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1F (Fukushima Daiichi Nuclear Power Plant) Decommissioning Governance in Japan and TMI-2 (Three Mile Island Nuclear Power Plant, Unit 2) Decommissioning Governance in USA

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This study examined 1F (Fukushima Daiichi Nuclear Power Station) decommissioning policy from a social science perspective. In doing so, the governance of the clean-up (decommissioning) programme for TMI-2 (Three Mile Island Nuclear Power Station Unit 2) in the USA, where the accident occurred in 1979,: and 1F decommissioning governance where the accident occurred in 2011, were targeted. A comparative study of TMI-2's partnership-based decommissioning governance under the GEND Agreement and 1F's central government-led decommissioning governance was conducted and three key conclusions were drawn. First, reform of decommissioning governance for 1F, i.e. the creation of social innovations, is important. Alongside scientific considerations, it is necessary to formulate a deliberative process based on dialogue with a wide range of stakeholders participation. Second is the importance of a "Place of Dialogue" with local communities. Decisions made by expert committees that lack a "Place of Dialogue" with local communities, such as the decision-making process for the policy of discharging ALPS treated water to the sea, cannot foster social acceptance and social understanding. Third is the importance of social awareness of trans-scientific questions. Effective policy formation is impossible without accurate awareness of the characteristics of social issues.

本研究は，1F（福島第一原子力発電所）の廃炉政策を社会科学の視点から考察した。その際，1979 年に事故を起こした米国の TMI-2（スリーマイル・アイランド原子力発電所 2 号機）の浄化（廃炉）計画のガバナンスと 1F 廃炉ガバナンスを対象とした。GEND 協定に基づく TMI-2 のパートナーシップ型廃炉ガバナンスと 1F の中央政府主導型廃炉ガバナンスとの比較研究を行い，以下の 3 つの重要な結論が得られた。第 1 に，1F の廃炉ガバナンスの改革，すなわち社会イノベーションの創造が重要である。科学的検討と同時に，多様なステークホルダーとの対話に基づく熟議プロセスの形成が必要である。第 2 に，地域社会との「対話の場」の重要性である。ALPS 処理水の海洋放出政策の決定プロセスのような地域社会との「対話の場」を欠いた専門委員会の判断では，社会的受容性や社会的納得性を醸成することはできない。第 3 は，トランス・サイエンス的課題に対する社会的認識の重要性である。社会課題の特性に関する正確な認識なくして効果的な政策形成はありえない。

1. 1F (Fukushima Daiichi Nuclear Power Plant) Accident and Nuclear Disaster

On March 11th, 2011, at 14:46 Japan Standard Time, a magnitude 9.0 earthquake struck off the Pacific coast of the Tohoku region of Japan (Northeast region of Japan). The big earthquake flooded the coast of the Tohoku Pacific region with a tsunami of over 10 to 16 meters. The Great East Japan Earthquake was a massive earthquake once in a lifetime.

At the time of the great earthquake, of the six reactors at the Fukushima Daiichi Nuclear Power

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Plant (hereinafter referred to as 1F), Units 4, 5, and 6 were under regular inspection, and Units 1, 2, and 3 were in operation. Due to the great earthquake, Units 1, 2, and 3 were automatically shut down. Due to severe damage, such as the collapse of power transmission lines, 1F lost the external power supply. However, the emergency diesel generator installed in the basement was started, and electric power was supplied.

Fifty minutes after the great earthquake, a tsunami with a height of 15 meters struck 1F, and the underground emergency diesel generator was submerged (1F is built 10 meters above sea level). 1F became a station blackout (SBO), and it became impossible to confirm the instruments showing the condition inside the reactors of Units 1, 2, and 3, and it became impossible to inject cooling water into reactors and the fuel pools.

At Units 1, 2, and 3, water injection into the pressure vessel stopped, and the water level continued to drop. The nuclear fuel rods were exposed, and a meltdown occurred. Due to the meltdown of Units 1, 2, and 3, their reactor cores began generating a large amount of hydrogen, and hydrogen explosions occurred. Many radioactive materials (mainly Cesium-134 and Cesium-137) were released into the atmosphere due to hydrogen explosion, venting, damage to the containment vessel and piping, and more. The amount of radioactive material released is estimated to be 90 PBq, about one-sixth of the amount released by the Chornobyl (Chernobyl) accident in 1986.

After the nuclear accident, the Japanese Government issued an emergency evacuation order for 20 km from 1F to around 30 km northwest. One year after the 1F accident, more than 160,000 residents, including voluntary evacuees, became evacuees, and 27,392 people are still evacuated (as of February 1st, 2023, Reconstruction Agency 2023). Areas where the annual radiation dose exceeds 20 mSv/y are considered Difficult-to-Return Areas, and there are still Difficult-to-Return Areas in seven municipalities (Tomioka, Okuma, Futaba, Namie, Katsurao, Minami-Soma, and Iidate). It will still take considerable time to cancel the total Difficult-to-Return Areas completely.

On December 16th, 2011, nine months after the accident, the Japanese government declared a cold shutdown of the accident reactors. It announced a "Mid and Long-Term Roadmap for decommissioning the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company" (Hereafter, "Mid and Long-Term Roadmap") towards the decommissioning of 1F. "Mid and Long-Term Roadmap," which has been revised five times to date, consistently states that the Japanese Government will complete the 1F decommissioning project in 30 to 40 years from the cold shutdown of the reactors in December 2011 (Matsuoka, 2022a).

However, the removal of spent nuclear fuel from the cooling pools of Units 1 & 2 and the experimental removal of fuel debris from Unit 2 are scheduled to start from the end of FY2023 to FY2024, which is far behind the original plan in "Mid and Long-Term Roadmap." There are many critical opinions on the Japanese Government's 1F decommissioning policy centered on "Mid and Long-Term Roadmap," including those from the nuclear village, such as the Atomic Energy Society of Japan (Matsuoka, 2022b).

Of particular importance is a governance issue that the decision-making mechanism surrounding 1F decommissioning policy is complex and difficult to understand. The current 1F decommissioning governance involves the Japanese Government (METI: Ministry Economy, Trade, and Industries, NRA: Nuclear Regulatory Agency), the national special corporation NDF (Nuclear Damage Compensation and Decommissioning Facilitation Corporation), TEPCO (Tokyo Electric Power Company) and JAEA (Japan Atomic Energy Agency) as key actors, but it is not clear, including the negative effects of sectionalism in government administration. In addition, the closed nature of the nuclear village continues to show strong path dependency even after the 1F accident, and opportunities for community participation and public deliberation in the 1F decommissioning project are scarce.

This study considers 1F decommissioning governance and community participation. In order to consider 1F decommissioning governance, the Three Mile Island Nuclear Power Plant, Unit 2 (hereinafter referred to as TMI-2) Cleanup Program will be compared. This chapter will also describe recent challenges and achievements to form a "place of dialogue" for 1F decommissioning with collaboration among science, politics, and society in Fukushima. The structure of this paper is as follows.

At first, outline and response of TMI-2 Accident will be described. Then, focusing on the GEND Agreement, we will consider the decommissioning governance of TMI-2 and compare it with 1F decommissioning governance. The GEND Agreement, whose name is come from the first letter of the acronym of the following organizations, was signed by the Electric Power Company (GPU), the American Institute of Electronic Power (EPRI), the Nuclear Regulatory Commission (NRC), and the Department of Energy (DOE) in March 1980, just one year after the TMI-2 Accident. Next, we examine the main components of the TMI-2 Cleanup Program: contaminated water treatment and fuel debris removal. In these sections, we think about the similarities and differences between TMI-2 and 1F. Then, the author discusses the relationship between decommissioning and the local communities, targeting the Citizen Advisory Panel established by NRC under U.S federal law from November 12th, 1980, to September 23rd, 1993.

2. Outline of TMI-2 Accident

March 28th, 1979, 4:01 am (Eastern United States, local time), in the Three Mile Island Nuclear Power Plant Unit 2 in Pennsylvania, USA (Pressurized Water Reactor: PWR , Electricity Output 900,000 kW), the main water pump stopped due to a trouble in the replacement work of the ion exchange resin of the secondary cooling water system and desalination tower, and a turbine trip (emergency stop) occurred (Walker, 2004: EPRI, 1990: GPUN, 1990).

Due to the turbine trip, the temperature and pressure of the reactor rose, and the reactor was shut down (scrum) in an emergency. At that time, due to a failure of the pressurizer relief valve, cooling water leakage continued, and the emergency core cooling system (ECCS) started automatically. TMI-2 shift operator could not understand the situation accurately, misunderstood that the cooling water was full, and narrowed down the cooling water filling amount of ECCS. As a result, the water level in the

pressure vessel dropped, the nuclear fuel assembly was exposed, meltdown (core meltdown) occurred, and about 45% of the nuclear fuel melted.

TMI-2 accident, radioactive substances such as Helium, Argon, and Xenon were released into the atmosphere, causing 140,000 local residents to temporarily evacuate. However, the amount of radioactive material released to the off-site was around 10 Ci (370 GBq) in terms of Iodine-131, and the exposure of the local residents was as low as 0.01 mSv/y to 1 mSv/y and the temporary evacuation of the residents was canceled within a few days to one week. The TMI-2 accident was rated Level 5 on the International Nuclear Event Scale (INES). By the way, Chornobyl (Chernobyl) Nuclear Power Plant Unit 4 accident on April 26th, 1986, and the 1F accident on March 11th, 2011, are evaluated as Level 7.

TMI-2 accident occurred 12 days after the release of the movie "China Syndrome" which depicts the meltdown caused by the nuclear power plant accident and had a great impact not only in the United States but also in the world. In the United States, the Energy Reorganization Act of 1974 dismantled the Nuclear Regulatory Commission (AEC), which was responsible for both promotion of nuclear energy utilization and nuclear safety regulation. AEC was reorganized by the Department of Energy (DOE) in 1977 and the safety regulations by the Nuclear Regulatory Commission (NRC) established in 1975.

TMI-2 accident had a major impact on the US nuclear safety regulations and the nuclear industry, which were in the process of being reorganized. In the wake of the TMI-2 accident, the nationwide operators responsible for nuclear power generation established the Institute for Nuclear Power Operations (INPO) in 1979. INPO functions as a self-regulatory body by nuclear power companies, promotes strong self-regulation, and plays a major role in establishing and improving the safety culture in electric power companies (Rees, 1994).

3. Response to TMI-2 Accident

On April 1st, 1979, four days after the TMI-2 accident, U.S. President Carter conducted a site visit to TMI-2. On April 11th, 1979, the Kemeny Committee was established as a TMI-2 Accident and Special Investigation Committee under a Presidential Decree (EO: Executive Order). On April 27th, 1979, the core of TMI-2, which caused the accident, fell below 100°C, and it was declared that a stable cold shutdown state would be achieved. The Kemeny Commission, which was responsible for the accident investigation, submitted a report to President Carter on October 30th, 1979. Following the Kemeny Commission report, on December 7th, 1979, President Carter issued a presidential statement stating the removal of the NRC chairman and the promotion of TMI-2 accident handling.

To create an effective and comprehensive TMI-2 Cleanup Program, the GEND Coordination Agreement was signed on March 26th, 1980, by the four major players mentioned above. Based upon the GEND Agreement, a local response team centered on DOE and GPU was created, technically supported by EPRI, NRC played a role in safety regulations and relations with the local community, and the TMI-2 Cleanup Program was created. Based on the program, decontamination of the power

plant (on-site) was promoted, and on July 23rd, 1980, after the accident, the first on-site inspection of the TMI-2 containment vessel was conducted by two engineers. It was carried out for 22 minutes.

Approximately 131.8 tons of fuel debris was removed from TMI-2 over a period of 4 years and 3 months from October 30th, 1985, to January 30th, 1990. In addition, the extracted fuel debris was stored in a dedicated canister and placed in a cask for rail transportation, using the time of 3 years and 10 months from July 20th, 1986, to May 9th, 1990, in Idaho. It was transported to the intermediate storage facility of the National Institute (INEL: Idaho National Institute, also referred to as INL).

On December 28th, 1999, the NRC approved the transition of TMI-2 to the Post-defueling Moni-

Table 1 TMI-2 Accident Management Timeline

date	event
February 8, 1978	Obtained TMI-2 operating license
September 18, 1978	TMI-2 power generation started
December 30, 1978	scale operation of TMI-2 (80% output)
March 28, 1979	TMI-2 accident occurred (97% output)
March 30, 1979	Evacuation advisory to the area around TMI (up to 140,000 people, less than a week)
April 1, 1979	President Carter TMI-2 field visit
April 11, 1979	Presidential Decree (EO) Establishes Chemenny Committee
April 27, 1979	TMI-2 achieves stable cold temperature (less than 100 degrees) stop state
May 21, 1979	Lancaster City filed proceedings to ban the release of contaminated water (treated water) into rivers
October 30, 1979	Chemenny Commission Report Submitted to President Carter
December 7, 1979	Presidential Statement (President Carter)
February 27, 1980	NRC and Lancaster City Reconciled (Prohibition of River Release)
March 26, 1980	Conclusion of GEND Agreement by GPU, EPRI, NRC, DOE
July 23, 1980	site inspection of TMI-2 building / containment vessel
November 12, 1980–September 23, 1993 (13 years)	Citizen Advisory Panel set up by NRC held 78 times
March 9, 1981	NRC/Environmental Impact Assessment (PEIS) final edition issued
May 1981	GEND-007 (Base estimate core condition: Debris retrieval strategy document) published
January 1, 1982	Ownership and management of TMI-2 transferred from GPU to GPU Nuclear
March 15, 1982	DOE and NRC agree to transport fuel debris to INEL, Idaho
July 24, 1984	TMI-2 containment vessel
September 18, 1985	TMI-1 restart
October 30, 1985–January 30, 1990 (4 years and 3 months)	132 tons of fuel debris
July 20, 1986–May 9, 1990 (3 years and 10 months)	Fuel debris transport to INEL, Idaho
1991–1993	9,000 tons of treated water
December 28, 1993	NRC, TMI-2 Post -defueling Monitored Stage (intermediate state) transition authorization

(Source) Created from EPRI (1990), GPUN (1990), and Walker (2004).

toring Stage (interim state, stable, safe storage), and the TMI-2 decommissioning project was temporarily terminated.

Three Mile Island Nuclear Power Plant Unit 1 (TMI-1), which had been restarted on September 18th, 1985, after the accident, was terminated, and the reactor was decommissioned. With the completion of the commercial operation of TMI-1 on September 20th, 2019, the reactor and building of TMI-2 will be dismantled and removed in the future. According to FirstEnergy, which currently owns the Three Mile Island Nuclear Power plant, the dismantling and removal of TMI-2 will begin in 2041 and will be completed in 2053 after the decommissioning of TMI-1.

Table 1 shows MI-2 Accident Management Timeline.

4. TMI-2: Partnership Decommissioning Governance

A four-party agreement (GEND Agreement) among GPU, EPRI, NRC, and DOE for cooperation in the TMI-2 Cleanup Program was established on March 26th, 1980. The official name of the four-party agreement is the "Coordination Agreement: TMI Unit 2 Information and Examination Program," but it is called the GEND Agreement in short. The GEND Agreement has three main objectives (GEND, 1980, pp. 2–3 in DOE, 1993).

(1) Utilize the information on the TMI-2 accident and Cleanup Program to improve the safety and reliability of light water nuclear reactors in the future, as well as to improve nuclear safety regulations and the operation of nuclear power plants.
(2) The experience and information of the TMI-2 Cleanup Program will be utilized in their respective R&D programs in cooperation with government agencies (DOE and NRC), research institutes (EPRI), and electric power companies (GPU).
(3) Effectively utilize the experience and information gained from R&D programs conducted jointly by government agencies (DOE and NRC), research institutes (EPRI), and the electric power companies (GPU) in the TMI-2 Cleanup Program.

To achieve the above objectives, the GEND Agreement has established a Joint Coordination Group of four executives, which meets once every two months, with the four-party meeting coordinated by EPRI. Moreover, DOE representatives will serve alternately. In addition, a Technical Working Group (TWG) will be established under the Integration Coordination Group, and a four-party Technical Integration Office (TIO) will be set up on or near the TMI site. It is going to be launched. The integrated office, which was the predecessor of TIO, was set up on the TMI site in October 1979, and it is said that it was almost fully operational in January 1980 (EPRI, 1990, pp. 2–27).

TMI-2 Cleanup Program is a project for which the GPU of the electric power company that operated TMI-2 should take responsibility. However, under the GEND Agreement, along with the utility GPU, collaboration with DOE and NRC, a federal agency, and EPRI, a national-level private research

institute. The fact that the system (decommissioning governance) was officially established less than a year after the accident occurred was crucial for the smooth progress of the TMI-2 Cleanup Program.

In the GEND Agreement, EPRI was in charge of developing the decontamination technology for the reactor's primary cooling system (RCS) and developed the technology for the mechanical decontamination method and the chemical decontamination method. In May 1998, the basic document on fuel debris retrieval, compiled around DOE, was approved as a GEND-007 (Base estimate core condition) document based on the GEND Agreement (Croucher 1981). It became the basic document of the debris retrieval strategy from TMI-2 (EPRI 1990, pp. 3–8). In addition, DOE and NRC treat, store, transport, and dispose of special waste with relatively high radioactive levels, such as EPICOR-II pre-filter liner and SDS liner generated by purification treatment of contaminated water and fuel debris taken out. The method was researched and developed (EPRI, 1990, pp. 2–28: Fujisaki and Matsuzuru, 1985, p.160).

5. TMI-2: Partnership Decommissioning Governance and 1F: Government-led Decommissioning Governance

The equivalents to the four parties who signed the GEND Agreement on the TMI-2 decommissioning project are TEPCO, JAEA, METI, and NRA in the case of 1F of Japan. However, the Level 7 1F accident was much more severe than the Level 5 TMI-2 accident, and the damage was enormous, so the national government needed to take the lead in dealing with the accident.

Specifically, the current version (5th revision) of "Mid and Long-Term Roadmap," which is the basic strategic document for 1F decommissioning, was decided on December 27th, 2019 at the government's decommissioning/contaminated water countermeasures ministerial meeting (currently, the decommissioning/contaminated water/treated water countermeasures ministerial meeting), including the Minister of Economy, Trade and Industry, the Minister of Reconstruction, the Minister of Foreign Affairs, the Minister of Finance, the Minister of Education, Culture, Sports, Science and Technology, the Minister of Health, Labor and Welfare, the Minister of Agriculture, Forestry and Fisheries, and the Minister of Land, Infrastructure, Transport and Tourism, and the Minister of the Environment. In the Ministerial Conference on Countermeasures against Decommissioning and Contaminated Water., the nine Ministers are the main members. Attendees at the conference include the NRA/Chairman, JAEA/Chairman, TEPCO/President, and NDF/Chairman. However, the impression that the non-ministerial conference participants are "end members" is hard to shake off.

Comparing TMI-2's partnership-type decommissioning governance under the GEND Agreement with the government-led 1F decommissioning governance, there are some important differences in the basic structure of governance and the responsibilities and roles of each player. TMI-2 Cleanup Program is a project carried out responsibly by the GPU of the electric power company. On that premise, the electric power company GPU, EPRI, and the federal government organizations DOE and NRC will cooperate and collaborate as equal partners. It was the GEND Agreement that stipulated

that. Furthermore, instead of the NRC on the regulatory side and the GPU on the regulated side, EPRI and DOE will alternately preside over the Joint Coordination Group meeting, which will be held once every two months. The GEND Agreement is based on the premise that the four parties will independently fulfill their legal and social responsibilities and share information and experience associated with the TMI-2 Cleanup Program. 1F decommissioning governance, headed by the Council of Ministers for Decommissioning, Contaminated Water, and Treated Water Countermeasures, is for the government (Cabinet) to determine the basic policy and strategy for 1F decommissioning centrally. The leading players are the government (METI and NRA), but NDF, JAEA, and TEPCO are only by-players.

Since each nuclear accident is extraordinary and individual, and the number of cases is limited, there can be no general principles or standards for decommissioning governance of accident reactors. Whether the government-led 1F decommissioning governance or the partnership-type TMI-2 decommissioning governance is appropriate depends on each society's historical, cultural, and institutional context.

6. 1F: Government-led Decommissioning Governance and the Need to Form a "Place of Dialogue"

In order to respond flexibly, effectively, and efficiently to the main items of the decommissioning business, such as decontamination of accident reactors, countermeasures against contaminated water, waste management and disposal, and removal/storage/management/disposal of fuel debris, flexible and transparent governance that suits the accident site is required. At the same time, in the decommissioning business of the accident reactor, it is essential to disclose information and accountability to the civil society as well as the local community around the nuclear power plant and various risk management associated with the accident and decommissioning. It is necessary to form a "place of dialogue" with local residents.

The current government-led 1F decommissioning governance has an important decommissioning policy set around Kasumigaseki, Tokyo, far from the decommissioning site in Fukushima. In addition, the decommissioning, contaminated water, and treated water countermeasures-related ministerial meetings have been held only five times in the eight years from the first (September 19th, 2013) to the present. The most recent is the 5th meeting on April 13th, 2021, which decided to release ALPS-treated water into the ocean.

The decommissioning/contaminated water/treated water countermeasures team meeting/secretariat meeting, which complements the ministerial meetings related to decommissioning/contaminated water/treated water countermeasures, has been held 95 times, almost once a month, for eight years from the first (December 26, 2013) to the present. However, at the decommissioning/contaminated water/treated water countermeasures team meeting/secretariat meeting, the countermeasures team was originally headed by METI, and the secretariat was set up by as the Deputy Minister of METI.

Therefore, the secretariat meeting has been held in Tokyo (usually held at the TEPCO Headquarters) under the presidency of the Resources and Energy Agency of METI.

If a 1F decommissioning governance had a vital characteristic regarding the essential matters discussed and decided under the initiative of bureaucrats at Kasumigaseki, it would have taken more time to evaluate whether the government-led 1F decommissioning governance is effective or efficient for the decommissioning project of the accident reactors, which requires flexible and adaptable responses to the site.

However, in terms of the ownership of TEPCO, which should take responsibility for the 1F decommissioning project, the possibility that the current government-led decommissioning governance of 1F is hindering the formation of autonomy and independence of the operator should be carefully examined. Although there are 'explanation forums' for the decommissioning project for the local community, such as the Fukushima Council, it is only an explanation meeting mainly for the heads of municipalities, groups, and organizations. The formation of 'dialogue forums' with the general public in the local community is essential to restore social trust in the 1F decommissioning project and nuclear policy. What is needed for the current government-led decommissioning governance of 1F to proactively address the issue of forming such a 'Place of Dialogue' should also be carefully considered.

Notably, in the partnership-type decommissioning governance based on the GEND Agreement, NRC played the role of forming a "place of dialogue" with the local community in the TMI-2 Cleanup Program in the United States. Under federal law, the Citizen Advisory Panel established by the NRC on November 12th, 1980, also included members of civil society organizations opposed to the nuclear power plant as official members of twelve members. In addition, the participation of the general public as an observer and remarks were accepted, and the panel functioned as a lively "place of dialogue" (NRC 1994). In September 1993, when the TMI-2 Cleanup Program reached the mid-stage, the Citizens Advisory Panel ended its role with 78 meetings held in 13 years (NRC, 1994).

A member of the Citizens Advisory Panel said it was a real surprise that it lasted for 13 years. Furthermore, although its original plan was to hold a meeting twice a year, this panel was held six times yearly. Many ordinary citizens participated in the panel discussion, and it became a very fulfilling citizen panel. The fact that he is very proud of his work speaks to the "success" of the citizens' panel set up by the NRC (NRC, 1994).

Ten years have passed since the 1F accident, and the 1F decommissioning project is scheduled to start debris retrieval in FY2022. It is indispensable to form a substantial "place of dialogue" with the local community regarding the future image of debris removal and decommissioning on the 1F in order to avoid repeating the same failure of the "treated water problem." Even with government-led 1F decommissioning governance, form a "place of dialogue" with the local community is possible and necessary. The establishment of a civil panel by the US Nuclear Regulatory Commission (NRC) and its "success" provide great hints for the formation of a "place of dialogue" between 1F decommissioning and the local community.

7. TMI-2: Treated Water/Evaporation Disposal and 1F: Treated Water Released into the Ocean: Recognition of Trans-Scientific Questions

Two weeks after the TMI-2 accident on March 28th, 1979, decontamination was carried out on the auxiliary and fuel handling building (AFHB) (Fujisaki and Matsuzuru, 1985, p.157). However, decontamination of main facilities such as the reactor building and primary cooling system (RCS) began in earnest in March 1982, three years after the accident. Decontamination of major parts, such as buildings, was completed in late 1984, and additional debris removal work was carried out from late 1984 to mid-1985 (EPRI, 1990).

Approximately 9,000 tons of contaminated water was generated during the TMI-2 reactor cooling, decontamination work, and debris removal work and was stored in two large tanks on the premises. The contaminated water was purified by a contaminated water treatment device such as EPICOR II and turned into treated water.

From the beginning of the accident, the city of Lancaster, which has a drinking water intake downstream of the TMI on the Susquehanna River, has been keenly interested in how to dispose of contaminated and treated water. Shortly after the accident, on May 21st, 1979, the city of Lancaster banned the disposal of contaminated water caused by the TMI-2 accident into rivers, even if the treated water was within environmental standards due to purification treatment.

In response, on February 27th, 1980, the NRC settled with the city of Lancaster by banning the release of water from the accident reactor into the river. The power company GPU strongly intended to release the treated water into the river, saying that it was optimal in terms of time and cost. However, a settlement clause between the NRC and the City of Lancaster adopted an alternative method of evaporation, which carried out the evaporation of 9,000 tons of treated water during the three years from 1991 to 1993 (EPRI, 1990).

The process of determining the disposal method of contaminated water and treated water due to the TMI-2 accident, as described above, significantly differs from the process of determining the disposal method of ALPS treated water on 1F. The government (METI) started a full-scale study of Japan's treated water disposal method by the Tritiated Water Task Force, established on December 25th, 2013, by ten experts focusing on nuclear engineering. After 15 meetings, the Tritiated Water Task Force stated on June 3rd, 2016, that, in effect, ocean release is the most scientific and rational solution, both in terms of time and cost. The report was compiled (METI, 2016: Matsuoka, 2019 a, b & 2021a,b,c).

The proposal of the ocean discharge method in this tritiated water task force report determined the path dependence of the subsequent process of determining the treated water disposal method based on the government-led 1F decommissioning governance. Following the Tritiated Water Task Force Report, on November 11th, 2016, METI established an ALPS subcommittee (subcommittee on the handling of treated water such as multi-nucleus species removal equipment) consisting of 14 experts, including social scientists. After 17 committee meetings, the ALPS Sub-Committee issued a report on February 10th, 2020, strongly suggesting that ocean release is, in effect, a scientifically optimal and

rational solution (METI, 2020).

Based on these circumstances, on April 13th, 2021, at the Meeting of Ministers for Decommissioning, Contaminated Water, and Treated Water Countermeasures, the government officially decided the policy to release ALPS-treated water into the ocean. Before and after the official decision, briefing sessions on ocean release policies were held for local organizations such as Fukushima Prefecture and fishing organizations. However, the briefing was a "place of explanation" that the government-determined ocean release policy was the most scientific and rational method. The "place of dialogue" between the government/TEPCO and the local community regarding various options for the disposal of treated water was never held.

What should be recalled here is the Tran-Scientific Questions proposed by Alvin Weinberg (1972), a renowned American nuclear physicist who also participated in the Manhattan Project. Weinberg asks these trans-science issues "questions which can be asked of science and yet which cannot be answered by science," using cases such as the health hazards of low-dose exposure and severe accidents at nuclear power plants. A task that can be done but cannot be answered by science) (Weinberg, 1972; Matsuoka, 2020 a, b & 2021a, b, c).

ALPS-treated water into the ocean is a classic example of a trans-science challenge. The solution to these problems can be asked by science, but science cannot determine the solution. If the solution to the problems related to science and technology risks, such as radioactive waste, is decided only by scientists/experts and the government/administration, it will lead to social conflict. Making decisions on risk management policies through the process of participation and deliberation by civil society is essential for fostering social acceptability and conviction.

Weinberg is renowned as a nuclear physician, but few know about his trans-science agenda. Without knowing the concept, one cannot even recognize that there is such a problem. In the situation of "unknown unknowns" in expertise, it is impossible to recognize what kind of problem needs to be solved in the problematic object, and it is necessary to work on problem-solving accurately. It means that it cannot be done (Wynne, 1992).

The design of the policy-making process would have been different if the Tritiated Water Task Force's nuclear engineers and Agency for Natural Resources and Energy officials knew that there was a debate about trans-science issues. In addition, if a local government officially insists on the demands of the local community, such as in Lancaster City in 1979 in the TMI-2 accident, it is thought that the government-led 1F decommissioning governance centered on Tokyo was forced to change.

In the TMI-2 case, large tanks containing contaminated water are classified as relatively low-pollution radioactive waste (5,100 m^3) that the electric power company GPU should be responsible for and are low in Barnwell, South Carolina. It was transported to a level radioactive waste disposal site and disposed of in a trench. Medium-level radioactive waste (200 m^3) of related materials, such as relatively polluted contaminated water treatment equipment (EPICOR II) and bentonite, was disposed of at the Hanford, Washington disposal site under the responsibility of DOE.

In the case of IF, as of April 20th, 2023), there are 1,068 storage tanks (total capacity 1.37 million tons, actual 1.33 million tons). Even if we recommend releasing ALPS-treated water to the ocean, the question of how to deal with the final disposal of the storage tanks will remain an issue.

8. TMI-2: Fuel Debris Removal and 1F Decommissioning

October 30th, 1985, six and a half years after the TMI-2 accident, its debris began to be removed, and it took four years and three months to remove 99% of the total on January 30th, 1990. About 132 tons of debris was taken out (GPUN 1990). TMI-2 reactor pressure vessel was not damaged by the PWR (Pressurized Water Reactor), and the fuel debris was relatively uniform and homogeneous compared to 1F (EPRI 1990). With the debris accumulated at the bottom of the pressure vessel, the top lid of the reactor pressure vessel was opened, and the debris was taken out from the platform at the top of the storage vessel with water in the reactor. Even so, about 1,125 kg of debris remained, and the entire debris could not be removed (GPUN, 1990, Chap. 8, p.1).

In the case of 1F, it is estimated that the properties of debris are not uniform and homogeneous because the 1F is a BWR (Boiling Water Reactor) in which control rods are taken in and out from below due to the accident of three adjacent nuclear reactors. In addition, the pressure vessel and containment vessel are considered damaged on 1F, and debris retrieval in 1F is much more difficult technically and socially than in TMI-2. The amount of debris of Unit 1 (460,000 kW), Unit 2 (784,000 kW), and Unit 3 (784,000 kW) on the 1F is estimated at 880 tons in total. It is known that the nuclear fuel weight of the fuel assembly that was originally loaded is 69 tons for Unit 1 and 94 tons for Units 2 and 3, but not only the nuclear fuel but also the equipment in the reactor is melted, so the accurate debris amount is still uncertain.

Even with TMI-2, which was easier to remove debris than 1F, it took 4 years and 3 months to remove 131,814 kg of debris. Assuming 260 working days in one year, 4 years and 3 months is 1,105 working days. The debris removal work efficiency of TMI-2 is 131,814 kg÷1,105 days＝119.3 kg/day. Total amount of debris on the 1F is estimated at 880 tones, and assuming that debris can be taken out with the same work efficiency as TMI-2, the number of years required to take out the total amount of debris on the 1F is 880,000 kg÷119.3 kg/day＝7,376 days, 7,376 days÷260 days/year＝28.3 years, which is about 28 years.

The amount of debris that can be taken out with a robot arm on 1F is estimated to be about 20 kg to 50 kg each time (based on interviews with members of the Japanese Atomic Physics). The debris removal work on 1F is arduous under the adverse environmental conditions of high radiation, and considering the measurement, storage, and management of the debris taken out. Optimistically, assuming that 50 kg of debris can be taken out per one workday, assuming that the annual workday is 260 days, 880,000 kg÷50 kg/day＝17,600 days, 17,600 days÷260 days/year＝67.7 years, about 68 years are required. Conservatively speaking, if 20 kg of debris is taken out per one working day, 880,000 kg÷20 kg/day＝44,000 days, 44,000 days÷260 days/year＝169.2 years. It is about 170 years. Optimistically,

it takes 70 years to remove all the debris of 1F, and 170 years if we look at it conservatively. It is estimated that 1,125 kg of debris and 900 kg of nuclear fuel remain in TMI-2 (GPUN 1990). Considering that even TMI-2, which was in good condition, could not remove all the debris, it must be said that taking out all the debris on 1F lacks an objective basis.

Regarding how the fuel debris was taken out from TMI-2, 119.3 kg per working day was put into the canister (fuel debris storage container). TMI-2 was carried out from the top of the containment vessel by opening the top lid of the reactor pressure vessel. The reactor was filled with water for radiation protection and shatter proofing. The canister was fixed in water, and the fuel debris taken out from the lower part of the reactor pressure vessel was directly put into the canister in water. A very rational and safe method was adopted. There are 271 canisters for fuel debris, which means that each one contains about 486 kg (4 working days) of debris.

The "Interim Report" of the 1F Accident investigation and analysis released by NRA in March 2021 shows that the 1F Units 2 and 3 have a three-layer shield plug (containment vessel top lid). It was revealed that there was a very high concentration of cesium contamination in between (NRA 2021). This means opening the containment vessel's top lid and removing debris from above on 1F is difficult. In addition, since the pressure vessel and containment vessel of Units 1, 2, and 3 on the 1F are damaged, it is impossible to fill the reactor with water and remove debris like TMI-2. On 1F, it is assumed that the robot arm can be inserted through the work window at the bottom of the containment vessel, but the work efficiency must be significantly lower than that of TMI-2.

9. TMI-2 Decommissioning and Local Community

TMI-2 Cleanup Program under the GEND Agreement, NRC played a role in forming a "place of dialogue" with the local community. NRC established the Citizen Advisory Panel on the TMI-2 Cleanup Program on November 12th, 1980, based on the FACA (Federal Advisory Committee Act of 1972) (NRC 1994). The 12-member panel of citizens is an independent advisory committee that discusses the ideal form of the TMI-2 decommissioning project from multiple perspectives. The Government Service Admission (GSA), which has jurisdiction over the Federal Government's Citizens Committee Establishment Law, stipulates the selection of fair and balanced members from various fields, including the general public. In principle, a citizens' committee is held open to the general public, including accessibility of places and times (GSA 2021).

The NRC selected TMI-2 Citizens Advisory Panel according to the following four criteria.

(1) Those who are elected and those who are not
(2) Engineers and non-technical people
(3) Persons in each position: promoting nuclear power, neutrality, and opposition to nuclear power
(4) General residents and experts

The 12 members included three local government chiefs. Among them, Art Morris, the second citizen panel chairperson, was the mayor of Lancaster. The NRC (1994) report praises Morris as a highly competent chair and shows excellent leadership (NRC 1994, p. 7). Morris, who became the second chair in 1983, then led the civic panel as chair until its mission ended on September 23, 1993. Morris' open, fair, and friendly management style was highly praised by many citizens, both pro- and anti-nuclear. The other 12 members included three scientists from the University of Pennsylvania, three Pennsylvania government officials (although they were soon replaced with experts and citizens after being criticized by the public), and three ordinary citizens. Three citizens were selected from Three Mile Island Alert (TMIA), an anti-nuclear organization with 2,000 members, and the Susquehanna Valley Alliance (SVA), a civil society organization that tackles the pollution problem of the Susquehanna River.

The Citizens Panel Secretariat (Designated Federal Officials: DFO) was undertaken by NRC staff under Federal Law (FACA). The Citizens Panel had the following seven agendas set by the NRC. However, the fourth agenda was added in 1986 from the discussions of the civil panel.

(1) Funding for cleanup and decommissioning
(2) Storage and disposal of high-level radioactive waste (Disposition of high-level radioactive waste)
(3) Emergency Response (Whistleblowing activity at TMI)
(4) Health effects and results of health studies
(5) Disposition of contaminated "accident" and cleanup water
(6) Radiation exposure of cleanup workers
(7) Long-term storage of the facilities prior to ultimate decommissioning

Citizens, NRC committee members, NRC staff, businesses (GPN), DOE staff, etc., also participated in the citizen panel, and such general participants were allowed to speak at the citizen panel and participate in the discussion. NRC 1994 report evaluates that the civic panel served as a very active "place of dialogue." In addition, the Citizens Advisory Panel evaluated that it acted as an "ultimate watchdog" for the TMI-2 Cleanup Program and was characterized by trust, legitimacy, and mutual learning.

Citizens' panels were held 78 times during the 13 years from November 12th, 1980, to September 23rd, 1993 (reaching intermediate state and stable storage). In addition, a public meeting was held in Harrisburg, the capital of Pennsylvania, near TMI-2. In addition, regular meetings were held with NRC members at the NRC headquarters in Washington, D.C., to exchange views and make proposals for the TMI-2 decommissioning project. The citizen panel proposal to the NRC required approval by a majority vote of 12 citizen panel committee members.

The NRC 1994 report points out the following three points as a citizen panel evaluation of each actor from interview surveys with various stakeholders.

(1) From the activities of the citizen panel, the NRC obtained the most information on effective information transmission and communication.
(2) The electric power company (GPUN) evaluated that the citizen panel strongly reflected the opinions of anti-nuclear citizens and did not fairly reflect the true voice of the general public.
(3) On the other hand, on the citizen side, there were many complaints that the citizen panel reflected the opinions of the nuclear power promotion group too much.

Finally, it is worthwhile introducing the opinions of the two members of the Citizens Panel:

> "TMI-2 decommissioning project in a way never seen anywhere else. But I keep doing it and I'll keep doing it, because it is an effective public forum. It stimulated a public dialogue about the cleanup of TMI-2 that never would have taken place otherwise."

> "I enjoyed the experience of the members of the Citizens Panel. It was a very useful learning place where I learned a lot about what is going on in the TMI-2 decommissioning project. The Panel was great fun. It is a tremendous educational experience. I know so much about how things work at TMI-2)" (NRC, 1994 p.27).

10. What should the 1F Decommissioning Governance Learn from the TMI-2 Decommissioning Governance?

The TMI-2 accident in March 1979 was severe in a prosperous, democratic society and was the first case in the world where full-scale fuel debris removal was carried out from the accident reactor. The quality and quantity of the TMI-2 and 1F accidents are very different, and the historical and social backgrounds of the United States and Japan differ widely. Nevertheless, it is essential for Japanese society to "learn from history" to face the unprecedentedly difficult task of 1F decommissioning three meltdown reactors. The author would like to ponder the maxim of German Chancellor Otto Bismarck, "The fool learns from experience, the wise learns from history."

1F decommissioning policy should be learned from the TMI-2 decommissioning project from the social science perspective and draws the following three points as conclusions.

First, it is necessary to have scientific and professional examinations and discussions with various stakeholders regarding the improvement and innovation of 1F decommissioning governance. The 1F decommissioning governance was formed as a government-led decommissioning governance, reflecting the seriousness of the 1F accident on the path dependence of the nuclear energy policy centered on the country.

Understanding a situation by looking at the Japanese case is not enough. However, if we compare and analyze the government-led 1F decommissioning governance with the partnership-type TMI-2

decommissioning governance, we can see the issues of 1F decommissioning governance more clearly. In order to effectively and efficiently carry out the business at the decommissioning site on 1F, the cooperation between the site (Fukushima) and the policymaking site (Tokyo) and the division of roles between the national government and the business operator should be re-examined. At the same time, a certain sense of distance from the site is necessary to form a long-term decommissioning policy of 1F.

The current government-led decommissioning governance of 1F is extremely half-hearted, both in terms of resourceful and flexible decision-making in line with the decommissioning site and in terms of forming a long-term decommissioning policy. Although formally government-led, it is insufficient to formulate a clear long-term decommissioning policy and does not allow the decommissioning sites to fully demonstrate their capabilities.

The second is the importance of creating a "place of dialogue" with local communities. As is the case with the issue of the discharge of ALPS-treated water into the sea, a technical committee decision that lacks a "place of dialogue" with local communities, even if it is based on scientific rationality, cannot brew social acceptance and social understanding (Matsuoka, 2018; Matsuoka et al., 2021).

Restoring social trust in the nuclear policy lost in the 2011 1F accident is essential for effectively and efficiently promoting the 1F decommissioning project. Recent trust studies have shown that high expertise, skills, and impartiality are insufficient to restore social trust (Nakayachi, 2008). In a society with diverse values, it is important to recognize and respect diverse values and opinions to build trust. Trust based on high professional knowledge/skills and fairness is a 20th-century type called "trust as competence." Trust that respects diverse values and opinions is 21st-century trust called "trust as care" (Johnson, 1999; Allum, 2007). Of course, not all social trust has transitioned from "trust as competence" to "rust as care." However, in forming social trust in the 21st century, forming a "place of dialogue" is a practical approach. The history of establishing a civil panel by the US NRC and its "success" in TMI-2's partnership-type decommissioning governance shows us the importance of forming a "place of dialogue" between the 1F decommissioning project and the local community.

Third is the importance of recognizing trans-scientific questions. We have to think again about the trans-science issue raised by Weinberg in 1972, "questions which can be asked of science and yet which cannot be answered by science." There is much debate about it. However, the issues cannot be seen without the people concerned recognizing the existence of such trans-science issues. The Japanese nuclear industry has a strong technocentric approach, and many followers of the "myth" say that it is possible to derive optimal solutions for social issues by engineering methods. However, all expertise has epistemic uncertainty in nature. Experts should always be aware that looking at a problem from individual expertise alone is a high risk of falling into a situation of "unknown Unknowns."

While working on Fukushima reconstruction research, the author, who talks about the importance of forming a "place of dialogue" with the local community, said from many experts that "even though discussions between experts in different fields are difficult, the dialogue with the residents is much

more difficult. This is quite correct. However, as long as risk management policies are socially relevant, our democratic society is a trans-science challenge that only can be resolved by continuing social learning in the context of science, politics, and society. If so, no matter how difficult it may be, it will be essential for scientists/experts, politicians/administrative officials to engage in dialogue with the local community and form their empathy.

11. Fukushima Reconstruction through Collaboration of Science, Politics and Society: Fukushima Forum and 1F Decommissioning Study Group

Researchers from Waseda University and other universities, in collaboration with local residents of Fukushima, established the Waseda University Fukushima Hamadori Research Center (hereinafter the Research Center) in May 2017.

The Research Center emphasizes collaboration between science, politics, and society, and as an embodiment of a place of collaboration, it holds the "Fukushima Forum" as a forum for thinking and discussing about Fukushima reconstruction together, transcending generations, regions, and fields.

The Fukushima Forum is an open-ended "forum for dialogue" that does not aim to reach conclusions, although themes such as "Thinking about the Future from Fukushima Now" (the 3rd Fukushima Forum) will be set. Although the Research Center operates on a membership system, participation in the Fukushima Forum is open to all citizens.

The objective has been to foster the "power of dialogue" through open-ended discussions that do not seek conclusions, and to discover new knowledge and ideas for social innovation for the reconstruction of Fukushima from free dialogue. However, the author, who has served as Director of the Research Center, has always had in mind the criticism from citizens that "experts do not return the results of their research to the local community".

In January 2019, at the 3rd Fukushima Forum held in Naraha Machi, Fukushima Prefecture, we proposed the Fukushima Hamadori Social Innovation Initiative, which aims to create a sustainable community in 2050. The first pillar of the Social Innovation Initiative is to preserve 1F as an accident heritage to consider positioning 1F as a future regional asset, and to have science, politics, and society work together to consider various options for 1F's future.

In order to study the Social Innovation Initiative in detail, the 1F Decommissioning Study Group (hereinafter the Study Group) was established in July 2019 to consider the future vision of 1F. At its inception, the Study Group consisted of 14 members, including people from local community organizations that are engaged in reconstruction support activities in the Hamadori region of Fukushima Prefecture, people from the Atomic Energy Society of Japan, and technical and social experts from universities and national research institutes. The study group also included METI, TEPCO, and members of the mass media, including the Asahi Newspaper and NHK, who participated as observers and discussed the issues together.

Unlike the Fukushima Forum mentioned earlier, the Study Group is a "community with a purpose"

with the clear objective of identifying various options for the future of 1F decommissioning and making proposals to society.

Based on the discussions from the first meeting (July 2019) to the fifth meeting (April 2020), the Study Group published the "1F Decommissioning Study Group, Interim Report" (May 2020). In the "Interim Report," the following issues were identified regarding the way forward for the 1F decommissioning project and the future vision of decommissioning.

On the technical side of the 1F decommissioning, the following four issues were pointed out: 1) the need to centralize the decommissioning implementation system, 2) the need to consider overall optimization, 3) the importance of understanding the local community in the treatment of contaminated water, and 4) the need to clarify the future vision of decommissioning and the interim state.

On the social side, the report pointed out the following four issues: 1) consideration of the roles and relationship between experts and citizens, 2) the need for an integrated vision of the future of the 1F decommissioning and the interim storage facility (approximately 1,600 ha of decontaminated soil storage area surrounding the 1F site), 3) establishment of clear decommissioning governance, and 4) creation of a mechanism to make the 1F decommissioning process itself a local resource.

In addition, as a tentative conclusion, the Interim Report made the following recommendations.

The current "Mid and Long-Term Roadmap" that defines the government's 1F decommissioning policy is based on a technical evaluation of decommissioning risks. However, it is necessary to reconsider "Mid and Long-Term Roadmap" from various perspectives including social evaluation such as environmental, social, and economic sustainability. In reviewing the "Mid and Long-Term Roadmap", it is essential to integrate the two aspects of technical and social issues, and to form a "place of dialogue" with broad public participation from the perspective of how 1F should be utilized in the future by Fukushima, Japanese society, and human society. In doing so, thinking beyond 1F decommissioning means not only drawing a picture of what will happen 40 or 100 years from now, but it is also important to consider the creation of a mechanism to expand and reproduce the decommissioning process itself involving various people in and outside the region, and to turn 1F into a local resource.

Based on the "Interim Report" from May 2020 to February 2021, the Study Group took on the challenge of forming various forms of "place of dialogue".

Next, we discuss what lessons and issues have emerged from these challenges to forming a "place of dialogue " on the future of 1F decommissioning.

12. "Place of Dialogue" on the Future of 1F Decommissioning

Based on the publication of the "Interim Report" in May 2020, the following goal of the Study Group is to form a "place of dialogue" through collaboration between citizens, government, business, and experts, and to discuss various options for the future of 1F decommissioning and the decommissioning process itself as a local resource.

12.1 "Place of Dialogue" with Local Residents

First, a "place of dialogue" to discuss the "Interim Report" was held with 14 Study Group members and 14 residents of the Fukushima Hamadori area (May 2020). The selection of participating citizens was based on generation, region (there are 13 municipalities in Hamadori, Fukushima Prefecture, from Iwaki City in the south to Shinchi Town in the north), field (occupation), and gender, and was recommended by the Study Group's regional members and discussed by the Study Group. Participants were from diverse generations and fields, including high school and university students, middle-aged and older adults, high school teachers, local government officials, fishery and tourism workers, with a gender balance of 7 : 7. METI officials also attended as observers. Including observers and the secretariat, the total number of participants in the "place of dialogue" was 36.

In order to facilitate a careful dialogue, the "Interim Report" was explained first, followed by a dialogue in three groups. Finally, a general discussion and "summary" based on the group discussions were held, and the next step was explained, which is to form a " place of dialogue" among local residents, the government, TEPCO, and experts (the Study Group) in the fall of 2020.

At this "place of dialogue", the following points were raised: 1) Public interest in 1F decommissioning is fading away, 2) The difficulty in understanding decommissioning information is hindering trust building, 3) The importance of public participation in decommissioning plan preparation, and 4) The importance of considering decommissioning as part of the future of local communities. In particular, the importance of considering 1F decommissioning as a part of the future of local communities was discussed in the Study Group and formulated as the necessity of a paradigm shift from the "society in 1F decommissioning" approach of the nuclear village to "1F decommissioning in society" and "1F decommissioning in the community".

12.2 "Place of Dialogue" with the Government and TEPCO

Following the "place of dialogue" with the public, a "place of dialogue" was held with the national government and TEPCO (August 2020). Two people from the national government (METI), four people from TEPCO, and 18 people from the Study Group and secretariat attended.

Regarding the future holding of "place of dialogue" with local communities, TEPCO is willing to participate in community dialogues, but is concerned about the possibility of conflict with local communities if it abruptly joins such meetings. For this reason, the opinion was expressed that it is necessary for the Study Group to act as an intermediary and mediator, and that a process to gradually bring the distance between both TEPCO and the public closer is needed.

The government pointed out that the lack of interest in decommissioning by the local community is a problem when promoting the 1F decommissioning process as a local resource. It was suggested that we need to consider how to increase the local community's interest in decommissioning.

Based on these opinions of TEPCO and the government, the study group has proposed that information should be shared with citizens, including technical difficulties, in order to balance the technical constraints of 1F decommissioning with the local community's desire for reconstruction and

decommissioning. Understanding the technical difficulties will allow citizens to participate more effectively in the discussion. In addition, the relationship between TEPCO and local communities has been clearly delineated in terms of perpetrators and victims, deepening the division and conflict structure and inhibiting mutual interaction. While there are many different positions within the community, it is necessary to overcome these barriers and build up a regional dialogue toward the future. We proposed that the process of accumulating regional dialogues will expand into a comprehensive conversation about the future vision of the regional community and enable collaboration based on trust.

13. "Place of Dialogue" between Local Residents, the Government, TEPCO, and the Study Group

Based on the above "place of dialogue", we decided to launch a "place of dialogue" (named "tripartite meeting") in the fall of 2021, to be presided over by the Study Group, and to be attended by the local community, the national government and TEPCO, and the Study Group.

Based on the two previous "place of dialogue", it was also decided to discuss what kind of regional platform (community organization) is needed to achieve these objectives. The number of participating members was expanded to 19 for the local community and 5 for TEPCO, succeeding the members of the two "place of dialogue".

The first tripartite meeting was held in October 2020, the second in November, the third in December, and the fourth in January 2021, with dialogue taking place once a month to discuss proposals for the formation of a regional platform to promote the "future vision of 1F decommissioning" and "local resource development of 1F decommissioning process". To prepare the proposal, a tripartite task force consisting of 15 members was convened in January 2021, selecting 5 members from the local community, 4 members from the government and TEPCO, and 6 members from the Study Group from among the tripartite meeting members.

However, the discussions in the tripartite task force went remarkably astray. It became clear that there were significant differences in perception among the participants regarding the interpretation of the agenda itself, such as 1) what is decommissioning of an accidental reactor in the first place, 2) how is the conversion of decommissioning projects into local resources different from subcontracting of decommissioning projects by local companies, and 3) what is a local platform. Furthermore, many "questions" were raised that even experts found difficult to answer, such as 4) Is it really possible to remove melted-down fuel debris, 5) How many years will it take to remove fuel debris, 6) Is ocean discharge the only disposal method for treated water, and 7) When will the 1F decommissioning be completed?

In response to the lost discussion of the tripartite task force in January 2021, the leader of the Study Group (the author) decided to suspend the tripartite task force and to identify the factors and conditions that make it difficult to have a "place of dialogue". To this end, the author, as the Study Group's representative, conducted individual interviews with 14 task force members to obtain the opinions of

each participant. As a result, it became clear that, under the current situation, there are significant differences in basic knowledge, information, and perceptions about 1F decommissioning among the participants, and that even discussions about the future of 1F decommissioning cannot easily lead to meaningful dialogue if there are too many differences in knowledge, information, and perceptions about 1F decommissioning as a premise for such discussions.

As an aside, during the interview with one of the task force members, perhaps because of the online system and the fact that the author lives in Tokyo, she told me that she was in the third grade of elementary school in Okuma Town when the nuclear accident occurred, evacuated to Niigata, moved to Aizu-wakamatsu City to attend the reopened elementary school in Aizu-wakamatsu City, stayed there until junior high school, moved to Iwaki City from high school, and wanted to go to university in Tokyo after graduation. After graduating from junior high school, she moved to Iwaki City and spent nearly an hour listening to the story of how she wanted to go to university in Tokyo after graduation.

I was puzzled at first, thinking that I would not like to be told personal stories, but after a while I began to think that she wanted someone to listen to her story, that she wanted to talk to someone but had no one around him to talk to. I thought that the person in Tokyo whom I had connected with online would listen to me without any second thoughts, so I thought he wanted to talk about the thoughts and feelings she had accumulated over the 10 years she had drifted from third grade to Okuma, Niigata, Aizu-wakamatsu, and Iwaki, and I listened intently, occasionally giving her a few words of advice. Toward the end of the conversation, I was strongly impressed by the fact that she had been pondering for some time whether his hometown was in Okuma, Aizu-wakamatsu, or Iwaki.

There is another thing that I was very much impressed by her story.

"I heard that Fukushima Prefectural government wants the 1F site to be cleared (green field). But I wonder what they are going to do if they clear the land. I don't think anyone will be happy if we force them to clear the land".

Based on the results of the individual interviews, the fifth tripartite meeting was held in March 2021 with 36 members in attendance. The Task Force then decided to 1) temporarily suspend setting the goal of "forming a regional platform for local resource development of the 1F decommissioning process," and 2) as a study group, strengthen research activities on fuel debris removal and "place for dialogue" in the 1F decommissioning process, including a case study of the Three Mile Island Nuclear Power Plant in the U.S.

14. Challenge of the 1F Community School: Formation of a "Place of Dialogue"="Learning Community" through Collaboration between Science, Politics, and Society

Based on the above background, since May 2021, the Study Group has held a workshop on 1F debris removal with NDF and TEPCO officials. In addition, two symposiums were held with NRA to discuss the investigation of the 1F accident. In addition, a workshop on fuel debris removal was held with U.S. nuclear engineers who participated in the TMI-2 decommissioning project in the 1980s, and a work-

shop on decommissioning projects and public participation was held with U.S. Department of Energy (DOE) officials.

From the FY2021 several workshops, it became clear that 1) it is important to review the 1F decommissioning project from the approach of "1F decommissioning in society" and "1F decommissioning in the community," 2) the fuel debris removal process from 1F is much more difficult than that from TMI-2, requiring over 100 years to complete, and it is difficult to remove all of it, and 3) the role of NRC in forming a "place of dialogue" is significant.

The practice of "place of dialogue" to date has also revealed the importance of forming "learning community" as well as "places of dialogue". The formation of "learning community" to understand diverse viewpoints is essential for "places of dialogue" as a "community with a purpose" to think the

Fig. 1 Flyer for recruiting people for the 1F Community School

future of 1F decommissioning. A "place of dialogue" is essentially a "learning community," a "place" for expanding and reproducing empathic abilities that enable science, politics, and society to understand each other.

In order to form a "place of dialogue" and at the same time a "learning community" regarding 1F decommissioning, the Study Group, in cooperation with Fukushima Prefectural Futaba Mirai-Gakuen Junior & Senior High School (Hirono Town, Fukushima Prefecture, which has concluded a cooperation agreement with the Research Center), decided to open "1F Community School: A Place to Think, Talk and Learn about the Future of 1F Decommissioning" in July 2022, The school opened in July 2022 (see Fig. 1).

The future vision of 1F decommissioning as considered by the 1F Community School is not a question with an answer, but a question without an answer. Like the private schools at the end of the Edo period that nurtured many of the reformers active in the Meiji Revolution, we want everyone to sit around a table in a mood of comradeship and equality, think, discuss and put things into practice. If modern Japan was a large theatre, the private schools at the end of the Edo period was a training ground for actors. In order to create a new history, we have decided to set up the 1F Community School in the hope that it will become a rehearsal space for the people of the future. We want to think, talk and learn together with people from the local community, experts, the state and the business community about the future vision of 1F decommissioning.

The knowledge gained from the action research of implementing "place of dialogue," which are places for collaboration among science, politics, and society regarding 1F decommissioning policy, is that creating "place of dialogue" alone is unlikely to lead to the formation of a "community with a purpose". In order to form a "community with a purpose" of thinking the future of 1F decommissioning, it is important to create a "place of dialogue" and a "learning community" at the same time. It is important to form a "place of dialogue" where citizens, government officials, business operators, and experts sincerely try to understand each other, and to form a "place of learning" where both sides learn what they really want to know and what is important to each other.

The sense of mission and ability of the presiding person are decisive in the formation of a "place of dialogue"＝"learning community". However, it is the enthusiasm, efforts, and empathetic abilities of the members of the "place of dialogue"—citizens, government officials, and experts—that bring out the sense of mission and abilities of the presiding person.

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