory body

A standing committee on nuclear energy issues should be established within the Diet to oversee the nuclear regulatory body and thereby to safeguard the health and security of the public. This committee should be responsible for:

1) conducting hearings with regulatory body officials to listen to their explanations and with stakeholders, members of academia, and so forth to seek their opinions, and undertaking other investigations on a regular basis;
2) establishing an advisory body of experts, who are independent from utilities and government agencies and equipped with global perspectives to enable the committee to address safety problems with the latest knowledge and expertise;
3) engaging in the on-going monitoring of progress in the implementation of corrective measures and improvements made regarding numerous problems identified in the investigation of the Fukushima Daiichi nuclear accident; and
4) monitoring progress in the government's implementation of recommendations made in this report and requiring the government to report regularly to the committee.[82]

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82 NAIIC's final report, July 2012, p.22.

As areas requiring monitoring by the Diet, the report cites challenges that should be addressed by utilities in continuing to use nuclear energy for civilian purposes, such as safeguarding nuclear power plants from the threats of cyberattacks and nuclear terrorism, in addition to calling for the establishment of a new regulatory body and new safety standards, and other efforts based on lessons learned from the Fukushima Daiichi nuclear accident.

The NAIIC maintains that such checking by the Diet on nuclear administration does not contradict the independence of the new regulatory body, another point made in its final report, noting that the transparency of nuclear regulatory administration can be ensured by requiring the regulatory body to fully disclose the safety standards it imposes on utilities, including by reporting to the Diet on the implementation of the standards and its evaluation of compliance therewith by utilities.[83]

2) Diet's involvement in nuclear regulatory administration

The NAIIC submitted its final report to the Speaker of the House of Representatives and the President of the House of Councilors in July 2012, but the recommendation calling for the establishment of a standing committee for oversight of nuclear administration was not given due consideration. It was in the final months of the government of the former Democratic Party of Japan (DPJ) and political parties were moving into an election mode amid the growing likelihood of snap general elections. It was on only after the change of government that brought the Liberal Democratic Party (LDP) back to power and during the regular Diet session of 2013 (January 28) that the Special Committee for Investigation of Nuclear Power Issues was established within the House of Representatives, with its first deliberation further delayed until April 8, 2013. Not designated as a standing committee, it was not keen to take strong actions to tackle the problems facing the Fukushima Daiichi nuclear accident or to deal with the newly established nuclear regulatory body.

Kiyoshi Kurokawa, who served as NAIIC chairman, has been repeatedly calling for the establishment of a standing committee for overseeing nuclear administration, but so far to no avail. As factors behind this, many cite the reality of Japanese politics, in which getting involved in scientific and technological policy decisions, including those on nuclear energy, does not win votes in elections, and Japan's inability to change the customary practice of making legislative decisions through behind-the-door deal making between senior members of the ruling and opposition parties.[84]

In his book, Yasuhisa Shiozaki, a legislator belonging to the LDP, who devoted considerable effort to establishing the NAIIC while the LDP was out of power, calls for Japan to break away from "*kokutai seiji*" or "politics of Diet management committees" as the practice is referred to, and shift to a system in which the Diet functions as a check on the government, one of the key roles expected of the legislature. He points out the importance of the Diet's role of overseeing nuclear regulatory administration, noting that legislators must enhance their expertise and investigative abilities so that they can draw up bills—even those covering highly technical policy areas such as nuclear—on

83 NAIIC's final report, pp.594-599

84 Interview with Kiyoshi Kurokawa conducted on July 19, 2019.

their own without relying on government agencies.[85]

As it appears, however, even after experiencing the catastrophe of the Great East Japan Earthquake and the Fukushima Daiichi nuclear accident, the customary *kokutai seiji* practice as referred to by Shiozaki remains unchanged. Speaking of the current situation, one ruling party legislator said that the Special Committee for Investigation of Nuclear Power Issues is like a fatal boomerang. "The NAIIC was established to denounce nuclear governance under the government of the (former) DPJ. If its activities are continued, we could be the one to be denounced this time around," he said.[86]

In the end, it was determined that the Special Committee for Investigation of Nuclear Power Issues would be set up by consultation and agreement between the ruling and opposition parties for each session of the Diet, thus it is not designated as a standing committee. Although the special committee has within itself a six-member advisory board made up mainly of members of the NAIIC, including Kurokawa, to discuss the current nuclear regulatory administration, it is far from playing an oversight role.

Had it been that the special committee was established as a standing committee requiring the NRA report to it on nuclear regulatory administration, for instance by summoning the NRA chairman on a regular basis, it could have been possible to draw public attention and the legislature might have been able to make proposals that lead to solutions to a series of problems discussed in Chapter 1, such as: problems with the current arrangements for emergency preparedness, in which local emergency preparedness plans are developed by individual municipalities without any involvement of the NRA. Also, if designated as a standing committee, it might be able to play an intermediary role in communication and reconciliation of interests among various parties concerned about the decommissioning and end state of the Fukushima Daiichi NPS to break the impasse in the discussions.

Kurokawa and other members of the advisory body are continuing to appeal to legislators of both the ruling and opposition parties on the importance of legislative oversight of nuclear administration while calling on other nuclear experts to join their cause. Kurokawa says, "Although a standing committee has not been established, the overall review of the Fukushima Daiichi nuclear accident and the examination of the current nuclear regulatory administration should be carried out under the responsibility of the Diet, which created the NAIIC, on the occasion of this milestone year marking the 10th anniversary of the accident."[87]

(3) Summary

Nuclear regulatory administration and government policy for the use of nuclear energy, which are too technical for the public to understand, are prone to opaque communication between the government agency in charge and utilities. Because of this, each country using nuclear power is seeking to ensure transparency by requiring the relevant government agency, by law, to disclose

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85 Yasuhisa Shiozaki, 2012, *Kokkai Genpatsu Jiko Chosa Iinkai: Rippofu karano Chosenjo [NAIIC: A letter of challenge from the legislature]*, Tokyo Press Club.

86 Interview with a Diet member conducted in November 2019.

87 Interview with Kiyoshi Kurokawa conducted in July 2019.

information on its communication with utilities. On top of this, some overseas countries are trying to raise public interest in nuclear energy by having the legislature undertake the function of oversight over nuclear administration.

In the United States, House and Senate standing committees are granted authority to oversee the NRC's nuclear regulatory administration, whereby they independently evaluate decisions made by the NRC and call for changes thereto if deemed necessary, acting upon requests or proposals from various parties concerned including utilities, residents in host communities, experts on nuclear engineering, and environmental NGOs. Meanwhile, Finland has a system in which the government's approval of nuclear projects, such as the construction of a new nuclear power plant, based on its review of safety measures taken by utilities and consent obtained from host municipalities, are considered as decisions-in-principle, which become official national decisions only after they are ratified by the relevant parliamentary committees and the parliament. In France, a parliamentary committee set up jointly by the National Assembly and the Senate evaluates, from a legislative standpoint, the adequacy of scientific and technological policies including nuclear policies, and if necessary, legislates a new law to impose new rules on government agencies in charge.

In Japan, following the Fukushima Daiichi nuclear accident, it was recommended that a standing committee responsible for overseeing nuclear regulatory administration be established within the Diet, but this has not been realized yet. In the meantime, it has been pointed out that the current system, in which local emergency preparedness plans—a set of measures to take in the event of a severe accident at a nuclear power plant—are the responsibility of individual municipalities without any involvement of the NRA, may not be as effective as systems in other countries. As such, 10 years after the accident, problems with the current nuclear regulatory administration have come into focus. It is about time for Japan to consider establishing a system in which the Diet exercises legislative oversight over nuclear administration as a means to enhance public interest in nuclear administration and realize democratic oversight over nuclear administration.

Chapter 4 (Conclusion): Enhancing the Effectiveness of Risk Management

In this report, we examined Japan's nuclear administration over the past 10 years since the Fukushima Daiichi nuclear accident by making the hypothesis that the accident represents a failure of society to manage the risks inherent in scientific technology and, because of this failure, public trust in the civilian use of nuclear energy was lost. We argued that in order to restore the lost trust, it is important to evaluate risks inherent in nuclear energy, specify in law which government agency should be responsible for measures to manage those risks, and communicate with residents in host communities and people at all levels of society by disclosing information. To that end, we examined three perspectives. First, we examined communication between the Nuclear Regulation Authority (NRA) and utilities on one side and municipalities and residents in the areas hosting nuclear power plants on the other. Second, we analyzed the governance of the decommissioning process at the Fukushima Daiichi NPS as to how the government and the Tokyo Electric Power Company (TEPCO) have disclosed information on risks involved and how they have been communicating with the host and nearby municipalities and residents. Lastly, we introduced overseas examples of legislative oversight of nuclear administration as a way to embrace more people at all levels of society interested in nuclear energy, and explored challenges faced in introducing such a system in Japan.

In all the three perspectives, the focal point is how to establish and enhance communication among parties concerned and people at all levels of society regarding risks inherent in nuclear energy. As discussed in the Introductory Chapter, up until the Fukushima Daiichi nuclear accident, both the government and utilities were extremely disinclined to disclose risk information out of fear of contradicting their initial explanation that Japanese nuclear power plants are free from severe accidents. After the accident, the NRA was established, and it was decided that virtually all meetings between NRA commissioners and utilities would be made open to the public and so would be information on risks. In Chapter 1, we analyzed specific examples of communication between the NRA and utilities and our findings pointed to the importance of ensuring the principle of information disclosure in nuclear regulatory administration and continuing to disclose risk information. However, information on risks associated with decommissioning work, such as the delays in the permanent disposal of contaminated water and the removal of nuclear fuel debris discussed in Chapter 2, has not been sufficiently disclosed, and legislative oversight over nuclear administration, which is the theme of Chapter 3, seems to have a long way to go before being realized with in-depth discussions taking place, and the momentum for introducing such a system, where a broad spectrum of people discuss the use of nuclear energy with sufficient knowledge of risks associated therewith, is not quite there. In other words, neither the disclosure of information on risks inherent in nuclear energy nor communication between and among the government, utilities, and public is sufficient.

At the same time, however, some new attempts and proposals have been made based on the recognition of the lack of communication under the current nuclear regulatory system. Examples include the NRA's communication with municipalities hosting nuclear power plants and the proposal by the mayor of Kashiwazaki City, Niigata Prefecture, which is home to TEPCO's Kashiwazaki-Kariwa NPS, calling for a legally established forum for communication between and among the local governments concerned, the utility, and the regulatory body, as discussed in Chapter 1. We do hope that these moves will lead to the establishment of permanent, legally based communication forums composed of the government, the utility concerned, the regulatory body, the local governments, and representatives of residents to discuss how to manage risks associated with the use of nuclear energy and review the safety regulations and local emergency preparedness plans on a constant basis to improve their effectiveness.

Once such legally based communication forums are established, forum members must engage in straightforward discussions even on the most challenging issues, i.e., how to deal with the risk of occurrence of severe accidents that would have the most serious impact on society and the environment or other unforeseen contingencies, and the whole society must work to establish a robust risk management system. The latest results of an annual public opinion survey conducted by the Japan Atomic Energy Relations Organization (JAERO) shows that the percentage of respondents with a negative view of the emergency preparedness of their nearby nuclear power plant continues to exceed by a significant margin that of those with a positive view, testifying to the reality that people are deeply distrustful of utilities regarding their preparedness for severe accidents and other unforeseen contingencies.

For instance, the lack of preparedness for unforeseen contingencies can be seen in Japan's inaction on a discrepancy between international recommendations and domestic guidelines on occupational radiation dose limits in the event of a severe accident. The current criteria for dose limits recommended by the International Commission on Radiological Protection (ICRP) provides 500 or 1000 mSv only as "reference levels" in emergency exposure situations and sets "no dose restrictions" for those engaging in rescue operations. Meanwhile, in Japan, the 250 mSv limit, which was introduced in a makeshift manner in the wake of the Fukushima Daiichi nuclear accident, has been used and remains effective today, and no discussion has been made on the discrepancy with the ICRP recommendations. It should also be pointed out that after the accident, not only disaster specialists but also some members of the Diet called for creating a government agency specialized in emergency response, an equivalent to the Federal Emergency Management Agency (FEMA) of the United States, to address the need for quick coordination among multiple agencies involved in on-site and off-site response operations in a nuclear accident,[88] but that little discussion has taken place on this proposal.

Given the current situation, where nuclear safety administration is being carried out with little regard given to proposals by legislators, it is all the more important for the legislature to implement democratic oversight over nuclear administration as discussed in Chapter 3. Establishing a standing committee responsible for such oversight within the Diet and requiring the NRA to report regularly to the committee on its regulatory activities for nuclear safety would increase the transparency of regulatory administration for nuclear safety. In addition, if the results of legislative assessment of nuclear regulatory administration is made available to the public, it would stimulate communica-

88 Minutes of the deliberations of the 186th session of the Diet, February 2014, (http://www.shugiin.go.jp/internet/itdb_kaigirokua.nsf/html/kaigirokua/001818620140224013.htm).

tion and raise public interest in the management of risks associated with the use of nuclear energy.

Today, 10 years after the Fukushima Daiichi nuclear accident, Japan and the world are beset with the COVID-19 pandemic. Just like the severe nuclear accident, the COVID-19 pandemic came as an event almost beyond imagination for Japan. The government could not implement emergency response measures quickly enough with opinions divided over which law to invoke to provide a legal ground for setting a policy for dealing with the pandemic. As such, it would be lying to say the lessons of the Fukushima Daiichi nuclear accident had been learned. How to establish and enhance a society-wide risk management system, including the capability of responding to unforeseen contingencies, remains a challenge for Japan, just as was at the time of the Fukushima Daiichi nuclear accident.

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Appendix 2: General Description of the Fukushima Daiichi NPS

The Fukushima Daiichi Nuclear Power Stations (NPS) played a leading role in expanding the civilian use of nuclear energy in Japan. With its first reactor, Unit 1, commissioned in March 1971, it commenced operations as the Tokyo Electric Power Company's (TEPCO's) first commercial nuclear power plant. The number of reactors increased to six by 1979 to supply electricity to the Tokyo metropolitan area. It is located some 250 km away from Tokyo, hosted by two towns—Futaba and Okuma—along the Pacific coast in the Hamadori region of Fukushima Prefecture (see Fig. 6). All six reactors are boiling water reactors (BWRs)[89] with a Mark I or Mark II containment system[90] developed by General Electric (GE) of the United States, subsequently with the participation of Toshiba and Hitachi for Unit 2 and those that followed (see Table 6).

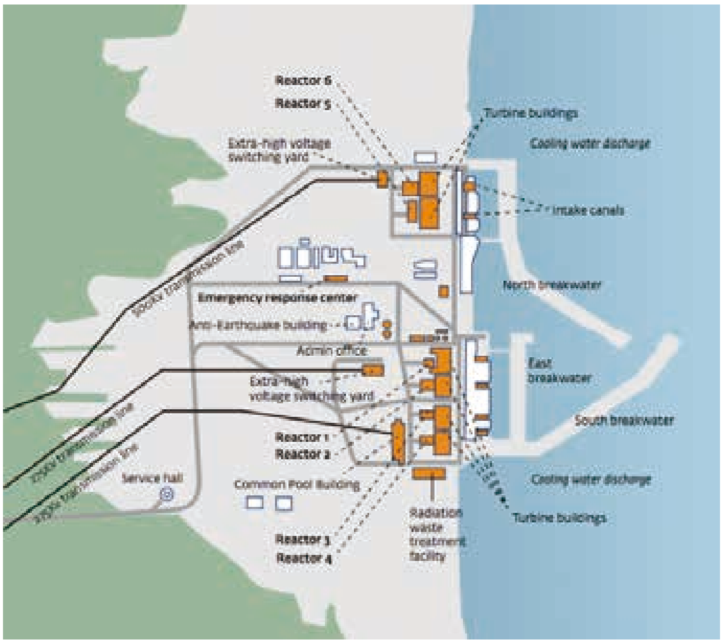

Fig. 6: Layout of the Fukushima Daiichi NPS

Source: Fukushima Nuclear Accident Independent Investigation Commission's (NAIIC's) final report (English version), 2012

Table 4: Nuclear reactors at the Fukushima Daiichi NPS

Reactor	Containment type	Capacity (MW)	Builder (s)	Start of operation
Unit 1	Mark I	460	GE	March 1971
Unit 2	Mark I	784	GE / Toshiba	July 1974
Unit 3	Mark I	784	Toshiba	March 1976
Unit 4	Mark I	784	Hitachi	October 1978
Unit 5	Mark I	784	Toshiba	April 1978
Unit 6	Mark II	1100	GE / Toshiba	October 1979

Source: Fukushima Nuclear Accident Investigation Committee's (TEPCO investigation committee's) report, 2012.

89 BWRs boil water by nuclear fission to create large quantities of steam which is then sent via pipes to drive the turbines to produce electricity. "*Keisuiro no Shikumi* [How a Light-Water Nuclear Reactor Works]" at the Federation of Electric Power Companies of Japan's (FEPC's) website (https://www.fepc.or.jp/enterprise/hatsuden/nuclear/keisuiro/index.html), accessed on February 27, 2020.

90 Classified by the shape and size of the containment vessel housing the nuclear reactor. Starting from Mark I, an early design, improvements were made in a step-by-step manner to increase the inner volume to make it easier to carry out inspections and maintenance. Entry under "*BWR (futtosui-gata genshiro) no genshiro kakuno yoki* [containment vessel of a BWR (boiling water reactor)]" in ATOMICA, an encyclopedia of nuclear energy (https://atomica.jaea.go.jp/data/detail/dat_detail_02-03-04-02.html), accessed on February 27, 2020.

One of the characteristics of the Fukushima Daiichi NPS is a large concentration of nuclear reactors. With six reactors, it has the second largest concentration of reactors in Japan, only next to TEPCO's Kashiwazaki-Kariwa NPS with seven reactors. Another characteristic is that containment vessels for those reactors and peripheral facilities vary from one reactor to another, a result of multiple builders involved in their development as shown Table 6. This complexity in the structure of the Fukushima Daiichi NPS was one factor that made the emergency response difficult. In a hearing conducted by the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations (ICANPS) after the accident, Masao Yoshida, who was then the manager of the Fukushima Daiichi NPS, stated as follows:

"We have a plant with a 460,000-kW reactor, four with 784,000-kW, and one with 1,100,000-kW. It is like a parade of different types of things, and we have GE, Toshiba, and Hitachi as builders. In a sense, the circumstance is peculiar in many ways. So, if I were asked whether we can bring someone from Kashiwazaki[-Kariwa NPS] to operate or do maintenance work for the Unit 1 reactor at the Fukushima Daiichi NPS, my answer would be no. And this will remain a big headache for us forever." [91]

"Operating in a small scale with four [reactors] at most, as is the case with the Fukushima Daini, would be the easiest in terms of operation management, including the scope of decisions under the purview of the manager. When you have six or seven, things get chaotic as was the case with Kashiwazaki at the time of the Chuetsu Earthquake." [92]

Until it became the site of the meltdown accident on March 11, 2011, the Fukushima Daiichi NPS had been a centerpiece of Japan's nuclear and overall energy policy, all the while being plagued with various structural problems such as those described by Yoshida. Since October 2010, the Unit 3 reactor of the Fukushima Daiichi NPS had been generating electricity using a new method of power generation called "pluthermal", which, together with fast-breeder reactors, constitutes a pillar of Japan's nuclear fuel cycle program involving the reuse of spent fuel.[93]

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91 Record of the ICANPS' hearing on August 8, 2011 (morning session), p.17.

92 Record of the ICANPS's hearing on August 9, 2011 (morning session), p.33.

93 Hitoshi Yoshioka, 2011, *Shinpan: Genshiryoku no Shakaishi [New Edition: A Social History of Nuclear Power]*, Asahi Shimbun Publishing, Inc., p.318. Out of total 54 nuclear reactors in Japan, only four reactors—Fukushima Daiichi Unit 3, Kyushu Electric Power's Genkai Unit 3, Shikoku Electric Power's Ikata Unit 3, and Kansai Electric Power's Takahama Unit 3—were generating electricity using the pluthermal method as of March 2011. Pluthermal refers to a method of power generation, in which plutonium extracted by reprocessing spent fuel is mixed with uranium to produce mixed oxide (MOX) fuel for use in nuclear power plants.

Appendix 3: Progression of the Fukushima Daiichi Nuclear Accident

At 2:46 pm on March 11, 2011, an earthquake of magnitude 9.0 occurred with an epicenter in the Pacific Ocean floor off the Sanriku coast, roughly 180 km to the north from the Fukushima Daiichi Nuclear Power Station (NPS) (see Fig. 7).

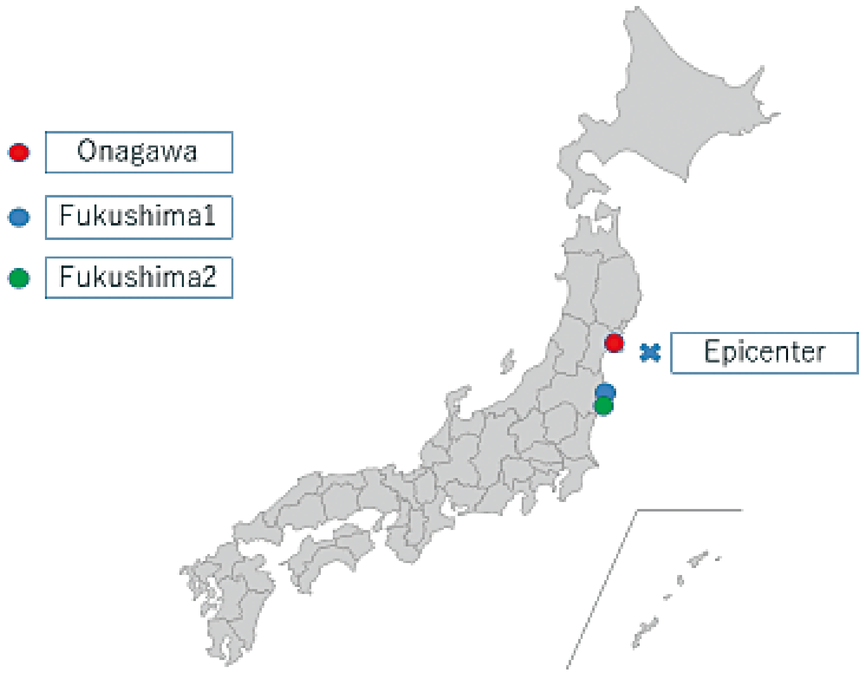

Fig. 7: Epicenter of the Great East Japan Earthquake

Note: The green and blue dots on the map indicate the locations of the Fukushima Daini and Daiichi Nuclear Power Stations respectively, while the red dot denotes the location of the Onagawa Nuclear Power Station operated by Tohoku Electric Power Company.

Source: Created by authors with reference to the final reports of the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of the Tokyo Electric Power Company (ICANPS) and the Fukushima Nuclear Accident Independent Investigation Commission (NAIIC), etc.

When the earthquake occurred, some 6,400 workers, including 750 employees of the TEPCO, were working at the Fukushima Daiichi NPS. Of the six reactors, Units 1, 2, and 3 were under normal operation, while Units 4, 5, and 6 were offline for scheduled inspections and maintenance. All three operating reactors were shut down automatically as emergency shutdown systems were activated upon detecting the ground motion and control rods were inserted to halt the fission chain reaction. In Unit 4, work had been going on since the fall of 2010 to replace the core shroud, a large structure within the reactor that surrounds the fuel assemblies, and there were more than 2,000 workers inside the nuclear reactor building. When the earthquake hit, most of them were evacuated and safe.

Then 41 minutes later, a giant tsunami of over 10 m, struck the Pacific coast the Tohoku region.

At Tohoku Electric Power Company's Onagawa NPS, a nuclear power plant closest to the epicenter, the tsunami height reached as high as 13.8 m. However, located in Miyagi Prefecture, which has experienced a series of tsunamis in its recorded history, the level of precautions against tsunamis was high even before the Fukushima accident. Accordingly, the Onagawa NPS has its reactors placed at 14.8 m above the sea level, higher than other nuclear power plants (for instance, compared to some 10 m at the Fukushima Daiichi NPS), and thanks for this, the damage from the tsunami was kept to the minimum. The Fukushima Daini NPS, located south of the Fukushima Daiichi NPS, was also hit by tsunami waves of over 9 m, but one of the four external power supply lines survived, and three of the 12 emergency diesel generators were not submerged. Using the remaining power sources, exhaustive efforts were made to cool reactors, and on March 15, four days after the earthquake, all four reactors were brought into cold shutdown.

The one that fell into the most serious situation was the Fukushima Daiichi NPS.

Tsunami waves reaching as high as 15 m overtopped a 6 m high seawall with ease, and a massive amount of seawater flooded into nuclear facilities. In the building housing the Unit 4 reactor, where the largest number of workers were at work, two employees were drowned while they were doing a safety check on equipment after the earthquake on the underground floor. They were the only fatalities among nuclear plant workers—including those at other nuclear power plants—that resulted from the earthquake and tsunami. At the Fukushima Daiichi NPS, all the external power sources and all the emergency diesel generators except one for Unit 6 were lost, and most of the storage batteries were inundated with seawater and became unusable.

The three steps crucial to preventing the occurrence of radiation leakage and other serious accidents at a nuclear power plant are to *stop*, *cool*, and *contain*.[94] The first step, "stop," is to shut down the reactor by inserting control rods to halt the fission chain reaction. This was done automatically at the Fukushima Daiichi NPS.

However, energy produced by the fission chain reaction is so enormous that the reactor continues to generate heat even after the fission stopped, and thus, it is crucial to "cool" the reactor by continuing to inject water. As a safety net in the event of inability to inject water into nuclear reactors due to a loss of power supply from external sources resulting from a power outage or other accident, each nuclear reactor building at the Fukushima Daiichi NPS had emergency diesel generators installed on the underground floor. Also, there were emergency reactor coolant systems that can supply water into reactors for a limited period of time after the loss of electricity, for instance, an isolation condenser (IC)[95] for Unit 1, a reactor core isolation condenser (RCIC)[96] for Unit 2, and a high pressure core injection (HPCI)[97] for Unit 3.

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94 TEPCO website (https://www.tepco.co.jp/nu/fukushima-np/outline/1_1-j.html), accessed on February 18, 2020.

95 An emergency safety system designed to maintain the cooling function when the ordinary system has failed. The steam inside the reactor is taken into a tank half-filled with water for condensation and reinjected as water into the reactor. Entry under "*Hijoyo fukusuiki* [Isolation condenser]" in ATOMICA, an encyclopedia of nuclear energy (https://atomica.jaea.go.jp/dic/detail/dic_detail_2876.html), accessed on March 3, 2020.

96 Another system, larger in size, designed to feed water into the reactor when the ordinary system has failed. The steam generated in a massive amount inside the reactor as a result of the cooling system failure is used to drive the pump to send water from external tanks, etc., to the reactor. Entry under "RCIC" in ATOMICA, an encyclopedia of nuclear energy (https://atomica.jaea.go.jp/dic/detail/dic_detail_2905.html), accessed on March 3, 2020.

97 Also called "high pressure water injection pump." In the event of a power outage, such as one caused by an earthquake, it is activated by batteries to send water from external tanks to the reactor. Japan Nuclear Technology Institute, "Tokyo Denryoku (Kabu) Fukushima Daiichi Genshiryoku Hatsudensho Jiko no Kento to Taisaku no Teigen [A Study on the TEPCO Fukushima Daiichi Nuclear Accident and a Proposal of Measures]," October 2011, p.12.

In the event that efforts to cool the reactor fail and nuclear fuel rods begin to melt in their self-generated heat and emit high-level radiation, it is vital to contain radioactive substances within the reactor or the containment vessel housing the reactor to prevent their release into the environment. The loss of power sources meant that it would become extremely difficult to cool the reactor, and that, if the reactor or its containment vessel is damaged by the resulting high temperature and high pressure, it could become impossible to contain radioactive substances.

The emergency coolant systems can feed water into reactors for several hours without power sources. The most crucial question was whether, within the span of several hours, power supply could be restored by deploying power supply cars and laying temporary power cables. The progression of the accident is as shown in Table 7.

Table 5: Progression of the Fukushima Daiichi nuclear accident

Date	Time	Events
3/11	14:46	The earthquake strikes.
	15:37	The largest tsunami wave (15 m) arrives.
	15:41	All the external power sources and all the diesel generators except one for the Unit 6 reactor are lost. It becomes unable to check the operating status of the IC for Unit 1 and the RCIC for Unit 2 (Loss of the function of the IC).
	18:10 (approx.)	Nuclear fuel rods are exposed above water in Unit 1.
	18:50 (approx.)	Nuclear fuel rods begin to melt in Unit 1.
	21:23	The government issues an evacuation order to residents within a radius of 3 km of the Fukushima Daiichi NPS.
3/12	00:06	Fukushima Daiichi NPS Manager Yoshida gives an order to vent the containment vessel of Unit 1.
	03:00–04:00	The venting of the containment vessel is attempted without success.
	05:44	The government expands the evacuation zone to a 10-km radius.
	07:10	Prime Minister Naoto Kan visits the Fukushima Daiichi NPS.
	09:00–10:00	Attempts to vent the containment vessel of Unit 1 continue to fail
	14:30	The containment vessel of Unit 1 is vented.
	15:36	A hydrogen explosion occurs in the Unit 1 reactor building.
	18:30	The government expands the evacuation zone to a 20-km radius. Residents in the area between 20-km to 30-km radius are asked to shelter in place.
3/13	02:42	The HPCI for Unit 3 stops. The water injection system for Unit 3 fails.
	09:10 (approx.)	Nuclear fuel rods are exposed above water in Unit 3.
	09:25	Fire engines start injecting water into Unit 3.
	10:40 (approx.)	Nuclear fuel rods begin to melt in Unit 3.
3/14	11:01	A hydrogen explosion occurs in the Unit 3 reactor building.
	13:25	The RCIC for Unit 2 stops.
	17:00 (approx.)	Nuclear fuel rods are exposed above water in Unit 2.
	19:00 (approx.)	Nuclear fuel rods begin to melt in Unit 2.
3/15	03:00 (approx.)	The pressure inside the Unit 2 containment vessel climbs to 750 kPa, a level nearly twice the design pressure. Concern heightens over the possibility of an imminent hydrogen explosion.
	05:00	Prime Minister Kan goes to TEPCO's head office and announces the establishment of the Government-TEPCO Integrated Response Office.
	06:00 (approx.)	After hearing an explosive sound, TEPCO staff in the central control room for the Unit 1 and 2 reactors check and confirm that the reading on the pressure gauge for the suppression chamber of the Unit 2 reactor has dropped to zero.
	06:10 (approx.)	Yoshida orders most of the staff to evacuate, keeping only 70 or so workers, the minimum required to continue injecting water into reactors and carry out other critical tasks.

Source: Created by authors based on information provided by the NAIIC and TEPCO's Fukushima Nuclear Accident Investigation Committee in their respective reports.

Nuclear accidents have two characteristics.

One is the rapid progression of events and the difficulty of understanding what is happening. The IC for Unit 1, which was supposed to operate even if power supply was lost because of tsunami, stopped. Control panel screens showing the status of reactors went black due to a power outage, and the staff inside the central control room were no longer able to check the situation of the reactors or the operating status of the coolant systems. While they were stunned and unable to do anything, the water levels inside the reactors dropped rapidly and nuclear fuel rods became exposed above water. Meltdown in the Unit 1 reactor began only three and a half hours after the quake hit. Since the earthquake and tsunami also damaged telecommunications infrastructure, telephone communication via the emergency line was the only way left to establish contact between the central control room and the seismically isolated building (designed to withstand earthquakes and built with radiation shielding materials) housing TEPCO's on-site emergency response center. The inability to share accurate information on the situation inside the reactor had profound consequences on the overall response operations and was partially responsible for the government's failure to issue timely evacuation orders for local residents.

"Venting" referred to in Table 7 is to release the highly radioactive steam to the atmosphere after removing most of the radioactive substances by trapping them in the water filled suppression chamber, a donut-shaped structure at the bottom of the containment vessel. Still, there is no completely avoiding radiation leakage into the nearby environment. Thus, the government had to scramble to respond, for instance, by expanding the evacuation zone to a radius of 10 km of the nuclear power plant. However, both TEPCO and the government were apparently unable to catch up with the progression of events, as evidenced by the fact that the government's announcement on the expansion of the evacuation zone to a 20 km radius came only after the hydrogen explosion in the Unit 1 reactor building.

The other characteristic of nuclear accidents is their tendency to involve a chain of crises.

In the Fukushima Daiichi nuclear accident, before response to events at one reactor were complete, another event occurred at a different reactor, making it all the more difficult to cope with the accident. At 11:02 am on March 14, a hydrogen explosion occurred in the Unit 3 reactor building. Before the TEPCO staff were able to resume water injection into the Unit 3 reactor, the RCIC for the Unit 2 reactor stopped. In the aftermath of the explosion, they were unable to make preparation for alternative water injection. And before they could do anything, the water level inside the Unit 2 reactor fell sharply and nuclear fuel rods began to melt. While the pressure inside the reactor and its containment vessel rose rapidly, venting attempts continued to fail, and the Unit 2 containment vessel fell into the situation where it could explode any time.

The explosive sound referred to in Table 7 as having been heard by TEPCO staff in the central control room for the Unit 1 and 2 reactors turned out to be the sound of an explosion that occurred in the spent fuel pool of the Unit 4 reactor, not in the Unit 2 reactor building. It was also later found the zero reading on the pressure gauge of the Unit 2 suppression chamber was the result of a malfunction of the gauge. As for the cause of the explosion in the spent fuel pool of the Unit 4 reactor, which was shut down for scheduled inspections at the time of the accident, it is believed that hydrogen gas produced in Unit 3 migrated, accumulating above the spent fuel pool of Unit 4 via plumbing partly shared by the two reactors.

However, the pressure gauge reading of zero for the suppression chamber attached to the containment vessel strongly suggested the presence of a hole in the chamber wall, which would let out the highly radioactive steam inside the chamber in an uncontrolled manner. Thus, Yoshida instructed most of the staff to evacuate and take shelter at the Fukushima Daini NPS, keeping only 70 or so workers, the minimum required to continue injecting water into reactors. Shortly after this, the radiation level measured by the monitor installed at the main gate of the Fukushima Daiichi NPS reached 10.9 mSv, the highest since the outbreak of the accident and roughly five times the typical level of natural radiation in Japan. At the time, it was thought that massive radiation leakage became reality. However, as aforementioned, the explosive sound heard in the main control room was not from Unit 2, and the basic functions of the containment vessel for the Unit 2 reactor were maintained. In due time, the radiation level came down and those who had been taking shelter at the Fukushima Daini NPS gradually came back to work and kept injecting water into reactors. From March 17 onward, members of the Japan Self-Defense Forces (JSDF), police officers, and firefighters joined the stabilizing efforts, such as injecting, shooting, and dumping water to cool reactors, and managed to avoid the worst-case scenario, in which the Tokyo metropolitan area would become uninhabitable.

The Unit 5 and 6 reactors, which are not mentioned in Table 7, were shut down at the time of the accident but still needed to be cooled because nuclear fuel rods were kept inside. These two reactors survived the crisis by using the emergency diesel generator for Unit 6, which was not damaged by the tsunami, to maintain the cooling functions of both reactors.

Appendix 4: Government reorganization after the Fukushima Daiichi Nuclear Accident

One major characteristic of Japan's nuclear safety regulation prior to the Fukushima Daiichi nuclear accident is that the regulatory body failed to fulfill its original role as a regulator, bowing to the will of developers and promoters of nuclear energy for civilian use.[98] Following the occurrence of extreme events such as the Chernobyl nuclear accident in the Ukrainian Republic of the Union of Soviet Socialist Republics in 1986, countries using nuclear energy for civilian purposes, except for Japan, implemented stricter regulatory requirements for nuclear safety and took steps to ensure the separation and independence of the regulatory body from government agencies promoting the use of nuclear energy.[99] In Japan, however, the Nuclear and Industrial Safety Agency (NISA) was part of the Ministry of Economy, Trade and Industry (METI), a government agency promoting the development and use of commercial nuclear reactors, until the occurrence of the Fukushima Daiichi nuclear accident, as shown in Fig. 8. As such, the NISA's independence as a regulatory body had been questioned.

One consequence of this was that the possibility of accidents beyond the basis of the original design of reactors were not assumed in safety measures implemented in Japan. As early as in October 1996, the International Atomic Energy Agency (IAEA) issued INSAG-10, a document setting out basic principles and approaches for ensuring nuclear safety, thereby calling on nuclear power using countries to implement five levels of defense as shown below, by assuming the possibility of extreme accidents that go beyond the basis of the original design of reactors, such as the Chernobyl nuclear accident. While other countries introduced a defense-in-depth structure in line with the IAEA standards, Japan did not, and hence, its nuclear safety measures were significantly weaker than those in other countries.

Table 6: Defense-in-depth standards (INSAG-10, IAEA, 1996)

Level	Objective	Essential means
Level 1	Prevention of abnormal operation and failures	Conservative design and high quality in construction and operation
Level 2	Control of abnormal operation and detection of failures	Control, limiting and protection systems and other surveillance features
Level 3	Control of accidents within the design basis	Engineered safety features and accident procedures
Level 4	Control of severe plant conditions, including prevention of accident progression and mitigation of the consequences of severe accidents	Complementary measures and accident management including the protection of containment vessels
Level 5	Mitigation of radiological consequences of significant releases of radioactive materials	Off-site emergency response

Although some utilities seem to have assumed the possibility of severe accidents, measures taken by Japanese utilities for the defense of their nuclear facilities basically excluded the possibility of nuclear reactors going out of control. In other words, they had in place defense measures of up to

98 Fukushima Nuclear Accident Independent Investigation Commission's (NAIC's) final report, 2012, p.555.

99 For instance, France enacted the Nuclear Transparency and Safety Law in 2006 to separate the regulatory body from the Ministry of Economy, a government agency promoting the civilian use of nuclear energy. Nuclear Safety Authority (ASN: *Autorité de Sûreté Nucléaire*) follow-up seminar on November 22, 2017.

level 3 under the definition of the IAEA. A report on the challenges of nuclear safety compiled by the NISA before its dissolution at least clearly acknowledges that the scope of safety inspections carried out by the regulatory body was limited to measures only up to level 3.[100]

On September 19, 2012, one year and a half after the Fukushima Daiichi nuclear accident, the Nuclear Regulation Authority (NRA) was established as a new body responsible for nuclear safety regulation. Its secretariat (NRA Secretariat) was organized as an agency under the Ministry of the Environment, separated from the METI. As shown in Fig. 8, the authority to perform inspections of safety measures implemented by utilities is now entirely separated from the METI, which has been promoting the commercial use of nuclear energy. The NRA has taken it over, together with the authority for safety inspections of research reactors owned by research institutions and universities, which used to belong to the Ministry of Education, Culture, Sports and Technology (MEXT).

The NRA had an initial staff of about 480, comprising about 350 from the former NISA, about 70 from the former Nuclear Safety Commission (NSC), and about 40 officials in charge of tasks related to research reactors at the MEXT. In a bid to prevent the exchange of personnel between the regulatory body and other government agencies promoting the civilian use of nuclear energy, the so-called "no-return rule" was introduced to prohibit senior officials—i.e., division directors and those in higher positions—from returning to government agencies they originate from, such as METI and MEXT.[101]

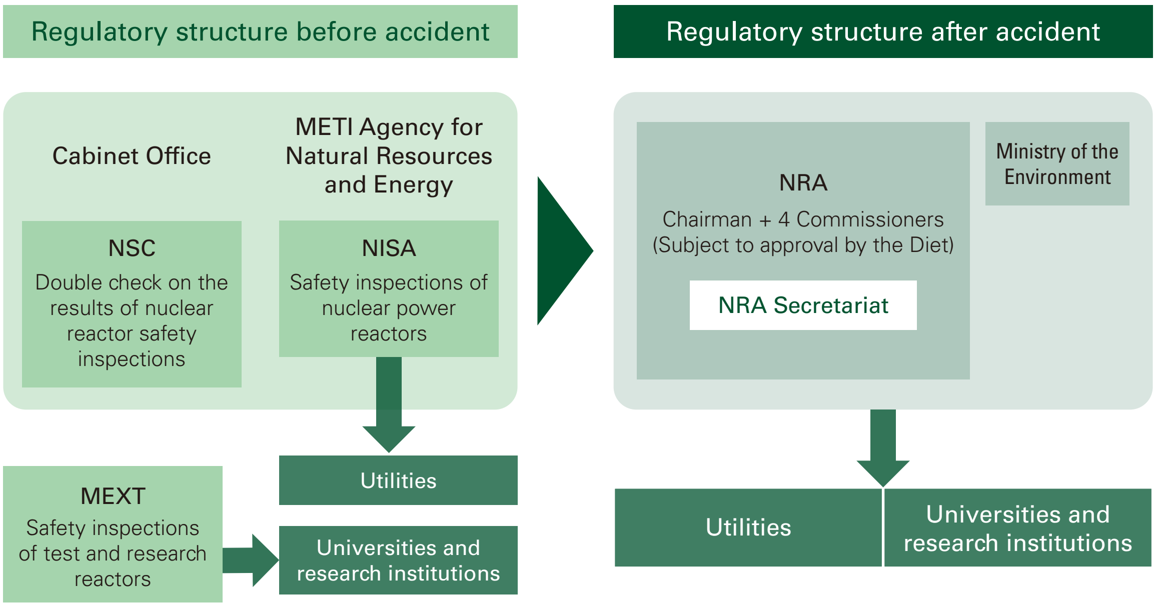

Fig. 8: Changes in organizational arrangements for nuclear safety regulation

Source: Created by authors based on information provided on the NRA's website, etc.

100 "*Genshiryoku Anzen Bunya ni okeru Genshiryoku Anzen Hoanin to shiteno Kaizen ni Muketa Torikumi to Nokosareta Kadai ni tsuite : Jiko Chosa Iinkai (Kokkai, Seifu) karano Shiteki wo Fumaete* [Nuclear and Industrial Safety Agency's Efforts for Improvement in the Area of Nuclear Safety and Remaining Challenges: Responding to points made by the legislative and government committees for investigation of the Fukushima Daiichi nuclear accident]," September 18, 2012, p.7.

101 "*Genshiryoku Kisei no tameno Atarashii Taisei ni tsuite* [New Organizational Arrangements for Nuclear Regulation]," Prime Minister's Office of Japan's website (https://www.kantei.go.jp/jp/headline/genshiryokukisei.html), accessed on March 4, 2020.

Furthermore, legislative changes were made to provide the basis for nuclear safety regulation, with a focus on the following three objectives:

1) Make the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors the sole basis for nuclear safety regulation
2) Provide in law for a mechanism to reflect the latest knowledge in safety regulation
3) Assume the possibility of severe accidents

With all those improvements made, the NRA is proclaiming that Japan has introduced the world's strictest safety requirements.

Appendix 5: Profiles of Study Group Members

Tatsujiro Suzuki, Vice-Director, Nagasaki University Research Center for Nuclear Weapons Abolition (RECNA)

Suzuki was vice chairman of the Japan Atomic Energy Commission (JAEC), Cabinet Office, from January 2010 through March 2014, and is continuing his activity as a council member of the Pugwash Conferences on Science and World Affairs, an international group of scientists advocating the elimination of nuclear weapons and war. He earned his PhD in engineering from the University of Tokyo, after graduating from the University of Tokyo in 1975 with a B.S. in nuclear engineering and earning an M.S. from the Massachusetts Institute of Technology in 1978.

Tomonori Iwamoto, Director, Institute of Nuclear Materials Management (INMM) Japan Chapter

After joining Japan Nuclear Fuel Ltd. (JNFL) in 1999, Iwamoto was appointed as section chief in charge of uranium enrichment technology at the Uranium Enrichment Plant in Rokkasho, Aomori Prefecture, from 2000, and served as general manager of Reprocessing Business Department (in charge of security and safeguard against disasters, and management of restricted information) and general manager in charge of the construction of a MOX fuel fabrication plant from 2013. Prior to joining JNFL, he worked at the Science and Technology Agency's Nuclear Safety Bureau as a technical official of the Prime Minister's Office, from 1988. He graduated in 1976 from the College of Technology, Ibaraki University, with a major in industrial chemistry.

Masakatsu Ota, Editorial Committee Member, Kyodo News

After joining Kyodo News in 1992, Ota worked as a correspondent in Hiroshima, Osaka (covering the Osaka Prefectural Police Headquarters) and as a political correspondent (covering the Ministry of Foreign Affairs and the Prime Minister's Office). From 2003 to 2007, he was a Washington correspondent. Ota was awarded the 2006 Vaughn-Ueda International Journalist Prize. He received a B.A. in political science from Waseda University in 1992. He entered the National Graduate Institute for Policy Studies (GRIPS) in 2007 and earned a doctorate in 2010 for his research on U.S.-Japan nuclear policy entitled "*'Kaku no Kasa' no Kochiku wo Meguru Rekishiteki Bunseki: Domei Kanri Seisaku to shiteno Kakumitsuyaku* [Historical Analysis on the Establishment of a 'Nuclear Umbrella': Secret nuclear deal as a means to manage alliances]."

Taketoshi Taniguchi, Visiting Professor, University of Tokyo Graduate School of Public Policy (GraSPP)

Taniguchi was specially appointed professor at Osaka University Graduate School of Engineering from 2004 to 2007 and visiting professor at the Department of Nuclear Engineering and Management (NEM) and the Nuclear Professional School (NPS) of the University of Tokyo School of Engineering from 2005 to 2011. He started his career at the Institute of Applied Energy in 1984, upon graduating from the University of Tokyo School of Engineering with a PhD in engineering. In 1994, he moved to the Central Research Institute of Electric Power Industry (CRIEPI), where he served in a series of positions including the director and associate vice president of the Socio-Economic Research Center.

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