The National Diet of Japan

The official report of

The Fukushima Nuclear Accident Independent Investigation Commission

Executive summary

The National Diet of Japan
Fukushima Nuclear Accident Independent Investigation Commission

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THE NATIONAL DIET OF JAPAN
FUKUSHIMA NUCLEAR ACCIDENT INDEPENDENT INVESTIGATION COMMISSION
(NAIIC)

To:
MR. TAKAHIRO YOKOMICHI, SPEAKER OF THE HOUSE OF REPRESENTATIVES
MR. KENJI HIRATA, PRESIDENT OF THE HOUSE OF COUNCILLORS
THE NATIONAL DIET OF JAPAN

THE UNPRECEDENTED NUCLEAR ACCIDENT that began on March 11, 2011 is the subject of the following report, which we hereby present to the members of the National Diet of Japan for their review. We do this in accordance with the Act Regarding the Fukushima Nuclear Accident Independent Investigation Commission.

Our investigative task is adjourned today, some six months after the appointment of our Chairman and Members in December of 2011.

This report is meant to reinforce the administrative authority of the legislative body and strengthen oversight activities on issues related to nuclear power. As the first independent commission chartered by the Diet in the history of Japan's constitutional government, we would like to emphasize how important it is that this report be utilized, for the Japanese people and for the people of the world.

CHAIRMAN:

KIYOSHI KUROKAWA

MEMBERS:

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YOSHINORI YOKOYAMA | MITSUHIKO TANAKA | KOICHI TANAKA

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Message from the Chairman

THE EARTHQUAKE AND TSUNAMI of March 11, 2011 were natural disasters of a magnitude that shocked the entire world. Although triggered by these cataclysmic events, the subsequent accident at the Fukushima Daiichi Nuclear Power Plant cannot be regarded as a natural disaster. It was a profoundly manmade disaster – that could and should have been foreseen and prevented. And its effects could have been mitigated by a more effective human response.

How could such an accident occur in Japan, a nation that takes such great pride in its global reputation for excellence in engineering and technology? This Commission believes the Japanese people – and the global community – deserve a full, honest and transparent answer to this question.

Our report catalogues a multitude of errors and willful negligence that left the Fukushima plant unprepared for the events of March 11. And it examines serious deficiencies in the response to the accident by TEPCO, regulators and the government.

For all the extensive detail it provides, what this report cannot fully convey – especially to a global audience – is the mindset that supported the negligence behind this disaster.

What must be admitted – very painfully – is that this was a disaster "Made in Japan." Its fundamental causes are to be found in the ingrained conventions of Japanese culture: our reflexive obedience; our reluctance to question authority; our devotion to 'sticking with the program'; our groupism; and our insularity.

Had other Japanese been in the shoes of those who bear responsibility for this accident, the result may well have been the same.

Following the 1970s "oil shocks," Japan accelerated the development of nuclear power in an effort to achieve national energy security. As such, it was embraced as a policy goal by government and business alike, and pursued with the same single-minded determination that drove Japan's postwar economic miracle.

With such a powerful mandate, nuclear power became an unstoppable force, immune to scrutiny by civil society. Its regulation was entrusted to the same government bureaucracy responsible for its promotion. At a time when Japan's self-confidence was soaring, a tightly knit elite with enormous financial resources had diminishing regard for anything 'not invented here.'

This conceit was reinforced by the collective mindset of Japanese bureaucracy, by which the first duty of any individual bureaucrat is to defend the interests of his organization. Carried to an extreme, this led bureaucrats to put organizational interests ahead of their paramount duty to protect public safety.

Only by grasping this mindset can one understand how Japan's nuclear industry managed to avoid absorbing the critical lessons learned from Three Mile Island and Chernobyl; and how it became accepted practice to resist regulatory pressure and cover up small-scale accidents. It was this mindset that led to the disaster at the Fukushima Daiichi Nuclear Plant.

This report singles out numerous individuals and organizations for harsh criticism, but the goal is not—and should not be—to lay blame. The goal must be to learn from this disaster, and reflect deeply on its fundamental causes, in order to ensure that it is never repeated.

Many of the lessons relate to policies and procedures, but the most important is one upon which each and every Japanese citizen should reflect very deeply.

The consequences of negligence at Fukushima stand out as catastrophic, but the mindset that supported it can be found across Japan. In recognizing that fact, each of us should reflect on our responsibility as individuals in a democratic society.

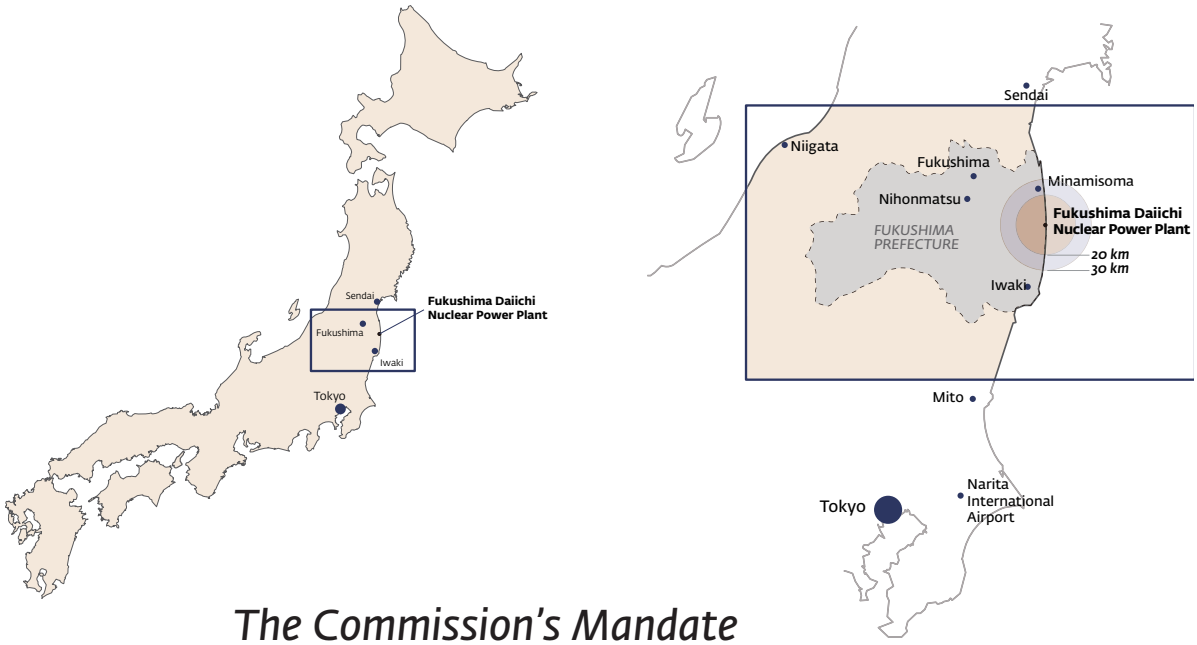
As the first investigative commission to be empowered by the legislature and independent of the bureaucracy, we hope this initiative can contribute to the development of Japan's civil society.

Above all, we have endeavored to produce a report that meets the highest standard of transparency. The people of Fukushima, the people of Japan and the global community deserve nothing less.

CHAIRMAN:

KIYOSHI KUROKAWA

Overview



The Commission's Mandate

On October 30, 2011, the NAIIC Act (officially, the Act regarding Fukushima Nuclear Accident Independent Investigation Commission) was enacted, creating an independent commission to investigate the Fukushima accident with the authority to request documents and request the legislative branch to use its investigative powers to obtain any necessary documents or evidence required. This was the first independent commission created in the history of Japan's constitutional government.

On December 8, 2011, our chairman and nine other members were appointed, and charged by the Speaker and the President of the National Diet with the following mandate, in accordance with Article 10 of the NAIIC Act:

1. To investigate the direct and indirect causes of the Tokyo Electric Power Company Fukushima nuclear power plant accident that occurred on March 11, 2011 in conjunction with the Great East Japan Earthquake.
2. To investigate the direct and indirect causes of the damage sustained from the above accident.
3. To investigate and verify the emergency response to both the accident and the consequential damage; to verify the sequence of events and actions taken; to assess the effectiveness of the emergency response.
4. To investigate the history of decisions and approval processes regarding existing nuclear policies and other related matters.
5. To recommend measures to prevent nuclear accidents and any consequential damage based on the findings of the above investigations. The recommendations shall include assessments of essential nuclear policies and the structure of related administrative organizations.
6. To conduct the necessary administrative functions necessary for carrying out the above activities.

Expectations of the Commission

Before the Commission began its investigation, we also received the following directives from the Joint Council of the Committee on Rules and Administration of Both Houses on the Accident at the Fukushima Nuclear Power Plants of the Tokyo Electric Power Company:

- The investigation is to be conducted thoroughly by experts from a logical, objective and scientific perspective, without bias for or against nuclear power.
- While an open and thorough investigation is the principle, parts of the investigation and the information gathered may be closed to keep the investigation process free of

outside influence.
- A global perspective should be emphasized, so that the results and conclusions will help to prevent nuclear accidents elsewhere.
- The investigation's priority should be on human safety, rather than the structural safety of nuclear reactors.
- The investigation should take place with the understanding that earthquakes and tsunami are still unpredictable but unavoidable events in Japan.
- The investigation should result in recommendations to benefit the nation's future, and provide an opportunity for strengthening the legislative body of the nation.

What we did

Our investigation included more than 900 hours of hearings and interviews with 1,167 people.

We made nine site visits to nuclear power plants including Fukushima Daiichi, Fukushima Daini, Tohoku Electric Power Company Onagawa Nuclear Power Plant, and The Japan Atomic Power Company Tokai Daini Power Plant, in order to conduct as thorough an investigation as possible.

To assure a maximum degree of information disclosure, all 19 of our commission meetings were open to public observation and broadcast on the internet (except for the first one), simultaneously in Japanese and English, to a total of 800,000 viewers. We also used social media, Facebook and twitter to communicate with the public, receiving over 170,000 comments. To gain a global perspective, we dispatched three teams overseas, and included interviews and hearings with experts from the U.S, France, Russia, Ukraine and Belarus.

In addition to this English version of the executive summary, the entire report will soon be published in English.

We focused on the selection of witnesses to those who held responsible positions at the time of the accident in the government, TEPCO and nuclear regulators.

In order to better comprehend the viewpoints of evacuees, we held three town hall meetings, at which we were able to hear first hand the opinions of more than 400 attendees. We also visited twelve municipalities—Futaba, Okuma, Tomioka, Namie, Naraha, Kawauchi, Hirono, Katsurao, Minamisoma, Tamura, Iitate, and Kawamata—within the designated evacuation area, to conduct interviews and survey the residents and workers at the nuclear power plant accident site. We received 10,633 responses to a survey of residents, and many responses from the on-site workers of about 500 related contractors.

What we did not do

There were a number of things we did not do, either because of time constraints or because they did not fit into the scope of our priorities or our mandate.

We did not study matters related to the future energy policies of Japan, including the promotion or abolition of nuclear power.

We did not investigate the treatment and disposition of used nuclear fuel rods.

We did not undertake investigations that would require on-site visits to reactors with dangerous levels of radioactivity.

While we studied the damage compensation and decontamination issues from a systematic perspective, we did not look at specific processes.

We did not address issues related to where responsibility lies in the case of TEPCO being unable to pay accident-related costs.

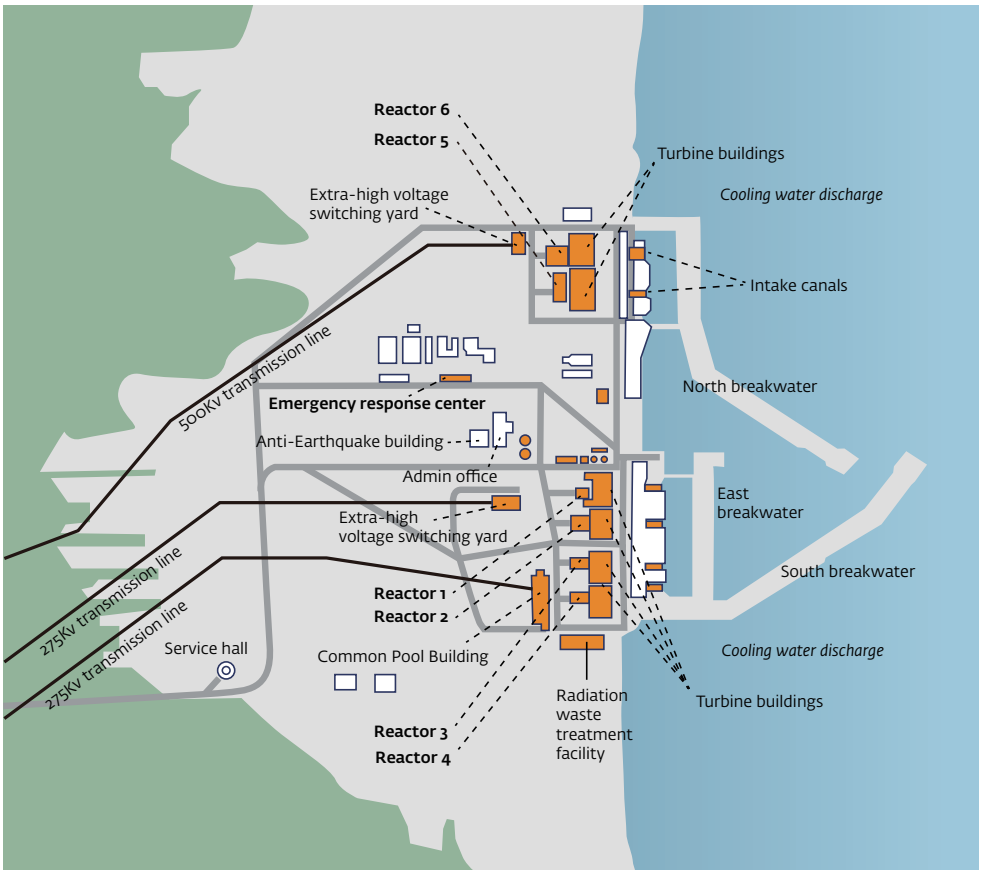
We did not address any stock market-related matters as a consequence of the accident.

We did not address the recommissioning of Japan's nuclear reactors that have halted operations for various reasons.

Nor did we study government administrative policies and regulations that are not related to nuclear safety issues.

We also did not directly investigate the condition of the Fukushima reactors involved in the accident, though we have become aware of the condition from other sources during our investigation. Nor have we attempted to assess the decommissioning methodology of the Fukushima reactors.

And, finally, we have not studied matters relating to the regeneration of the environment surrounding the power plant.



Layout of the Fukushima Daiichi Nuclear Power Plant ▶
Adapted from: INPO "Special Report on the Nuclear Accident at the Fukushima Daiichi Nuclear Power Station"

The accident

On March 11, 2011, the Great East Japan Earthquake triggered an extremely severe nuclear accident at the Fukushima Daiichi Nuclear Power Plant, owned and operated by the Tokyo Electric Power Company (TEPCO). This devastating accident was ultimately declared a Level 7 ("Severe Accident") by the International Nuclear Event Scale (INES).

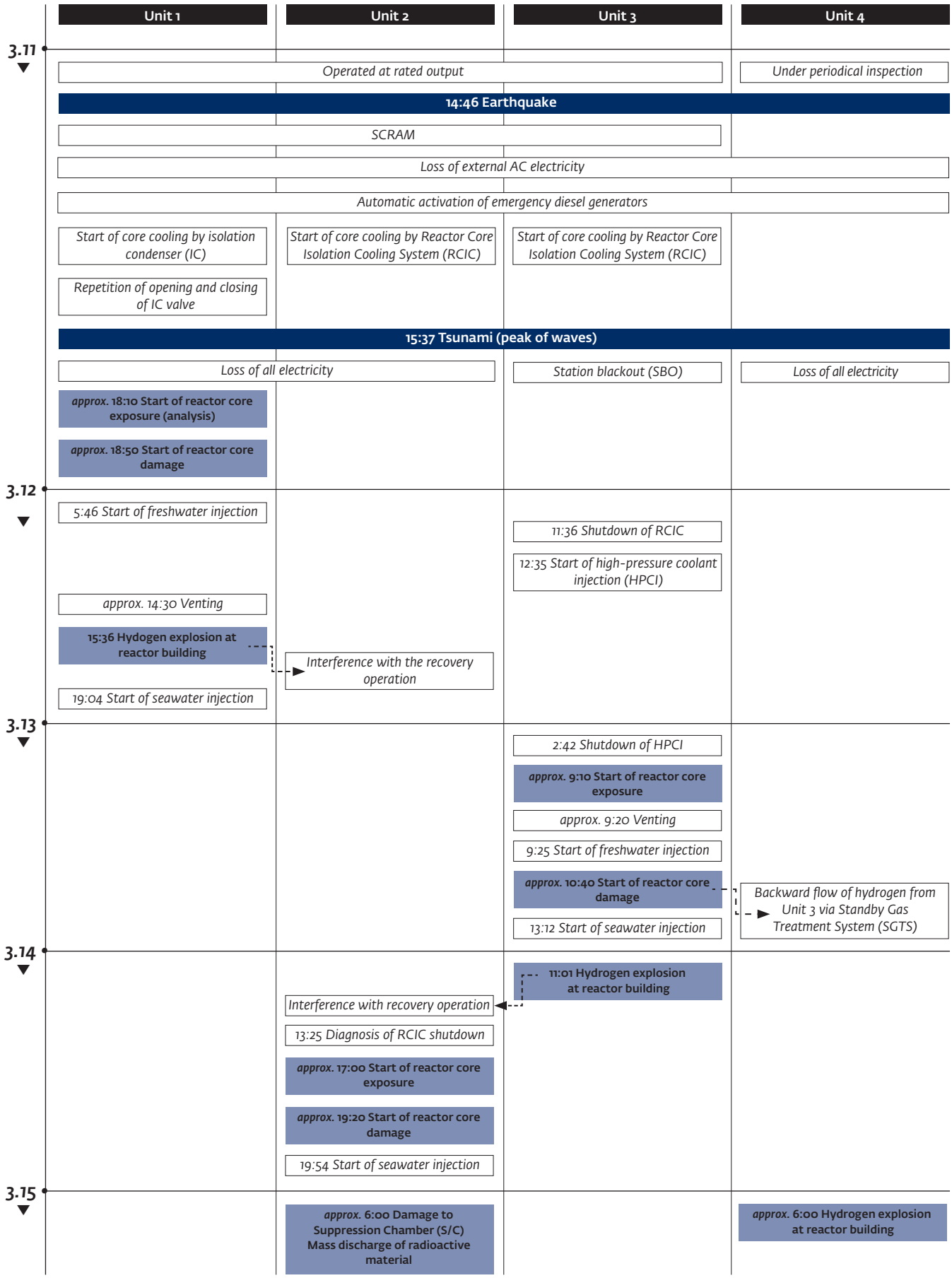
When the earthquake occurred, Unit 1 of the Fukushima Daiichi plant was in normal operation at the rated electricity output according to its specifications; Units 2 and 3 were in operation within the rated heat parameters of their specifications; and Units 4 to 6 were undergoing periodical inspections. The emergency shut-down feature, or SCRAM, went into operation at Units 1, 2 and 3 immediately after the commencement of the seismic activity.

The seismic tremors damaged electricity transmission facilities between the TEPCO Shinfukushima Transformer Substations and the Fukushima Daiichi Nuclear Power Plant, resulting in a total loss of off-site electricity. There was a back-up 66kV transmission line from the transmission network of Tohoku Electric Power Company, but the back-up line failed to feed Unit 1 via a metal-clad type circuit (M/C) of Unit 1 due to mismatched sockets.

The tsunami caused by the earthquake flooded and totally destroyed the emergency diesel generators, the seawater cooling pumps, the electric wiring system and the DC power supply for Units 1, 2 and 4, resulting in loss of all power—except for an external supply to Unit 6 from an air-cooled emergency diesel generator. In short, Units 1, 2 and 4 lost all power; Unit 3 lost all AC power, and later lost DC before dawn of March 13, 2012. Unit 5 lost all AC power.

The tsunami did not damage only the power supply. The tsunami also destroyed or washed away vehicles, heavy machinery, oil tanks, and gravel. It destroyed buildings, equipment installations and other machinery. Seawater from the tsunami inundated the entire building area and even reached the extremely high pressure operating sections of Units 3 and 4, and a supplemental operation common facility (Common Pool Building). After the water retreated, debris from the flooding was scattered all over the plant site,

Timeline following the earthquake and tsunami



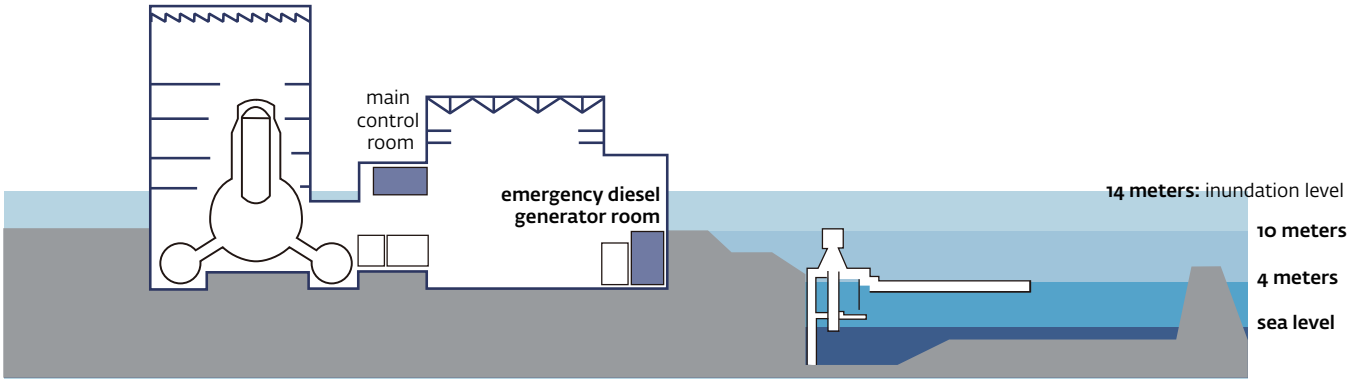
*Start of reactor core exposure and start of reactor core damage times are both from TEPCO's MAAP analysis results.

hindering movement. Manhole and ditch covers had disappeared, leaving gaping holes in the ground. In addition, the earthquake lifted, sank, and collapsed building interiors and pathways, and access to and within the plant site became extremely difficult. Recovery tasks were further interrupted as workers reacted to the intermittent and significant aftershocks and tsunami. The loss of electricity resulted in the sudden loss of monitoring equipment such as scales, meters and the control functions in the central control room. Lighting and communications were also affected. The decisions and responses to the accident had to be made on the spot by operational staff at the site, absent valid tools and manuals.

The loss of electricity made it very difficult to effectively cool down the reactors in a timely manner. Cooling the reactors and observing the results were heavily dependent on electricity for high-pressure water injection, depressurizing the reactor, low pressure water injection, the cooling and depressurizing of the reactor containers and removal of decay heat at the final heat-sink. The lack of access, as previously mentioned, obstructed the delivery of necessities such as alternative water injection using fire trucks, the recovery of electricity supply, the line configuration of the vent and its intermittent operation.

The series of events summarized above are an overview of the severe accident that ultimately emitted an enormous amount of radioactive material into the environment. These are described in detail in the full-length report.

Cross section of the plant showing the inundation level



Conclusions and recommendations

Conclusions

After a six-month investigation, the Commission has concluded the following:

> ***In order to prevent future disasters, fundamental reforms must take place. These reforms must cover both the structure of the electric power industry and the structure of the related government and regulatory agencies as well as the operation processes. They must cover both normal and emergency situations.***

A "manmade" disaster

The TEPCO Fukushima Nuclear Power Plant accident was the result of collusion between the government, the regulators and TEPCO, and the lack of governance by said parties. They effectively betrayed the nation's right to be safe from nuclear accidents. Therefore, we conclude that the accident was clearly "manmade." We believe that the root causes were the organizational and regulatory systems that supported faulty rationales for decisions and actions, rather than issues relating to the competency of any specific individual. (see Recommendation 1)

The direct causes of the accident were all foreseeable prior to March 11, 2011. But the Fukushima Daiichi Nuclear Power Plant was incapable of withstanding the earthquake and tsunami that hit on that day. The operator (TEPCO), the regulatory bodies (NISA and NSC) and the government body promoting the nuclear power industry (METI), all failed to correctly develop the most basic safety requirements—such as assessing the probability of damage, preparing for containing collateral damage from such a disaster, and developing evacuation plans for the public in the case of a serious radiation release.

TEPCO and the Nuclear and Industrial Safety Agency (NISA) were aware of the need for structural reinforcement in order to conform to new guidelines, but rather than demanding their implementation, NISA stated that action should be taken autonomously by the operator. The Commission has discovered that no part of the required reinforcements had been implemented on Units 1 through 3 by the time of the accident. This was the result of tacit consent by NISA for a significant delay by the operators in completing the reinforcement. In addition, although NISA and the operators were aware of the risk of core damage from tsunami, no regulations were created, nor did TEPCO take any protective steps against such an occurrence.

Since 2006, the regulators and TEPCO were aware of the risk that a total outage of electricity at the Fukushima Daiichi plant might occur if a tsunami were to reach the level of the site. They were also aware of the risk of reactor core damage from the loss of seawater pumps in the case of a tsunami larger than assumed in the Japan Society of Civil Engineers estimation. NISA knew that TEPCO had not prepared any measures to lessen or eliminate the risk, but failed to provide specific instructions to remedy the situation.

We found evidence that the regulatory agencies would explicitly ask about the operators' intentions whenever a new regulation was to be implemented. For example, NISA informed the operators that they did not need to consider a possible station blackout (SBO) because the probability was small and other measures were in place. It then asked the operators to write a report that would give the appropriate rationale for why this consideration was unnecessary. In order to get evidence of this collusion, the Commission was forced to exercise our legislative right to demand such information from NISA, after NISA failed to respond to several requests.

The regulators also had a negative attitude toward the importation of new advances in knowledge and technology from overseas. If NISA had passed on to TEPCO measures that were included in the B.5.b subsection of the U.S. security order that followed the 9/11 terrorist action, and if TEPCO had put the measures in place, the accident may have been preventable.

There were many opportunities for taking preventive measures prior to March 11. The accident occurred because TEPCO did not take these measures, and NISA and the Nuclear Safety Commission (NSC) went along. They either intentionally postponed putting safety measures in place, or made decisions based on their organization's self interest, and not in the interest of public safety.

From TEPCO's perspective, new regulations would have interfered with plant operations and weakened their stance in potential lawsuits. That was enough motivation for TEPCO to aggressively oppose new safety regulations and draw out negotiations with regulators via the Federation of Electric Power Companies (FEPC). The regulators should have taken a strong position on behalf of the public, but failed to do so. As they had firmly committed themselves to the idea that nuclear power plants were safe, they were reluctant to actively create new regulations. Further exacerbating the problem was the fact that NISA was created as part of the Ministry of Economy, Trade & Industry (METI), an organization that has been actively promoting nuclear power.

Earthquake damage

We conclude that TEPCO was too quick to cite the tsunami as the cause of the nuclear accident and deny that the earthquake caused any damage. We believe there is a possibility that the earthquake damaged equipment necessary for ensuring safety, and that there is also a possibility that a small-scale LOCA occured in Unit 1. We hope these points will be examined further by a third party. (see Recommendation 7)

Although the two natural disasters—the earthquake and subsequent tsunami—were the direct causes of the accident, there are various points in the unfolding of the event that remain unresolved. The main reason for this is that almost all the equipment directly related to the accident is inside the reactor containers, which are inaccessible and will remain so for many years. A complete examination and full analysis are impossible at this time.

TEPCO was quick, however, to assign the accident cause to the tsunami, and state that the earthquake was not responsible for damage to equipment necessary for safety (although it did add, "to the extent that has been confirmed," a phrase that also appears in TEPCO reports to the government and to the IAEA). However, it is impossible to limit the direct cause of the accident to the tsunami without substantive evidence. The Commission believes that this is an attempt to avoid responsibility by putting all the blame on the unexpected (the tsunami), as they wrote in their midterm report, and not on the more foreseeable earthquake.

Through our investigation, we have verified that the people involved were aware of the risk from both earthquakes and tsunami. Further, the damage to Unit 1 was caused not only by the tsunami but also by the earthquake, a conclusion made after considering the facts that: 1) the largest tremor hit after the automatic shutdown (SCRAM); 2) JNES confirmed the possibility of a small-scale LOCA (loss of coolant accident); 3) the Unit 1 operators were concerned about leakage of coolant from the valve, and 4) the safety relief valve (SR) was not operating.

Additionally, there were two causes for the loss of external power, both earthquake-related: there was no diversity or independence in the earthquake-resistant external power systems, and the Shin-Fukushima transformer station was not earthquake resistant. (See Section 2 of the Summary of Findings)

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Evaluation of operational problems

The Commission concludes that there were organizational problems within TEPCO. Had there been a higher level of knowledge, training, and equipment inspection related to severe accidents, and had there been specific instructions given to the on-site workers concerning the state of emergency within the necessary time frame, a more effective accident response would have been possible. (see Recommendation 4)

There were many problems with on-site operations during the accident. Events make it clear that if there are no response measures for a severe accident in place, the steps that can be taken on-site in the event of a station blackout are very limited. Recovery work, such as confirming the operation of the isolation condenser (IC) in Unit 1, should have been conducted swiftly because of the loss of DC power, but was not. TEPCO did not plan measures for the IC operation, and had no manual or training regimens, so these are clearly organizational problems. Regarding the vent line composition, conducting line configuration work in a situation with no power and soaring radiation levels must have been extremely difficult and time consuming. On top of this, sections in the diagrams of the severe accident instruction manual were missing. Workers not only had to work using this flawed manual, but they were pressed for time, and working in the dark with flash-

lights as their only light source. The Kantei's (Prime Minster's Office) distrust of TEPCO management was exacerbated by the slow response, but the actual work being done was extremely difficult.

Many layers of security were breached simultaneously, and the power to four reactors was lost at the same time. Had there not been some coincidental events—such as the RCIC in Unit 2 operating for so many hours, the blow-out panel falling out and releasing pressure, and the speed with which subcontractors cleaned up wreckage—Units 2 and 3 would have been in an even more precarious situation. We have concluded that—given the deficiencies in training and preparation—once the total station blackout occurred, including the loss of a direct power source, it was impossible to change the course of events.

Emergency response issues

The Commission concludes that the situation continued to deteriorate because the crisis management system of the Kantei, the regulators and other responsible agencies did not function correctly. The boundaries defining the roles and responsibilities of the parties involved were problematic, due to their ambiguity. (see Recommendation 2)

The government, the regulators, TEPCO management, and the Kantei lacked the preparation and the mindset to efficiently operate an emergency response to an accident of this scope. None, therefore, were effective in preventing or limiting the consequential damage.

NISA was expected to play the lead role as designated in the Act on Special Measures Concerning Nuclear Emergency Preparedness, which was enacted after a criticality accident at the JCO uranium conversion facility at Tokaimura, Ibaraki Prefecture in 1999. However, NISA was unprepared for a disaster of this scale, and failed in its function.

In the critical period just after the accident, the Kantei did not promptly declare a state of emergency. The regional nuclear emergency response team was meant to be the contact between the Kantei and the operator, responsible for keeping the Kantei informed about the situation on the ground. Instead, the Kantei contacted TEPCO headquarters and the Fukushima site directly, and disrupted the planned chain of command. A TEPCO-Kantei response team was created in TEPCO headquarters on March 15, but this body had no legal authority.

The Kantei, the regulators and TEPCO all understood the need to vent Unit 1. TEPCO had been reporting to NISA, as was the standard protocol, that it was in the process of venting. But there is no confirmation that the venting decision was conveyed to senior members of METI, or to the Kantei. This failure of NISA's function and the scarcity of information at TEPCO headquarters resulted in the Kantei losing faith in TEPCO.

The Prime Minister made his way to the site to direct the workers who were dealing with the damaged core. This unprecedented direct intervention by the Kantei diverted the attention and time of the on-site operational staff and confused the line of command. While TEPCO headquarters was supposed to provide support to the plant, in reality it became subordinate to the Kantei, and ended up simply relaying the Kantei's intentions. This was a result of TEPCO's mindset, which included a reluctance to take responsibility, epitomized by President Shimizu's inability to clearly report to the Kantei the intentions of the operators at the plant.

At the same time, it is hard to conclude that it was the Prime Minister who discouraged the idea of a full pullout by TEPCO, as has been reported elsewhere, for a number of reasons: 1) there is no evidence that the TEPCO management at the plant had even thought of a complete withdrawal; 2) There is no trace of a decision on a complete withdrawal being made at TEPCO headquarters; 3) The evacuation planned before Mr. Shimizu's visit to the Kantei included keeping emergency response members at the plant (though evaculation criteria were discussed); 4) The director-general of NISA reported that when Shimizu called him, he was not asked for advice on a full withdrawal; and 5) The off-site center, which was connected through a video conference system, claimed there was no discussion of a complete withdrawal. Crisis management related to public safety should be assured without having to rely on the capability and judgement of the prime minister of any given time.

Evacuation issues

The Commission concludes that the residents' confusion over the evacuation stemmed from the regulators' negligence and failure over the years to implement adequate mea-

sures against a nuclear disaster, as well as a lack of action by previous governments and regulators focused on crisis management. The crisis management system that existed for the Kantei and the regulators should protect the health and safety of the public, but it failed in this function. (see Recommendation 2)

The central government was not only slow in informing municipal governments about the nuclear power plant accident, but also failed to convey the severity of the accident. Similarly, the speed of information in the evacuation areas varied significantly depending on the distance from the plant. Specifically, only 20 percent of the residents of the town hosting the plant knew about the accident when evacuation from the 3km zone was ordered at 21:23 on the evening of March 11. Most residents within 10km of the plant learned about the accident when the evacuation order was issued at 5:44 on March 12, more than 12 hours after the Article 15 notification—but received no further explanation of the accident or evacuation directions. Many residents had to flee with only the barest necessities and were forced to move multiple times or to areas with high radiation levels. There was great confusion over the evacuation, caused by prolonged shelter-in-place orders and voluntary evacuation orders. Some residents were evacuated to high dosage areas because radiation monitoring information was not provided. Some people evacuated to areas with high levels of radiation and were then neglected, receiving no further evacuation orders until April.

The Commission has verified that there was a lag in upgrading nuclear emergency preparedness and complex disaster countermeasures, and attributes this to regulators' negative attitudes toward revising and improving existing emergency plans.

Continuing public health and welfare issues

The Commission recognizes that the residents in the affected area are still struggling from the effects of the accident. They continue to face grave concerns, including the health effects of radiation exposure, displacement, the dissolution of families, disruption of their lives and lifestyles and the contamination of vast areas of the environment. There is no foreseeable end to the decontamination and restoration activities that are essential for rebuilding communities. The Commission concludes that the government and the regulators are not fully committed to protecting public health and safety; that they have not acted to protect the health of the residents and to restore their welfare. (see Recommendation 3)

Approximately 150,000 people were evacuated in response to the accident. An estimated 167 workers were exposed to more than 100 millisieverts of radiation while dealing with the accident. It is estimated that as much as 1,800 square kilometers of land in Fukushima Prefecture has now been contaminated by a cumulative radiation dose of 5 millisieverts or higher per year. Insufficient evacuation planning led to many residents receiving unnecessary radiation exposure. Others were forced to move multiple times, resulting in increased stress and health risks—including deaths among seriously ill patients.

The government must move to analyze the state of the residents' lives in the affected areas and systematically map out measures to improve their quality of life. These measures should include the realignment of the evacuation zones, the restoration of the foundations of everyday life, decontamination issues, and realigning the medical and welfare systems to meet the public's needs. It has yet to do so. The more than 10,000 people who responded to our surveys, and the comments the Commission Members heard at town hall meetings offer harsh judgment of the government's present stance.

While exposure levels are set as a threshold against acute radiation disorder, there is no widely accepted threshold for long-term radiation damage caused by low doses. The international consensus, however, is that the risk does increase in proportion to the dose. The impact of radiation on health may vary from one person to another depending on age, sensitivity to radiation and other factors, some unknown. After the accident, the government unilaterally announced a benchmark on dosage without giving the specific information that residents needed, including answers to questions like: What is a tolerable level of exposure in light of long-term health effects? How do health implications differ for individuals? How can people protect themselves from radioactive substances?

The government has not seriously undertaken programs to help people understand the situ-

ation well enough to make their own behavioral judgments. They failed to explain, for example, the risks of radiation exposure to different segments of the population, such as infants and youths, expecting mothers, or people particularly susceptible to the effects of radiation.

Reforming the regulators

The Commission has concluded that the safety of nuclear energy in Japan and the public cannot be assured unless the regulators go through an essential transformation process. The entire organization needs to be transformed, not as a formality but in a substantial way. Japan's regulators need to shed the insular attitude of ignoring international safety standards and transform themselves into a globally trusted entity. (see Recommendation 5)

The regulators did not monitor or supervise nuclear safety. The lack of expertise resulted in "regulatory capture," and the postponement of the implementation of relevant regulations. They avoided their direct responsibilities by letting operators apply regulations on a voluntary basis. Their independence from the political arena, the ministries promoting nuclear energy, and the operators was a mockery. They were incapable, and lacked the expertise and the commitment to assure the safety of nuclear power. Moreover, the organization lacked transparency. Without the investigation by this Commission, operating independently of the government, many of the facts revealing the collusion between the regulators and other players might never have been revealed.

Reforming the operator

TEPCO did not fulfil its responsibilities as a private corporation, instead obeying and relying upon the government bureaucracy of METI, the government agency driving nuclear policy. At the same time, through the auspices of the FEPC, it manipulated the cozy relationship with the regulators to take the teeth out of regulations. (see Recommendation 4)

The risk management practices of TEPCO illustrate this. If the risk factors of tsunami are raised, for example, TEPCO would only look at the risk to their own operations, and whether it would result in a suspension of existing reactors or weaken their stance in potential lawsuits. They ignored the potential risk to the public health and welfare. (See Section 5)

Problems with TEPCO's management style, based on the government taking final responsibility, became explicit during the accident. It prioritized the Kantei's intent over that of the technical engineers at the site. TEPCO's behavior was consistently unclear, and the misunderstanding over the "complete withdrawal" from the plant is a good example of the confusion that arose from their behavior. (See Section 3)

After the accident, TEPCO continued to avoid transparency in disclosing information. It limited disclosure to confirmed facts, and failed to disclose information that it felt was uncertain or inconvenient. Some examples of continuing disclosure issues include the delay in releasing electricity demand projections used as the basis for rolling blackouts, and the lack in up-to-date information on the core conditions at the plant.

Reforming laws and regulations

The Commission concludes that it is necessary to realign existing laws and regulations concerning nuclear energy. Mechanisms must be established to ensure that the latest technological findings from international sources are reflected in all existing laws and regulations. (see Recommendation 6)

Laws and regulations related to nuclear energy have only been revised as stopgap measures, based on actual accidents. They have not been seriously and comprehensively reviewed in line with the accident response and safeguarding measures of an international standard. As a result, predictable risks have not been addressed.

The existing regulations primarily are biased toward the promotion of a nuclear energy policy, and not to public safety, health and welfare. The unambiguous responsibility that operators should bear for a nuclear disaster was not specified. There was also no clear guidance about the responsibilities of the related parties in the case of an emergency. The defense-in-depth concept used in other countries has still not been fully considered.

Cosmetic solutions

Replacing people or changing the names of institutions will not solve the problems. Unless these root causes are resolved, preventive measures against future similar accidents will never be complete. (see Recommendations 4, 5 and 6)

The Commission believes the root causes of this accident cannot be resolved and that the people's confidence cannot be recovered as long as this "manmade disaster" is seen as the result of error by a specific individual. The underlying issue is the social structure that results in "regulatory capture," and the organizational, institutional, and legal framework that allows individuals to justify their own actions, hide them when inconvenient, and leave no records in order to avoid responsibility. Across the board, the Commission found ignorance and arrogance unforgivable for anyone or any organization that deals with nuclear power. We found a disregard for global trends and a disregard for public safety. We found a habit of adherence to conditions based on conventional procedures and prior practices, with a priority on avoiding risk to the organization. We found an organization-driven mindset that prioritized benefits to the organization at the expense of the public.

Recommendations

Based on the above findings, the Commission makes the following seven recommendations for the future. We urge the National Diet of Japan to thoroughly debate and deliberate on these recommendations.

Recommendation 1:
Monitoring of the nuclear regulatory body by the National Diet
A permanent committee to deal with issues regarding nuclear power must be established in the National Diet in order to supervise the regulators to secure the safety of the public. Its responsibilities should be:

1. To conduct regular investigations and explanatory hearings of regulatory agencies, academics and stakeholders.
2. To establish an advisory body, including independent experts with a global perspective, to keep the committee's knowledge updated in its dealings with regulators.
3. To continue investigations on other relevant issues.
4. To make regular reports on their activities and the implementation of their recommendations.

Recommendation 2:
Reform the crisis management system
A fundamental reexamination of the crisis management system must be made. The boundaries dividing the responsibilities of the national and local governments and the operators must be made clear. This includes:

1. A reexamination of the crisis management structure of the government. A structure must be established with a consolidated chain of command and the power to deal with emergency situations.
2. National and local governments must bear responsibility for the response to off-site radiation release. They must act with public health and safety as the priority.
3. The operator must assume responsibility for on-site accident response, including the halting of operations, and reactor cooling and containment.

Recommendation 3:
Government responsibility for public health and welfare
Regarding the responsibility to protect public health, the following must be implemented as soon as possible:

1. A system must be established to deal with long-term public health effects, including stress-related illness. Medical diagnosis and treatment should be covered by state funding. Information should be disclosed with public health and safety as the priority, instead of government convenience. This information must be comprehensive, for use by individual residents to make informed decisions.
2. Continued monitoring of hotspots and the spread of radioactive contamination must be undertaken to protect communities and the public. Measures to prevent any potential spread should also be implemented.
3. The government must establish a detailed and transparent program of decontamination and relocation, as well as provide information so that all residents will be knowledgable about their compensation options.

Recommendation 4:
Monitoring the operators
TEPCO must undergo fundamental corporate changes, including strengthening its governance, working towards building an organizational culture which prioritizes safety, changing its stance on information disclosure, and establishing a system which prioritizes the site. In order to prevent the Federation of Electric Power Companies (FEPC) from being used as a route for negotiating with regulatory agencies, new relationships among the electric power companies must also be established—built on safety issues, mutual supervision and transparency.

1. The government must set rules and disclose information regarding its relationship with the operators.

2. Operators must construct a cross-monitoring system to maintain safety standards at the highest global levels.
3. TEPCO must undergo dramatic corporate reform, including governance and risk management and information disclosure—with safety as the sole priority.
4. All operators must accept an agency appointed by the National Diet as a monitoring authority of all aspects of their operations, including risk management, governance and safety standards, with rights to on-site investigations.

Recommendation 5:

Criteria for the new regulatory body

The new regulatory organization must adhere to the following conditions. It must be:

1. Independent: The chain of command, responsible authority and work processes must be: (i) Independent from organizations promoted by the government (ii) Independent from the operators (iii) Independent from politics.
2. Transparent: (i) The decision-making process should exclude the involvement of electric power operator stakeholders. (ii) Disclosure of the decision-making process to the National Diet is a must. (iii) The committee must keep minutes of all other negotiations and meetings with promotional organizations, operators and other political organizations and disclose them to the public. (iv) The National Diet shall make the final selection of the commissioners after receiving third-party advice.
3. Professional: (i) The personnel must meet global standards. Exchange programs with overseas regulatory bodies must be promoted, and interaction and exchange of human resources must be increased. (ii) An advisory organization including knowledgable personnel must be established. (iii) The no-return rule should be applied without exception.
4. Consolidated: The functions of the organizations, especially emergency communications, decision-making and control, should be consolidated.
5. Proactive: The organizations should keep up with the latest knowledge and technology, and undergo continuous reform activities under the supervision of the Diet.

Recommendation 6:

Reforming laws related to nuclear energy

Laws concerning nuclear issues must be thoroughly reformed.

1. Existing laws should be consolidated and rewritten in order to meet global standards of safety, public health and welfare.
2. The roles for operators and all government agencies involved in emergency response activities must be clearly defined.
3. Regular monitoring and updates must be implemented, in order to maintain the highest standards and the highest technological levels of the international nuclear community.
4. New rules must be created that oversee the backfit operations of old reactors, and set criteria to determine whether reactors should be decommissioned.

Recommendation 7:

Develop a system of independent investigation commissions

A system for appointing independent investigation committees, including experts largely from the private sector, must be developed to deal with unresolved issues, including, but not limited to, the decommissioning process of reactors, dealing with spent fuel issues, limiting accident effects and decontamination.

Summary of findings

1

Was the accident preventable?

The Commission has verified that on March 11, 2011, the structure of the Fukushima Daiichi Nuclear Plant was not capable of withstanding the effects of the earthquake and the tsunami. Nor was the Fukushima Daiichi Nuclear Plant prepared to respond to a severe accident. In spite of the fact that TEPCO and the regulators were aware of the risk from such natural disasters, neither had taken steps to put preventive measures in place. It was this lack of preparation that led to the severity of this accident.

The yield strength of the Fukushima Daiichi Unit 1

The structure of Fukushima Daiichi Unit 1 was incapable of withstanding the powerful earthquake and massive tsunami of March 11, 2011. The specifications for the plant lacked adequate anti-quake and anti-tsunami yield strengths because: 1) the guidelines for nuclear plant construction were insufficient at the time the construction permit was granted for Units 1 through 3 in the late 1960's, and 2) the area surrounding the plant was considered to have minimal seismic activity and had never experienced earthquake damage. Based on that assessment, a safety tolerance level for the maximum seismic acceleration in the anti-seismic design was set at 265 gal (i.e. unit of gravitational acceleration), a remarkably low earthquake resistance.

In 1981, a "Guideline for Anti-seismic Design Regarding Nuclear Reactor Facilities for Electricity Generation" was set by NSC. In 2006, NSC released a revised version of the former guideline. NISA acted to require that nuclear operators assess the anti-seismic safety of their sites according to the new guideline – the so-called "anti-seismic backcheck." In March 2008, TEPCO submitted an interim anti-seismic backcheck report on Unit 5 of Fukushima Daiichi, stating the safety of its anti-seismic measures, and assuming an increased safety tolerance level of the maximum seismic acceleration to 600 gal. In 2009, NISA accepted the contents of the interim report, even though the scope of the assessment included the reactor building and only seven of many other important safety installations and equipment. In June 2009, similar reports for Units 1 through 4 and 6 were submitted but these were similarly limited.

No further anti-seismic backcheck reports were released by TEPCO, because no significant anti-seismic safety assessments were performed. While the official deadline was June 2009, TEPCO made the decision internally and unilaterally to reschedule the deadline to January 2016. TEPCO learned through the interim report assessment process that many reinforcements were required to meet the standards of the new guideline, but our investigation verified the fact that TEPCO had added no reinforcements to Units 1 through 3 at the time of the March 11 earthquake. Although NISA had recognized the need for both the reinforcements and the backcheck, the regulator failed in its oversight of TEPCO's progress.

In their analysis and evaluation after the accident, both TEPCO and NISA confirmed that some of the important safety parts of piping and supports for Unit 5 were not up to the anti-seismic safety standards at the time of the quake. TEPCO reported that they did not find material damage to these parts in their visual inspection, but the Commission believes that a conclusion denying quake damage cannot be drawn, as inspection, including non-destructive inspection, is not complete. The Commission believes that the same is true for Units 1 through 3, which are much older than Unit 5. Section 2 includes details illustrating the fact that the recorded seismic motion at Fukushima Daiichi exceeded the assumption of the new guideline. It is clear that appropriate anti-seismic reinforcements were not in place at the time of the March 11 earthquake.

The lack of tsunami countermeasures

The construction of the Fukushima Daiichi Plant that began in 1967 was based on the seismological knowledge at that time. As research continued over the years, researchers repeatedly pointed out the high possibility of tsunami levels reaching beyond the assumptions made at the time of construction, as well as the possibility of core damage in the case of such a tsunami. TEPCO overlooked these warnings, and the small margins of safety that existed were far from adequate for such an emergency situation.

Since 2006, the regulatory authorities and TEPCO have shared information on the possibility of a total outage of electricity occurring at Fukushima Daiichi should tsunami levels reach the site. They also shared an awareness of the risk of potential reactor core damage from a breakdown of seawater pumps if the magnitude of a tsunami striking the plant turned out to be greater than the assessment made by the Japan Society of Civil Engineers.

There were at least three background issues concerning the lack of improvements. First, NISA did not disclose any information to the public on their evaluations or their instructions to reconsider the assumptions used in designing the plant's tsunami defenses. Nor did NISA keep any records of the information. As result, third parties could never know of the true state of affairs.

The second issue concerned the methodology used by the Japan Society of Civil Engineers to evaluate the height of the tsunami. Even though the method was decided through

an unclear process, and with the improper involvement of the electric power companies, NISA accepted it as a standard without examining its validity.

A third issue was the arbitrary interpretation and selection of a probability theory. TEPCO tried to justify the belief that there was a low probability of tsunami, and used the results of a biased calculation process as grounds to ignore the need for countermeasures. TEPCO also argued that basing any safety assessment against tsunami on a probabilistic approach would be using a methodology of technical uncertainties, and used that argument to postpone considering countermeasures for tsunami.

As the regulatory agency, NISA was aware of TEPCO's delaying of countermeasures, but did not follow up with any specific instructions or demands. Nor did they properly supervise the backcheck progress.

The reason why TEPCO overlooked the significant risk of a tsunami lies within its risk management mindset—in which the interpretation of issues was often stretched to suit its own agenda. In a sound risk management structure, the management considers and implements countermeasures for risk events that have an undeniable probability, even if details have yet to be scientifically confirmed. Rather than considering the known facts and quickly implementing counter measures, TEPCO resorted to delaying tactics, such as presenting alternative scientific studies and lobbying.

Countermeasures not up to international standards

All of the measures against a severe accident (SA) that were in place in Japan were practically ineffective. The assumptions made in SA countermeasures only included internal issues, such as operational human error, and did not include external factors such as earthquakes and tsunami, even though Japan is known to frequently suffer from these natural events.

From the outset, operators were allowed to set SA countermeasures autonomously. In 1991, the Common Issue Discussion Panel of NSC explicitly stated that "the accident management, including expedient and flexible measures that might be required under actual situations, shall be considered and implemented by the operators based on their 'technical competency' and 'expertise,' but shall not require authority to regulate the specific details of measures."

The severe accident measures that were autonomously set did not even reach the standards of measures set by the regulatory agencies. In fact, the severe accident safety equipment turned out to have a lower yield strength than the safety equipment used during normal operation that met regulated requirements. Clearly, using severe accident safety equipment with lower capability than the equipment used in normal operations undermines the entire reason for developing these measures. As a result of inadequate oversight, the SA countermeasures implemented in Japan were practically ineffective compared to the countermeasures in place abroad, and actions were significantly delayed as a result.

Allowing autonomous SA countermeasures also left room for the operators to actively negotiate terms with the regulators via the Federation of Electric Power Companies (FEPC). This was especially true after 2010, when the regulators began leaning towards regulating SA countermeasures in step with global trends, and the operators, via FEPC, began to aggressively lobby the regulators to slow the process down. The operators negotiated with the regulators for two reasons: 1) to avoid or minimize the risk of potential lawsuits and 2) to avoiding backfitting requirements that would interfere with the operation of existing reactors. Again, this meant that no countermeasures had been prepared against severe accidents like the one that took place beginning on March 11—in other words, an accident that may have very small odds of occurring, but creates a catastrophic situation when it does.

2

Escalation of the accident

The Commission closely investigated the development of the accident. We studied whether the accident could have been contained, and whether it could have become even more serious. We also examined the role of the earthquake as a cause of the accident, and the validity of TEPCO's claim that the tsunami was the sole direct cause.

How the accident developed

The measures in place to prevent a severe accident at the Fukushima Daiichi Nuclear Power plant were far from sufficient. The power supply system was especially poor from a defensive perspective, and suffered from a lack of redundancy, diversity and independence.

Although there were a number of external power lines to the plant, there were only two source stations, and both were put out of commission by the earthquake, resulting in a loss of external power to all the units. The diesel generators and other internal power equipment, including the power distribution buses, were all located within or nearby the plant, and were inundated by the tsunami that struck soon after. The assumptions about a normal station blackout (SBO) did not include the loss of DC power, yet this is exactly what occurred.

In the chaos following the destruction wrought by the tsunami, workers were hindered greatly in their response efforts. The loss of control room functions, lighting and communications, and the struggle to deliver equipment and materials through the debris-strewn plant, were further hindered by continued aftershocks. These also had not been anticipated.

Response manuals with detailed anti-severe accident measures were not up to date, and the diagrams and documents outlining the venting procedures were incomplete or missing. Even emergency drills and training had not been sufficiently prioritized. These were all symptomatic of TEPCO's institutional problems.

Units 1, 3 and 4 exploded, and the containment vessel was breached in Unit 2. Core damage was avoided in Units 5 and 6, which shut down safely. The Commission discovered that, in reality, an even worse situation could have developed at Units 2 and 3, and the situations at Unit 5 and 6 could have easily worsened. If preventive measures against terrorist attacks had been implemented, the accident might have been handled and developed in a different way. Damage to the spent fuel of Unit 4 could have occurred, with greater affect to the wider surrounding environment. There was a distinct potential at the time for this disastrous accident to result in an even more frightening scenario.

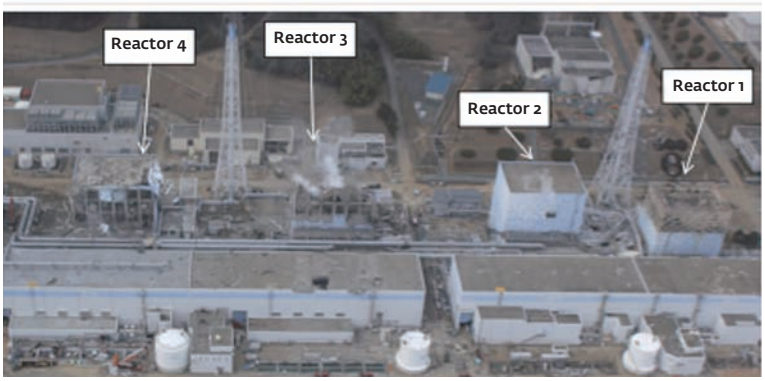
Verification of events

The accident is clearly attributable to the natural phenomena: the earthquake and resulting tsunami. Yet a number of important factors relating to how the accident actually evolved remain unknown, mainly because much of the critical equipment and piping relevant to the accident are inside the reactor containment facility and are thus beyond the reach of inspection or verification for many years to come.

In spite of this, TEPCO specified in its interim investigation report that equipment providing key safety features was not damaged by the earthquake, and that the main cause of the accident was the tsunami. Included in the report was a disclaimer that the report is based on findings "to the extent confirmed." The government also wrote a similar accident report that was submitted to the International Atomic Energy Agency (IAEA).

We conducted our investigations and hearings carefully, conscious of not jumping to conclusions based on preordained policy. The Commission recognizes the need for the regulators and TEPCO to investigate and verify causes of the accident based on the following facts:

1. Strong tremors at the facility began 30 seconds after the SCRAM, and the plant shook hard for more than 50 seconds. That does not mean, however, that the nuclear reactors were incapable of being impacted by the seismic movements. It is thought that the ground motion from the earthquake was strong enough to cause damage to some key safety features, because seismic backchecks against the earthquake design basis and anti-seismic reinforcement had not been done.
2. The reactor pressure and water levels make it obvious that a massive loss of coolant (LOCA) did not occur in the time period between the earthquake and the tsunami. However—as has been published by the Japan Nuclear Energy Safety Organization (JNES) in the "Technical Findings" composed by NISA—a minor LOCA, from a crack in the piping and a subsequent leak of coolant would not affect the water level or pressure of a reactor, and could have occurred without being apparent to operators. If this kind of minor LOCA were to remain uncontrolled for 10 hours, tens of tons of coolant would be lost and lead to core damage or core melt.
3. The government-run investigation committee's interim report, NISA's "Technical Findings," and specifically TEPCO's interim report, all concluded that the loss of emergency AC power—that definitely impacted the progression of the accident—



▲ *Views of the reactor buildings following the explosions*

"was caused by the flooding from the tsunami." TEPCO's report says the first wave of the tsunami reached the site at 15:27 and the second at 15:35. However, these are the times when the wave gauge set 1.5km offshore detected the waves, not the times of when the tsunami hit the plant. This suggests that at least the loss of emergency power supply A at Unit 1 might not have been caused by flooding. Based on this, some basic questions need to be logically explained before making a final determination that flooding was the cause of the station blackout.

4. Several TEPCO vendor workers who were working on the fourth floor of the nuclear reactor building at Unit 1 at the time of the earthquake witnessed a water leak on the same floor, which houses two large tanks for the isolation condenser (IC) and the piping for IC. The Commission believes that this was not due to water sloshing out of the spent fuel pool on the fifth floor. However, since we cannot go inside the facility and perform an on-site inspection, the source of the water remains unconfirmed.
5. The isolation condensers (A and B2 systems) of Unit 1 were shut down automatically at 14:52, but the operator of Unit 1 manually stopped both IC systems 11 minutes later. TEPCO has consistently maintained that the explanation for the manual suspension was that "it was judged that the per-hour reactor coolant temperature excursion rate could not be kept within 55 degrees (Celsius), which is the benchmark provided by the operational manual." The government-led investigation report, as well as the government's report to IAEA, states the same reason. However, according to several workers involved in the manual suspension of IC who responded to our investigation, they stopped IC to check whether coolant was leaking from IC and other pipes because the reactor pressure was falling rapidly. While the operator's explanations are reasonable and appropriate, TEPCO's explanation is irrational.
6. There is no evidence that the safety relief (SR) valve was opened at Unit 1, though this should have taken place in the case of an accident. (Such records are available for Units 2 and 3.) We found that the sound of the SR valve opening for Unit 2 was heard at the Central Control Room and at Unit 2, but no one working at Unit 1 heard the sound of the Unit 1 SR valve opening. It is therefore a possibility that the SR valve might not have worked in Unit 1. In this case, a minor LOCA caused by the seismic motion could have taken place in Unit 1.

3

Emergency response to the accident

The Commission investigated the accident response of TEPCO, the regulatory agencies, the government and the Kantei (Prime Minister's office)—including the early stages of the response, the development of the accident, the emergency response system and the crisis management system.

TEPCO's accident response

At the time of the accident, neither the Chairman nor the President of TEPCO were present or accessible, an inconceivable situation for an operator of nuclear power plants. The Chairman and the President also had different understandings of the emergency response structure, a fact that very likely contributed to the delay in TEPCO's response to the accident.

TEPCO's manual for emergency response to a severe accident was completely ineffective, and the measures it specified did not function. The manual assumed that reactor readings could be monitored, but failed to account for a prolonged station blackout like the one that occurred at Fukushima, which prevented any monitoring.

The chain of command was disrupted during the emergency. In an accident situation, TEPCO management at the plant was supposed to communicate with the Nuclear and Industrial Safety Agency (NISA) through the off-site Emergency Response Center (ERC), but this was not possible due to the malfunctioning of the off-site center, which was powerless from earthquake damage. The actual on-site situation of the vent in Unit 1 was not communicated to NISA or the Prime Minister's office, which helped create an atmosphere of distrust between TEPCO's on-site management, the regulatory agencies and the Prime Minister's office. The Prime Minister's consequential decision to go to the site and give directions not only took the time of the on-site operators, but caused a disruption in the planned chain of command for the nuclear power company, the regulatory agencies, and the Prime Minister's office. Had the head office of TEPCO actively communicated the on-site situation from the start, and explained the severity of the situation to the other parties, there is a possibility that the distrust—and the confusion in the chain of command that followed—could have been prevented.

Former TEPCO president Masataka Shimizu at the 18th Commission meeting

Neither did TEPCO's head office offer sufficient technical support. As the situation at Unit 2 continued to deteriorate, Masao Yoshida, the general manager of the Fukushima plant, asked CEO and VP Sakae Muto for technical advice, but he was in transit from the off-site center at the time, and was unable to respond. TEPCO's headquarters also failed to protect Yoshida from direct questioning by the Kantei, and approved the instructions of NSC Chairman Madarame, despite being contrary to decisions made at the site, the true front line of the response.

Finally, TEPCO's management mindset of "obedience to authority" hindered their response. The confusion over the "withdrawal" comment by President Shimizu and the intervention by the Kantei arose from this mindset. Rather than make strong decisions and clearly communicating them to the government, TEPCO insinuated what it thought the government wanted and therefore failed to convey the reality on the ground. It is hard to conclude that it was the Prime Minister who discouraged the idea of a full withdrawal, as has been reported elsewhere, for a number of reasons: 1) management at the site never considered a full withdrawal of its workers; 2) there is no evidence that a decision for a full withdrawal was made at the TEPCO head office, 3) the evacuation plan, made before Mr. Shimizu's visit to the Kantei, included keeping emergency response members at the plant; 4) the Director-General of NISA, who Mr. Shimizu contacted, claimed that he was not asked for advice on a full withdrawal; and 5) staff at the off-site center, connected through a video-conference system, claim there was no discussion of a complete withdrawal. It is clear that there was a misunderstanding by the Kantei, but the fundamental cause lies in TEPCO's mindset of deference to and reliance on government authority, and the abdication of their own responsibilities, in spite of its position as a private-sector entity.

The government's emergency response organizations

At the time of the accident, the government's accident response system did not function as planned. The systems that had been planned for use in a disaster—such as the communication and transportation infrastructure–were disabled due to the effects of the tsunami and the earthquake. The failure of the government's accident response system to function in the early stages was one of the reasons that the Kantei increased its involvement in the response to the accident.

The main organizations of the government's accident response system were the Prime Minister's Nuclear Emergency Response Headquarters, the Secretariat of the Nuclear Emergency Response Headquarters of NISA and the Regional Nuclear Emergency Response team. Overall, none of these organizations functioned as planned.

The Prime Minister's Nuclear Emergency Response Headquarters and its Secretariat were intended to lead the overall coordination of emergency response measures, such as

Former prime minister Naoto Kan at the 16th Commission meeting

deciding what measures to take to protect nearby residents, but they were unable to carry out these functions.

Although the intervention of the Kantei contributed to the worsening of the accident, the failure of the Secretariat of the Nuclear Emergency Response Headquarters to gather and share information concerning the development of the accident and the response was a significant factor. Additionally, the Regional Nuclear Emergency Response Team did not take the initiative in the local response to the accident, such as issuing the evacuation order. This was due to the earthquake, the tsunami and the nuclear accident occurring at the same time, and the lack of a prepared response to a prolonged, severe accident.

The Crisis Management Center, located in the Kantei building, already had its hands full with the earthquake and tsunami disaster, and was unable to respond to the nuclear accident. The Nuclear Safety Commission had many problems and was unable to provide advice based on the their own organization's knowledge. The Ministry of Education also failed to make use of the systems that it had prepared.

At a time of rapidly escalating events, it is absolutely vital that every stream of information be shared in real time. Although there was a teleconference system connecting the Kantei and each related organization, there is no evidence that the system was used, especially for sharing information between the Kantei and the related organizations. TEPCO brought its own teleconference system to the off-site center and used it to connect the head office with the plant in Fukushima. Had TEPCO connected its system to the government's teleconference system it may have been able to share information in real time in the early stages, but this was not done.

The Kantei's emergency response

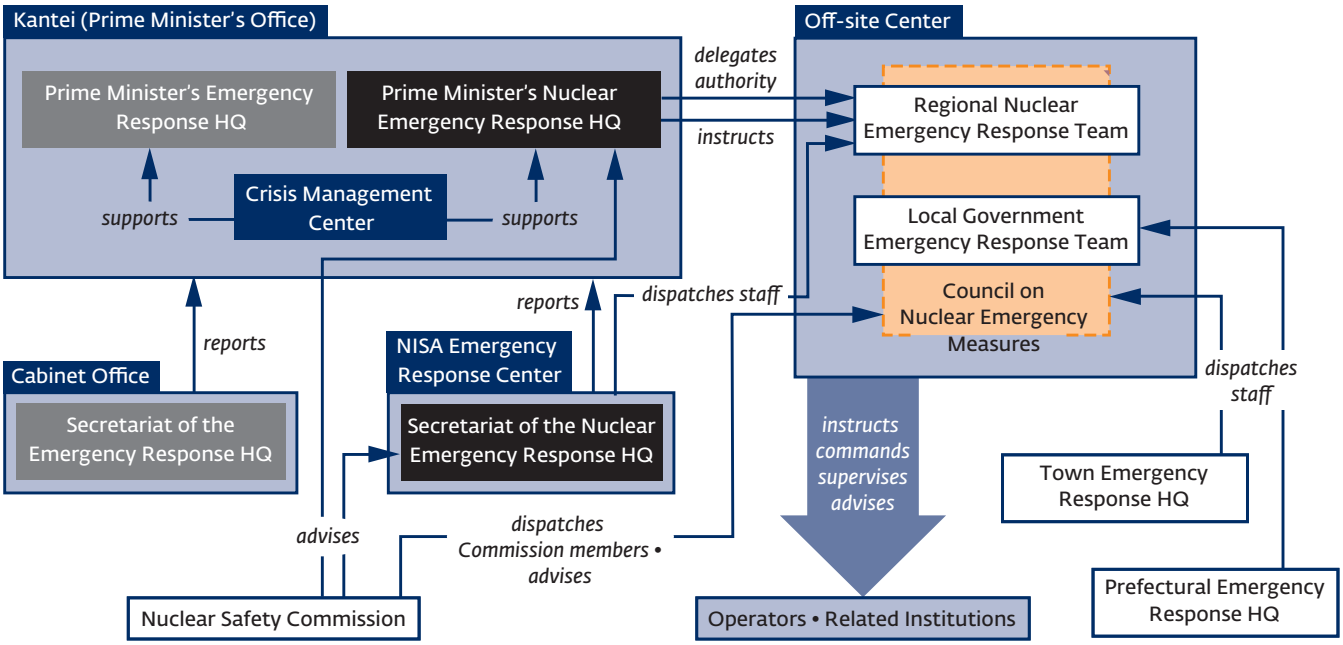
As the situation deteriorated and the planned government accident response systems failed to function, control of the emergency response was taken by the Kantei, with Prime Minister Kan at the center of an ad hoc group of politicians, advisors and the chairman of NISA. This group included people who were neither experts nor had an adequate understanding of the on-site situation.

The Kantei had problems from the start. After being notified by TEPCO that the situation met the conditions of Article 15 of the Act on Special Measures Concerning Nuclear Emergency Preparedness, it took two hours to issue the Declaration of a Nuclear Emergency Situation, a necessary step in launching the emergency response. In fact, Prime Minister Kan was not fully aware that issuing the "Declaration of an Emergency Situation" was a necessary first step in response to the accident, and those around him failed to advise him correctly.

The Kantei group understood that the Crisis Management Center, which was responsible for the initial response, had their hands full dealing with the earthquake and tsunami. The senior members of NISA and NSC had joined the group in order to provide advice. They failed, however, to adequately answer questions, leading to a sense of distrust. This distrust reached its peak at the time of the Unit 1 explosion. From then on, the Prime Minister's office on the fifth floor of the Kantei effectively became the front line of the accident response efforts.

Although TEPCO and the regulators had agreed on how to deal with the vent and the injection of seawater, the Kantei was unaware of this, and intervened, resulting in further disorder and confusion. In the early morning of March 15, feeling a sense of urgency from the lack of information, Prime Minister Kan decided to visit the site himself. In response to TEPCO's bid to "pull out" from the increasingly worsening situation at Unit 2, Prime Minister Kan summoned President Shimizu to his office, where he rejected the withdrawal. Soon afterwards, the government decided to establish a government-TEPCO headquarters structure in the head office of TEPCO.

Throughout the course of this accident, the Prime Minister's office was also central in decisions regarding the evacuation zones. Contingency plans called for the on-site headquarters to have responsibility for drawing up evacuation proposals, with the duty being transferred to the Secretariat of the Nuclear Emergency Response Headquarters in the event that the on-site headquarters was unable to do so. This was exactly the case; but when the response from the Secretariat of the Nuclear Emergency Response Headquarters was delayed, the Kantei stepped in and ordered the evacuations. This resulted in the following problems: 1) as the decisions were made on an ad hoc basis, there was insufficient cooperation between the governmental agencies; 2) there was a deficiency in the details of evacuation



▲ *Diagram of the emergency communication protocol*

operations; and 3) there was a lack of suitable explanation to the public. This led to an increased state of disorder and confusion on the ground.

Evaluating the government and Kantei emergency response

We respect the efforts of the government and other concerned parties considering the extreme conditions in which they found themselves—dealing with the accident, the earthquake and tsunami at the same time under extremely high-pressure conditions. There was little time for a measured approach, and they were required to go without eating or sleeping for long periods of time.

But there are two points which must be stated. First of all, the group at the Kantei did not understand the proper role the Kantei should have taken in a crisis. There has been much attention given to the miscommunication between the Kantei and TEPCO on the issue of whether the withdrawal from the plant that TEPCO planned would be all of the workers or a fraction of them. However, the state of the reactors was so severe that TEPCO had to ask for some kind of retreat. In this situation, the Kantei should have confirmed the possibility that all workers would have to retreat, in order to plan the evacuation of residents and take other measures to protect residents.

It is clear that the Kantei should not have intervened in issues that TEPCO was capable of handling, such as the condition of the vent and the injection of seawater, and should have confirmed the meaning of President Shimizu's comments about the retreat. Its intervention, establishing a government-TEPCO headquarters at TEPCO, is equally unfathomable.

A second point is that the direct intervention by the Kantei, including Prime Minister Kan's visit to the Fukushima Daiichi plant, disrupted the chain of command and brought disorder to an already dire situation at the site. Starting with the Prime Minister's visit to the Fukushima Daiichi plant, a new route was established to communicate information between the Kantei and Fukushima Daiichi and the head office of TEPCO. This new route was contrary to the official information flow from Fukushima Daiichi to the head office of TEPCO and on to NISA and the Kantei (the Prime Minister's Nuclear Emergency Response Headquarters). The new route required TEPCO to communicate its information not only to NISA but also to the Kantei, contributing to the disruption of TEPCO's response and disorder in the plant.

At all times, the government's priority must be its responsibility for public health and welfare. But because the Kantei's attention was focused on the ongoing problems at the plant—which should have been the responsibility of the operator—the government failed in its responsibility to the public. The Kantei's continued intervention in the plant also set the stage for TEPCO to effectively abdicate responsibility for the situation at the plant.

According to the nuclear emergency manual, NISA and the other bureaucratic institutions have the responsibility to collect and organize information for delivery to the Nuclear Emergency Response Headquarters for use in decision-making. However, with the new route in place between the Kantei and TEPCO, the bureaucratic institutions' awareness of their responsibility decreased and their approach became passive. The vertical sectionalism of the various ministries involved also prevented effective information sharing. In order to guarantee public safety, it is necessary for these agencies not only to respond flexibly in times of crisis, but to raise their crisis management capability through a continuous training regimen.

Fukushima Prefecture's accident response

Fukushima Prefecture's emergency response system was also built on the assumption that a nuclear disaster would not occur at the same time as an earthquake and tsunami. As a result, it was totally unprepared to respond to the accident.

The disaster response structure of Fukushima Prefecture was laid out in the Fukushima Prefecture Regional Disaster Prevention Plan, but this did not include the possibility of a nuclear disaster caused by natural disasters. Due to the breakdown in communication from the central government in the post-accident time period, neither the Fukushima prefectural government nor the central government were aware of each other's actions. Feeling a sense of crisis, the Fukushima prefectural government unilaterally ordered that residents within a two-kilometer radius of the plant be evacuated, based on prior emergency prevention training. This was followed 30 minutes later by the central government ordering the evacuation of residents within a three-kilometer radius. However, the earthquake and tsunami had seriously damaged the emergency communication systems, and it was difficult to transmit the order to local municipalities and the public.

Fukushima Prefecture also was unable to conduct emergency monitoring. Only one of the 24 fixed monitoring posts was still working; the others were either washed away or were no longer connected. Mobile monitoring posts were unusable until March 15 due to problems with the mobile telephone network. There was one vehicle equipped with monitoring equipment, but this was also out of action due to a lack of fuel.

Information disclosure by the central government

Detailed accuracy was made a priority, at the expense of quickly getting the information to those who needed it for informed decisions. Mr. Edano, the cabinet secretary, repeatedly stated that there were no immediate health effects from the release of radiation, giving the public a false sense of security. In his statements, however, the necessity and urgency of the evacuations was never adequately explained from the residents' point of view, and the government never followed up with evidence that would support his statements. This caused a great deal of anxiety among the public. Last but not least, the government chose to release information purely from a subjective perspective, rather than reacting to the needs of the public.

4

Spread of the damage

The Commission made a number of findings regarding the spread of damages from the accident at the nuclear plant. We studied how decisions were made, and how the policies and defensive measures were communicated to the public. We also investigated these matters from the perspective of the residents affected by the accident damage.

Damage from the nuclear power plant accident

The effects of the accident, of course, are still being felt, and will continue to affect the country. As a result of the accident, approximately 900PBq of radioactive substances were emitted, 1/6 the amount of emmissions from the Chernobyl accident when converted to iodine. There are now vast stretches of land—1,800 square kilometers—of Fukushima Prefecture with levels equaling a potentially cumulative dose of 5mSv/year or more.

Residents are greatly concerned about their radiation exposure levels. However, the health implications are still unknown because of the different conditions that apply to each individual. An estimate of the cumulative external exposure over the first four months following the accident for approximately 14,000 residents (excluding plant workers) from three towns and villages where radiation doses were relatively high, shows that 0.7 percent of the residents have been exposed to 10mSv or more, and 42.3 percent have been exposed less than 10mSv, of which 57 percent have been exposed to 1mSv or less. While the values are generally low, it is clear that residents are suffering from stress brought on by fear of the unknown.

Chaotic evacuation orders

The Commission's investigation revealed that many residents were unaware that the accident had occured, or of its drastic escalation and the radiation leakage, even after the government and some municipalities were informed.

As the damage from the accident began to escalate, evacuation destinations and other evacuation details were often revised. But, even during the escalation, most nearby residents remained unaware of the accident and its severity, not to mention the potential for increased danger.

A total of 146,520 residents were evacuated as a result of the government's evacuation orders. However, many residents in the plant's vacinity evacuated without accurate information. Unaware of the severity of the accident, they planned to be away only for a few days and evacuated with only the barest necessities. Evacuation orders were repeatedly revised as the evacuation zones expanded from the original 3-kilometer radius to 10 kilometers and later, 20 kilometers, all in one day. Each time the evacuation zone expanded, the residents were required to relocate. Some evacuees were unaware that they had been relocated to sites with high levels of radiation. Hospitals and nursing homes in the 20-kilometer zone struggled to secure evacuation transportation and find accommodations; 60 patients died in March from complications related to the evacuation. Frustration among the residents increased.

On March 15, residents in the zone between 20 and 30 kilometers from the plant were ordered to shelter-in-place. Since the order lasted for several weeks, these residents suffered greatly from a lack of communication and necessities. As a result, the shelter-in-place order was then revised to voluntary evacuation. Again, information on the basis for revising the evacuation order was sadly lacking, and residents found themselves having to make evacuation decisions without the necessary facts. The Commission concludes that the government effectively abandoned their responsibility for public safety.

The fact that some areas within the 30-kilometer zone suffered from high radiation levels was known after the System for Prediction of Environmental Emergency Dose Information (SPEEDI) data was released on March 23. But neither the government nor the nuclear emergency response headquarters made a quick decision to evacuate residents from those areas; it was only one month later that they were evacuated.

Lack of preparation for a nuclear disaster

The regulators had become aware of a number of issues concerning nuclear disaster preparedness prior to the accident, but did not review disaster prevention measures. As a result, delays in taking action contributed to the inappropriate response seen during the accident.

The Nuclear Safety Commission (NSC) started reviewing the disaster-prevention guidelines in 2006 to accommodate new international standards. However, NSC was apprehensive that the residents could become concerned by the necessity of additional defense measures after being repeatedly assured of the safety of nuclear power, and that their worries might spill over to arguments against the plutonium-thermal project then in progress. NSC failed to explain how the civil defense initiative would benefit the residents, and failed to introduce the international standards in a substantial way. Although revision of the disaster-prevention guidelines continued after 2007, the accident broke out as the review was proceeding.

After the Niigata Earthquake in 2007, it was obvious that the assumption of a complex disaster should be included in nuclear accident prevention measures. Still, NISA continued with countermeasures based on assuming a low probability of a complex disaster. NISA eventually only provided passive advice regarding disaster drills based on a complex disaster.

Meanwhile, the government also failed to assume a severe accident or a complex disaster in its comprehensive nuclear disaster drills. As the scope of the drills expanded, they lost substance, and were performed for cosmetic purposes, rather than to develop preparedness. The irrelevant drills were lacking instruction in the necessity of using tools such as the radiation monitoring information from SPEEDI. Though it was applied in the annual drills, participants found the drills useless at the time of the accident.

The Emergency Response Support System (ERSS) and the SPEEDI system are in place to protect public safety. The environment monitoring guideline assumption is that ERSS predicts and forecasts the release of radioactive substances and release data, and SPEEDI predicts and forecasts the spread of radioactive materials based on ERSS. Public safety measures, including those for evacuation, should be planned based on the use of these systems.

If emission data cannot be retrieved from ERSS, the SPEEDI output is not accurate or reliable enough to use in delineating evacuation zones. Some of the people involved were aware of the limitations of the system, but no revisions were made before the accident. There was no other monitoring network in place that could supplement or replace the forecast systems.

The system failed. The emission data could not be retrieved from ERSS, and the government was unable to use the SPEEDI results in planning protection measures and fixing evacuation zones. A few weeks later, NSC released an estimation of the plume of radioactivity at the time of the accident. Though the NSC's estimation was created by reverse analysis based on long-term monitoring data, the public mistakenly believed that it was made with data from the time of the accident which the government had ignored or failed to release. This resulted in further public distrust.

At the same time, the emergency radiation medical systems had been established in a stopgap way, based on problems that arose during the JCO accident in 1999. No one had considered the need for preparation over a wide area of radiation exposure as happened in Fukushima. Because of this, most of the facilities were not used because of their location too close to the plant, their capacity, and the number of trained medical personnel. Those medical institutions with capacity for emergency radiation treatment did not function as anticipated.

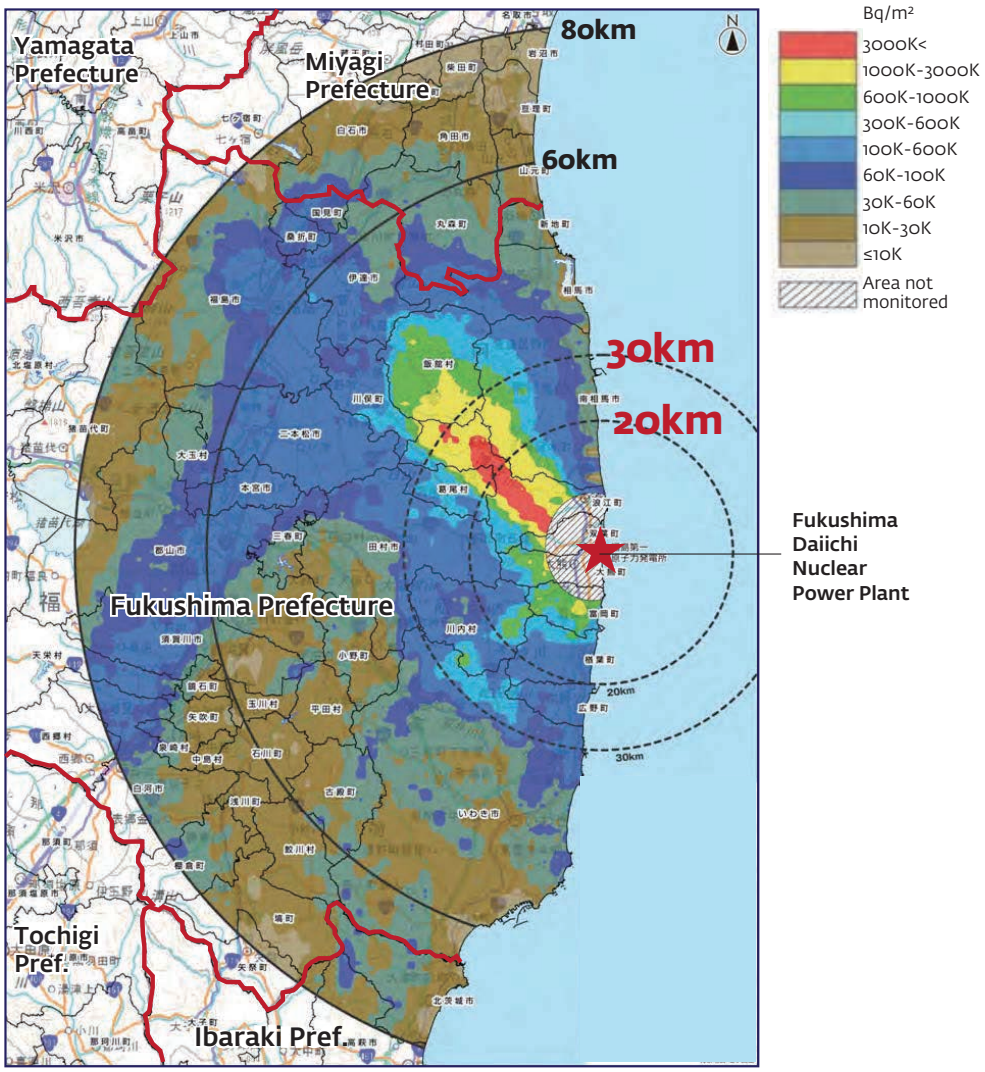
Current and future health damage from radiation

One of the biggest concerns among residents is the impact of radiation on their health. Nevertheless, the government and Fukushima Prefecture have yet to make a proper response to the pressing concerns of residents regarding radiation doses in their neighborhood, its impact on their health, and other radiation issues. What the government needs to do is convey detailed information to the residents and provide options for informed decision-making.

There is no consensus among experts on the health effects of low dose radiation exposure, but we agree that the limits should be set as low as can be reasonably achieved. The government needs to make efforts to explain the need for limits, and the levels decided, in ways that are clear and understandable to ordinary citizens. The government has not seriously undertaken programs to help people understand the situation well enough to make their own informed decisions. The government did not, for example, clearly explain the variations in the risk of radiation exposure to different segments of the population, such as infants and youths, expectant mothers, or others more susceptible to the effects of radiation.

Much was learned from the Chernobyl accident about low dose radiation exposure, including the risk of thyroid cancer among children. Although the positive effects of administering stable iodine and the proper timing were fully known, the government's nuclear emergency response headquarters and the prefectural government failed to give proper instructions to the public.

Appropriate control of the public's internal exposure is important for managing health over the mid- and long-term. Although standards have been categorized in detail, it is more important that the government communicates in ways that are clearly helpful to the public: identifying what is edible, what is the tolerable intake level, which foods continue to be safe, and whether tests are reliable. Through thorough inspection and transparent disclosure



Map showing accumulated cesium-137 ▶
From data collected by MEXT on July 2, 2011

of information, the government should efficiently address public concerns. Neither the government nor Fukushima Prefecture have prepared plans to accumulate data on internal exposure to radioactive cesium.

TEPCO did not prepare worker safety measures in the case of a severe accident, and information on environmental dosage was not provided to them immediately after the accident. It is important that nuclear power plant workers' exposure be controlled properly, and securing the safety of workers during the accident response is critical.

At the same time, radiation exposure is not the only health issue. People in Fukushima are suffering from mental health issues, which evolved into a serious social problem among those affected by the Chernobyl accident. The Commission places the mental and physical health of the residents as the first priority, and concludes that action needs to be taken urgently. Surveys that monitor the health conditions of residents of Fukushima are necessary, but an adequate inspection system with inspection equipment is urgently needed. Measures need to be taken with a priority on public health. Unfortunately, we see few signs of anything being done.

Prolonged environmental and decontamination issues

Once radioactive substances are released, they continue to affect the environment, and must be effectively dealt with. Of all the issues from the accident, the Commission considers the problem of environmental pollution to be the least addressed. As is apparent from the Chernobyl accident, radioactive fallout that spread over a broad area remains in mountain and forest areas for many years, and their levels do not naturally diminish for many decades. Wildfires, floods and other causes can spread contamination further.

Rainfall flushes radioactive materials and creates relatively high dose locations

("hotspots"), in areas such as lakes. Highly contaminated deposits also tend to collect on the seabed. The government should address these problems promptly with a long-term view toward rectifying the situation.

The government is spending massive amounts of financing and energy on decontamination programs, but major issues have arisen regarding the implementation. Many regions have been unable to secure temporary storage sites for the contaminated debris, a problem exacerbated by the government's unilateral action in pushing decontamination without first gaining consent from the residents. It has been proven that the better the communication between the residents and the municipal governments, the more success the community has in securing temporary debris storage sites.

The Commission recognizes that the residents also have different decontamination agendas depending on the region, and consideration needs to be given to their demands. Some want to remain in their homeland and actively support decontamination; others want to move away and are requesting compensation to support their relocation. Many residents have a choice and, in these cases, the government must help them make informed decisions.

It is time to begin monitoring decontamination cost effectiveness and its effect on the environment, as well as the methods used in the decontamination process. Without in-depth analysis, the major concerns of the residents will remain unanswered: Can they return home? If yes, when? If they return, will they be able to support themselves?

Decontamination should not be treated as a unilateral decision, but must be categorized according to its effect. It must be remembered that at the root of residents' questions is not decontamination, but whether they can reconstruct their former lives. The government must continue the decontamination process while revising the plans to reflect the experiences gained.

5

Organizational issues in accident prevention and response

The Commission found a number of organizational issues regarding preventive measures prior to the accident, the causes of the accident and the crisis management response after the accident. We investigated the entire chain of events in order to discover what went wrong with the organizations and systems involved. We also examined the relationship between TEPCO and the regulatory agencies with a view to reform in the future.

Background issues

There were many opportunities for NISA, NSC and TEPCO to take measures that would have prevented the accident, but they did not do so. They either intentionally postponed putting safety measures in place, or made decisions based on their organization's self interest—not in the interest of public safety.

Following the implementation of new regulations in other countries, discussions were held about revising the guidelines to include a scenario where the AC power source was lost. The discussion also included reviewing the reliability of existing DC power sources. Unfortunately, these talks did not result in any revision to the guideline or the regulations, and at the time of the accident no serious consideration had been given to a scenario involving loss of AC power to the plant.

Both TEPCO and NISA were aware that if tsunami levels rose beyond the assumptions made by the Society of Civil Engineers, there was a risk of core damage from a malfunction of the seawater pumps. They were also aware that a tsunami with water levels above the ground level of the power plant was a possibility, and would result in a total loss of power.

Despite the fact that both TEPCO and NISA were aware of the risks, no attempts were made to amend the existing regulations or bring them in line with international standards. NISA gave no compulsory instructions to carry out specific measures, and TEPCO took no action.

NISA did instruct TEPCO to conduct an anti-seismic backcheck, but by not completing the backcheck as originally scheduled, TEPCO effectively invited the accident that followed. NISA is equally at fault because it did not ensure that the backcheck was completed in a timely fashion, despite its awareness of the backcheck's importance. NISA's failure to demand action, and TEPCO's failure to act, together constitute negligence which led to the accident. They cannot use the excuse of circumstances occurring that were beyond their expectations.

The "regulatory capture" of Japan's nuclear industry

The fundamental causes of the accident, including the failure to carry out earthquake and tsunami measures and the lack of measures for dealing with a severe accident, can be also traced to the Federation of Electric Power Companies (FEPC). This is an unregulated lobbying association of electric power companies, and thus also bears a share of the responsibility.

Despite the fact that constant vigilance is needed to keep up with evolving international standards on earthquake safeguards, Japan's electric power operators have repeatedly and stubbornly refused to evaluate and update existing regulations, including backchecks and backfitting. The Japanese nuclear industry has fallen behind the global standard of earthquake and tsunami preparedness, and failed to reduce the risk of severe accidents by adhering to the five layers of the defense-in-depth strategy.

The Commission's examination of the way safety regulations are deliberated and amended reveals a cozy relationship between the operators, the regulators and academic scholars that can only be described as totally inappropriate. In essence, the regulators and the operators prioritized the interests of their organizations over the public's safety, and decided that Japanese nuclear power plant reactor operations "will not be stopped."

Because the regulators and operators have consistently and loudly maintained that "the safety of nuclear power is guaranteed," they had a mutual interest in averting the risk of existing reactors being shut down due to safety issues, or of lawsuits filed by anti-nuclear activists. They repeatedly avoided, compromised or postponed any course of action, and any regulation or finding that threatened the continued operation of nuclear reactors. The FEPC has been the main organization through which this intransigent position was maintained among the regulatory agencies and in the academic world.

Our investigation focused on the significant lobbying role taken by FEPC on behalf of the operators, and scrutinized the relationship between the operators and regulators. The Commission found that the actual relationship lacked independence and transparency, and was far from being a "safety culture." In fact, it was a typical example of "regulatory capture," in which the oversight of the industry by regulators effectively ceases. We found examples of this in the neutering of revisions in the Guideline for Anti-seismic Design, and the improper discussions that took place on regulating severe accident countermeasures.

TEPCO's organizational issues

Again, we must point to TEPCO's organizational mindset as one cause of the accident: on

one hand they strongly influenced energy policy and nuclear regulations while abdicating their own responsibilities and letting METI take the responsibility on the front line. But they also manipulated the cozy relationship with the regulators to take the teeth out of rules and regulations.

TEPCO did hold meetings about what it viewed as risks to nuclear power production; such risks were defined as the potential loss of trust in the utility on the part of the public regarding natural disasters and possible decreases in the operation rates of reactors. The risk of a potentially severe accident never appeared in TEPCO's list of risks. TEPCO explained this glaring omission by arguing that nuclear safety was supposed to be dealt with by its on-site plant department, hence such risks were not to be recorded in the records of the central risk management meetings. The risk of damage to public health and welfare was not an issue for TEPCO.

As the nuclear power business became less profitable over the years, TEPCO's management began to put more emphasis on cost cutting and increasing Japan's reliance on nuclear power. While giving lip service to a policy of "safety first," in actuality, safety suffered at the expense of other management priorities. An emblematic example is the fact that TEPCO did not have the proper diagrams of piping and other instruments at the Daiichi plant. The absence of the proper diagrams was one of the factors that led to a delay in venting at a crucial time during the accident.

After the accident, TEPCO had the twin responsibilities of containing the accident situation and disclosing facts regarding the status of the accident to the surrounding residents, the nation and the international community in an appropriate and timely manner. We assert that the actual disclosure of facts by TEPCO was inappropriate, and that such inappropriateness was also an indirect cause of the deterioration of the situation. For example, regarding the disclosure of an increase of reactor vessel pressure at Unit 2, TEPCO issued a press release about seawater injection at 23:00 on March 14, but made no disclosure about an increase in radiation dosage at the entrance of the plant that occurred between 19:00 and 21:00 on the same day. TEPCO also downplayed the severity of the situation in their disclosure regarding the plague in the suppression chamber of Unit 2; moreover, there was a significant delay from when TEPCO informed the Kantei and when it disclosed the information publicly.

The Commission also found a record by TEPCO noting that they did not inform the public of an increase in reactor vessel pressure at Unit 3, as of 8:00 on March 14, because NISA had banned the release. In fact, the Kantei had merely instructed TEPCO to inform them of the contents of releases when they were made. In obeying NISA's order to halt the release of this crucial information, TEPCO effectively prioritized its own interests and those of NISA over the greater good of the public and their right to be informed.

Organizational issues concerning regulatory bodies

Prior to the accident, the regulatory bodies lacked an organizational culture that prioritized public safety over their own institutional wellbeing, and the correct mindset necessary for governance and oversight. The Commission concludes that the structural flaws in Japan's nuclear administration must be identified through a critical investigation into the organizational structures, laws and regulations and personnel involved. We should identify the areas in need of improvement, recognize the lessons to be learned, and plot the fundamental reforms necessary to ensure nuclear safety in the future.

Autonomy and transparency must be built into the new regulatory organizations to be created. They must have significant powers of oversight in order to properly monitor the operators of nuclear power plants. New personnel with highly professional expertise must be employed and trained. It is necessary to adopt drastic changes to achieve a properly functioning "open system." The incestuous relationships that existed between regulators and business entities must not be allowed to develop again. To ensure that Japan's safety and regulatory systems keep pace with evolving international standards, it is necessary to do away with the old attitudes that were complicit in the accident that occurred.

6

The legal system

The Commission investigated the need for the fundamental reform of laws and regulations governing nuclear power. It outlined the need to prepare an organizational structure that would assure sound decision-making processes for the implementation of nuclear laws and regulations.

Laws and regulations governing nuclear power

The Commission has found that prior to the accident, revision and amendments of laws and regulations were only undertaken on a "patchwork" basis, in response to micro-concerns. The will to make large, significant changes in order to keep in step with the standards of the international community was utterly lacking.

At the time of the accident, the laws, regulations and infrastructure were based on the assumption that the scope and magnitude of possible natural disasters would not exceed precedent. There was a failure to take into account the prospect of unprecedented events such as the earthquake and tsunami on March 11, 2011, despite the fact that the possibility of such events was known.

Those in charge of the laws and regulations that governed the nuclear power industry in Japan had a dogmatic mindset that failed to keep pace with evolving international laws, standards and practices, and which disregarded pertinent technological advice and improvements from abroad. As a result, the laws and regulations governing Japan's nuclear power industry at the time of the accident were outdated relative to those of other countries and, in some cases, obsolete.

Prior to the accident, the primary purpose of the nuclear laws and regulations was the promotion of nuclear energy. The laws need to be rewritten with emphasis placed on prioritizing public safety, health and welfare. The roles, responsibilities and relationships of the operators, regulators and other involved entities need to be clearly delineated in the Act on Special Measures Concerning Nuclear Emergency Preparedness. The defense-in-depth needs to be formally enshrined in the regulations so that it will function properly when needed in the future.

The accident has highlighted the need for sweeping, fundamental reform of said laws and regulations to bring them into line with international standards, make use of cutting-edge technical knowledge and learn from other accidents around the world. It is necessary to create a system wherein regulators have an ongoing obligation to insure that the laws and regulations reflect changing international standards. A mechanism for monitoring the resulting infrastructural implementations must be devised.

Once such new systems, laws and regulations are established, they must then be retroactively applied to existing reactors. It should be explicitly stated in the laws that reactors that do not meet the new standards should be decommissioned or otherwise dealt with appropriately.

Appendices

These survey results are based on the data announced at the 19th Commission meeting on June 9, 2012

Survey of the evacuees from the Fukushima nuclear power plant accident

The survey drew 10,633 responses, a reply rate of approximately 50 percent. Of these, 8,073 respondents provided comments in the free comment space. Furthermore, 431 respondents wrote on both the front and back of the survey sheet and/or provided further comments on separate papers, expressing their strong will to be heard.

1. ***Delay by the government in communicating information about the accident led to confusion thereafter.***
2. ***Because instructions for evacuation were made on an ad hoc basis, many people were evacuated multiple times, evacuated to areas with high radiation, and evacuated with only the barest necessities.***
3. ***Messages of agony borne by the evacuees were delivered to us. The issues are not yet resolved. Proper measures should be considered as soon as possible.***

Communication of information on the accident

- Awareness of the accident was extremely low among residents, despite releases of information according to Article 10 at 15:42 on March 11, a report according to Article 15 at 16:45, and declaration of state of emergency at 19:03.
- There were significant differences in the speed of transmission of accident information to the evacuation areas, depending on the distance from the plant.
- Municipalities and the police served as the sources of accident information for 40% of residents of Futaba and Naraha, but only for 10% of residents of Minamisoma, Iitate, and Kawamata.

Evacuation order

- Residents were informed of the accident a few hours after it occurred, but they did not receive any information about the situation or the accident, or information that would be useful for their evacuation. As a result, many residents were only able to leave with the bare necessities.

Voluntary evacuations

- Inside the 30km radius area, the shelter-in-place order was issued at 11:00 on March 15, and the call for voluntary evacuations was issued on March 25. However, as the government was slow in issuing instructions, many residents evacuated on a voluntary basis.
- Although it was clear that there were high radiation levels in Iitate and Kawamata, the planned evacuations were late. The government may have been late in deciding the designation of the evacuation zones of areas with high radiation levels.

Evacuations to areas with high radiation levels

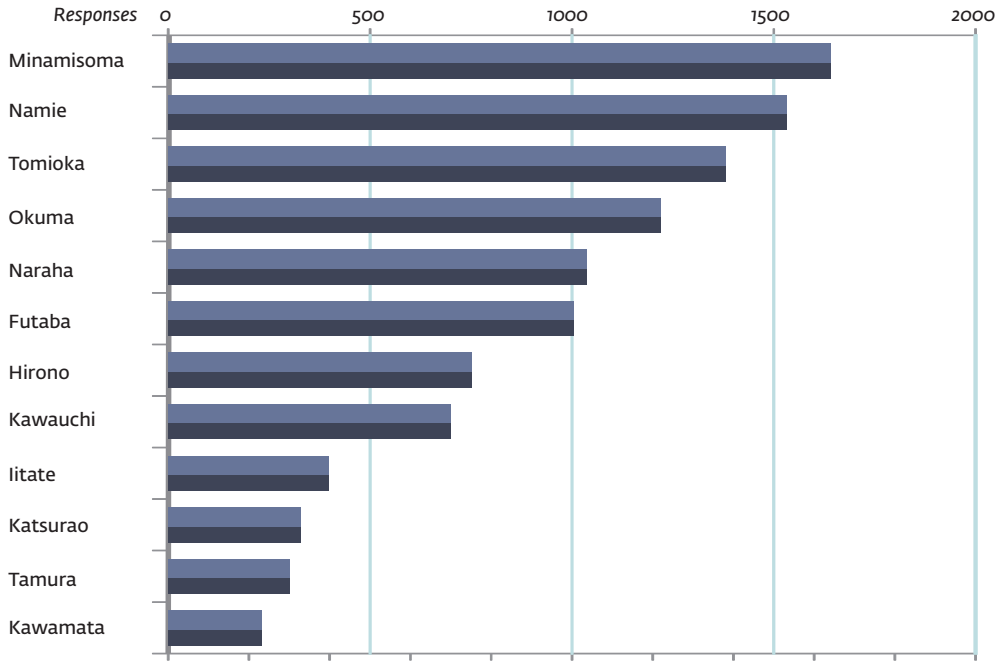
- Approximately 50 percent of the residents of Namie temporarily evacuated to areas with high concentrations of radiation.
- The government was slow in disclosing monitoring information.

Expansion of evacuation zones and the phased evacuation

- Through more than four evacuations, over 70 percent of residents from the areas near the Fukushima Daiichi and Fukushima Dai-ni plants (Futaba, Okuma, Tomioka, Naraha, Namie) evacuated.
- There were numerous complaints about evacuation orders that required the residents living nearest the nuclear plants to evacuate so many times.

Accident precautions

- Even at the plant itself, there was little explanation of the possibility of a nuclear accident. Less than 15 percent of residents reported receiving evacuation training for a nuclear disaster and less than 10 percent of residents reported receiving explanations about the possibility of a nuclear accident.



◀ *Number of Replies by Municipalities*

Survey results

- This survey was sent to citizens who were forced to evacuate as a result of this accident.
- *Objective:* To grasp the reality of how the evacuation was ordered and how the risks of nuclear power were explained
- *Method*: Postal survey
- *Duration*: March 15 to April 11, 2012
- *Targeted respondents*: 21,000 randomly selected households in 12 cities, towns and villages (55,000 households) in the evacuation zones
- *Surveyed cities and villages*: Futaba, Okuma, Tomioka, Naraha, Namie, Hirono, Tamura Minamisoma, Kawauchi, Katsurao, Kawamata, Iitate.
- *Total Respondents*: 10,633
- The Commission would like to express its gratitude to the many people who cooperated with this survey. The response rate was extremely high—50 percent.
- Of the 10,633 respondents, 8,073 (76%) provided comments in the free comment space. Furthermore, 431 respondents (4%) wrote on both the front and back of the survey sheet and provided further comments on separate papers, expressing their strong will to be heard.

Delay in information communication

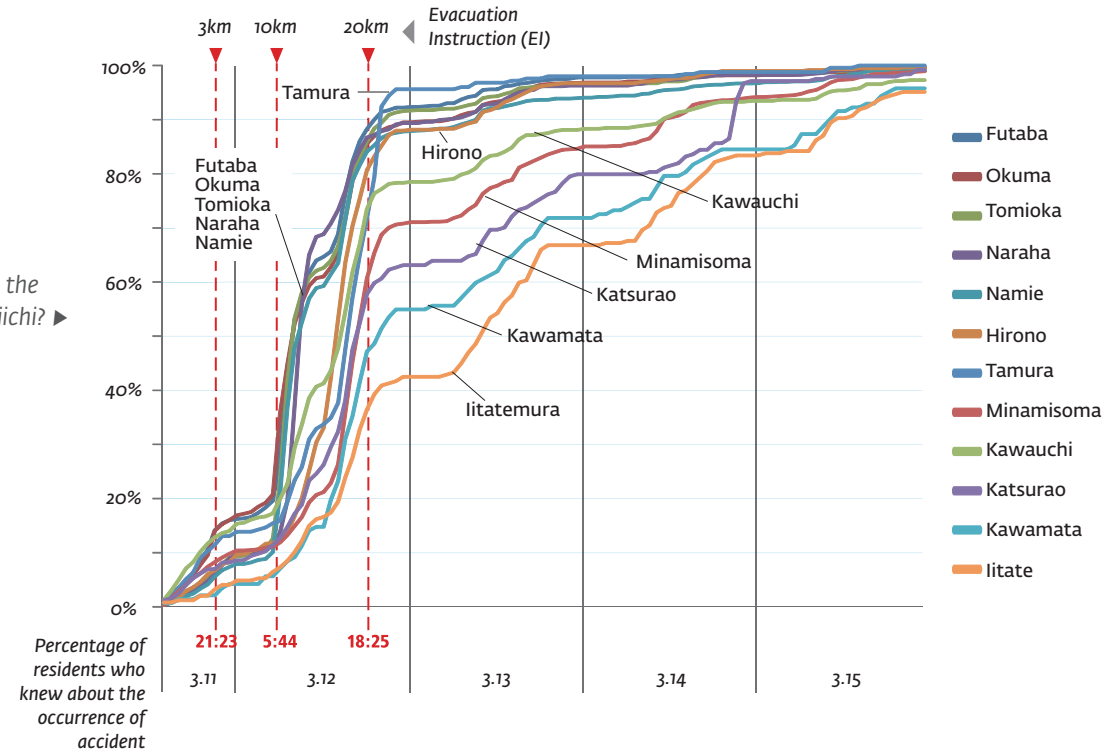
- Awareness of the accident was extremely low among evacuated residents. despite releases of information according to Article 10 at 15:42 on March 11, a report according to Article 15 at 16:45, and declaration of state of emergency at 19:03.
- There were significant differences in the speed of transmission of accident information to the evacuation areas.
- Municipalities, the emergency radio system, or the police served as the sources of accident information for 40% of residents of Futabamachi and Narahamachi, but only for 10% of residents of Minamisoma, Iitate, and Kawamata.

Time of the evacuation order and source of information

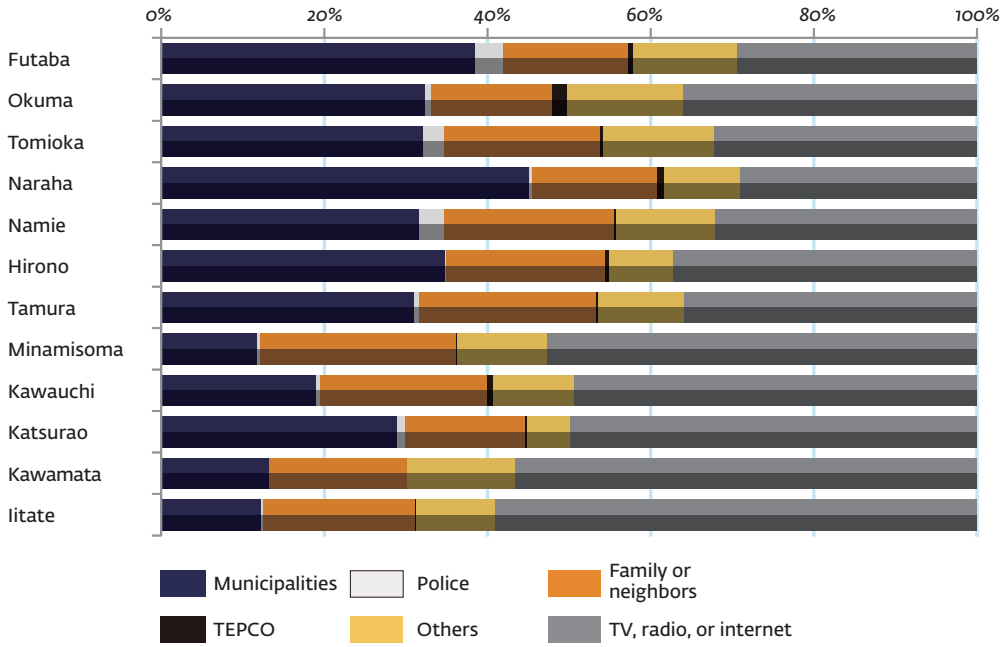
- Within a few hours after the evacuation order was issued, the municipalities communicated the evacuation order to residents, showing that there was a high level of communication between the municipal governments and residents.

  However, as there were areas in which the municipalities did not receive evacuation orders from the government, there were major problems in the transmission process of the evacuation order from the government to the municipalities.
- Residents were given the evacuation order, but they did not receive information about

When did you know about the accident at Fukushima Daiichi? ▶



Source of Information About the Accident ▶

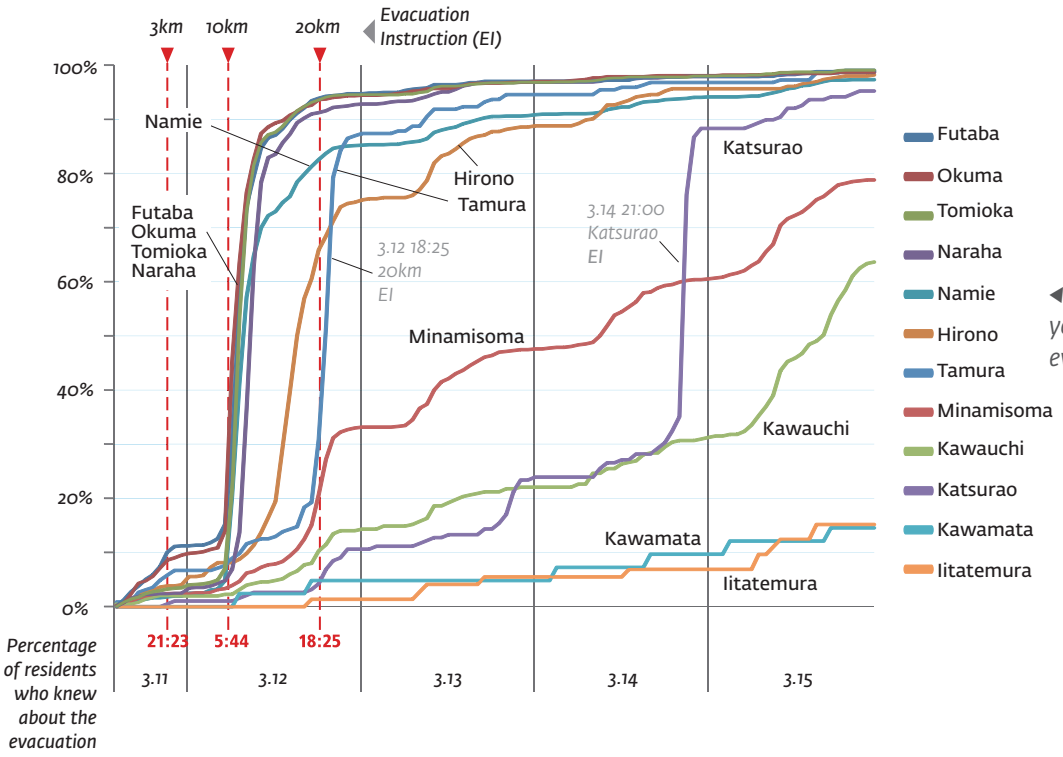


the situation or the accident that would be useful for their evacuation. As a result, many residents left with only the bare necessities.

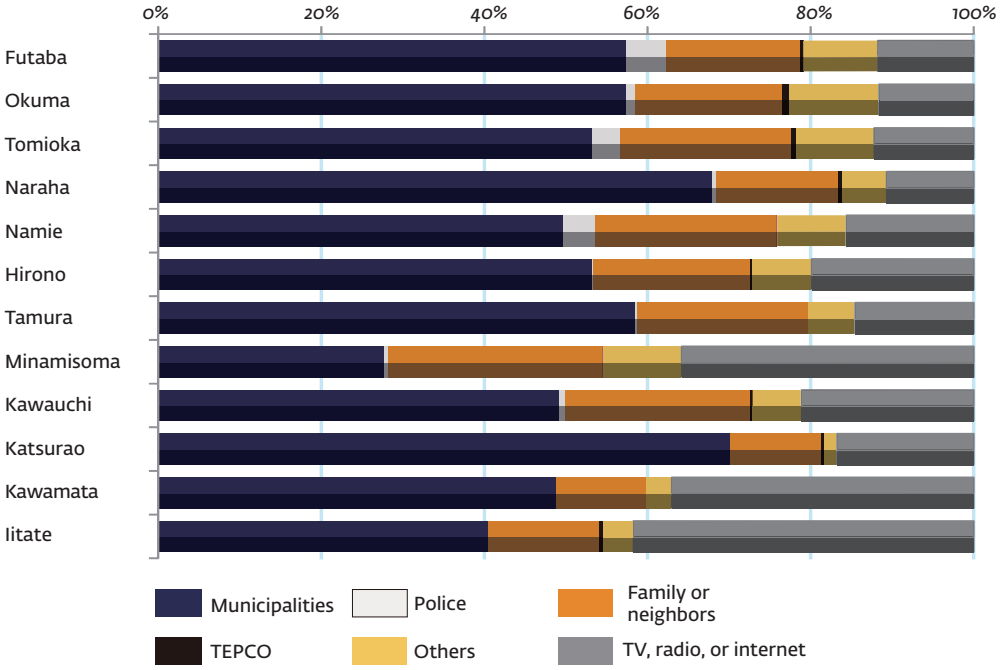
- Many residents received information from the municipalities.
- A high percentage of residents of Minamisoma, Kawamata and Iitate received information from TV, radio or the internet.

(i) Comment by a resident of Futaba:

"I left my house with only the bare necessities. I learned where to go through the emergency radio system while I was on the road. I arrived at the first evacuation site where I was instructed to go, taking 6 hours by car instead of only 1 hour in an ordinary situation. On my way there, my son who lives away called and told me that I should not expect to return soon. Only then did I start to recognize little by little what was



◀ *When did you learn that your residential area was an evacuation zone?*



◀ *Source of Information About the Evacuation Instruction*

actually happening. That is what I recall. Can you think what life is like when you are displaced and separated from your friends and people you know?"

(ii) Comment by a resident of Okuma:

"If there had been even a word about a nuclear power plant when the evacuation was ordered, we could have reacted reasonably, taken our valuables with us or locked up the house before we had left. We had to run with nothing but the clothes we were wearing. It is such a disappointment every time we are briefly allowed to return home only to find out that we have been robbed again."

(iii) Comment by a resident of Tomioka:

"We wanted to hear clearly that we would not be able to return for awhile. I couldn't bring

my valuables with me. In particular, because records of medical treatment were left at home, my parents' conditions worsened during evacuation. It is hard especially for elderly people to flee unprepared. I have no attachment to Tomioka because we were only renting the house, but if we cannot live in the temporary housing forever, we will lose a place to live permanently. There are other problems, too. So I want to be on welfare support again. It was not staff from the prefectural government or the town hall who were there to guide us during the evacuation, it was the medical service workers who were usually seeing my father. It took half a day to figure out where he was taken. It took too long to create a roster of evacuees."

(iv) Comment by a resident of Namie:

"I managed to spend a night in an elementary school in Tsushima district after hearing an announcement in the town gymnasium in the morning of March 12 that a tsunami had approached Namie-Higashi Junior High School, instead of being told of the accident at the nuclear power plant. If I had been told specifically about the accident, I would have evacuated to somewhere further than Tsushima. It is disappointing that information was not given."

(v) Comment by a resident of Minamisoma's Odaka ward:

"We didn't know there was a hydrogen explosion at the plant, so we couldn't guess why we had to evacuate. The director (of TEPCO) at the time of the accident recalled on TV that he thought he might die at the time, but that sort of information should have been announced to the nearby residents instantly. In any event, information was released too slowly. The residents have not been treated properly."

Time of evacuation

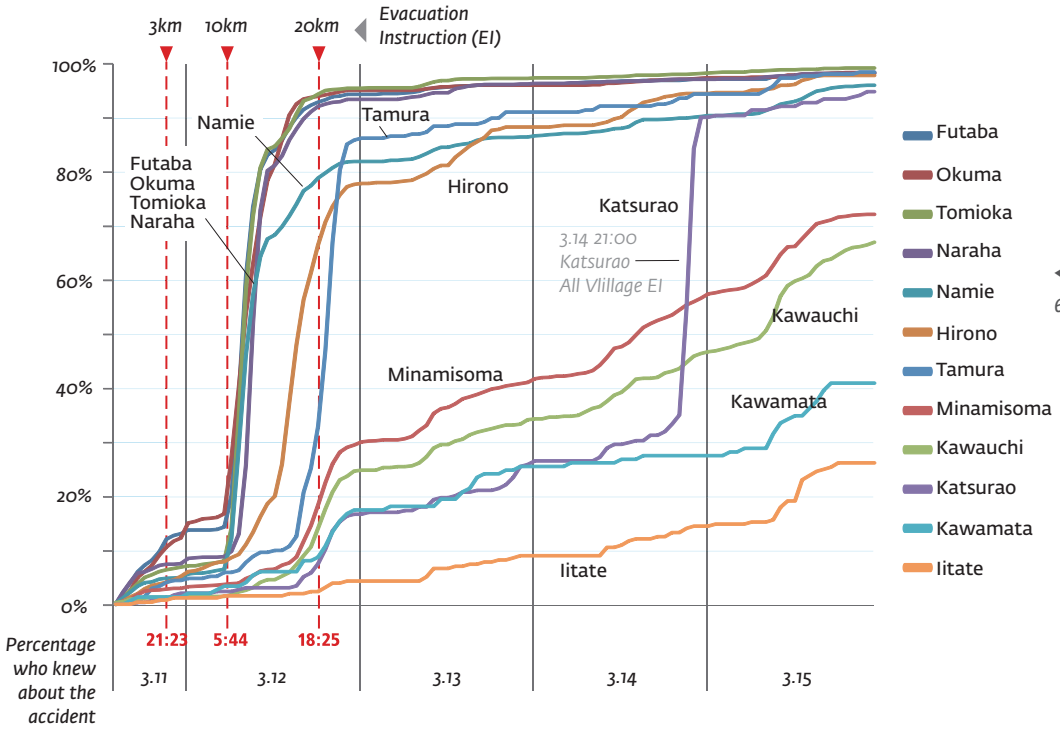
- A few hours after the evacuation order was issued, most of the residents (80-90%) in the evacuation zones started to evacuate.
- In the 30km area surrounding the nuclear power plant residents had no choice but to evacuate voluntarily. Even though a high level of radiation was observed in Kawamata and Iitate, designation of the planned evacuation area was delayed.
- Inside the 30km radius area, the shelter-in-place order was issued at 11:00 on March 15, and the call for voluntary evacuations was issued on March 25. However, as the government was slow in issuing instructions, many residents evacuated on a voluntary basis.
- Although it was clear that there were high radiation levels in Iitate and Kawamata, the planned evacuations were late. The government may have been late in deciding the designation of the evacuation zones of areas with high radiation levels.
- In the space for comments, some residents from these areas expressed criticism that the government was slow in issuing the evacuation order or even that the government did not issue the order for their area.

(i) Comment by a resident of Minamisoma

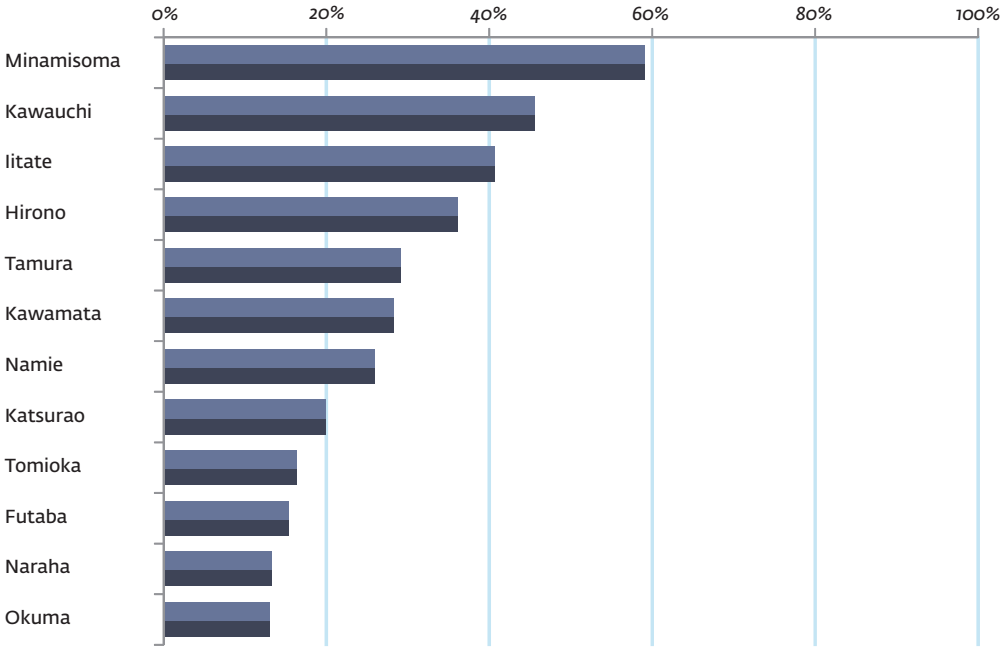
"In Haramachi in Minamisoma, we were told to 'stay at home,' and were never once told to evacuate. On TV, all they said was 'there are no immediate health effects,' making us even more afraid. Nothing has changed since the accident occurred. When there is very little progress in decontamination, it is too strange that the evacuation order has been lifted already. The government should think more about the local people."

(ii) Comment by a resident in Kawauchi (20km-30 km area)

"On March 11, immediately after hearing first news of the accident, many people in the village evacuated to this area. Young people were emailing 'evacuate' to each other, almost like chain mail. However, we did not receive any official information on the evacuation. We were only told to stay indoors through the emergency radio system. After hearing a neighbor who has a policeman in his family say, 'I'm going to evacuate because it seems dangerous,' I decided to evacuate. I heard that the police had left Kawauchi by March 14. The volunteers who were giving out food had used up the remaining gasoline for their transportation. I wanted them to help us evacuate as early as possible. I can only think that they abandoned us."



◀ *When did you start evacuating?*



◀ *Percentage of residents who evacuated voluntarily*

(iii) Comment by a resident of Iitate

"This area did not receive any information on the early stages of the nuclear accident. We heard about the radiation level only after the IAEA research team came in. Chief Cabinet Secretary Edano repeatedly said on TV that the radiation level 'will not have immediate health effects.' The reality is that residents in Iitate were exposed to radiation until April 22 (when the planned evacuation was ordered). It has been a year since then but we have received no damage compensation and the government is trying to cover it up by lifting the evacuation orders."

(iv) Comment by a resident of Hirono

"Because they might panic... Because people in areas with more danger would not be able to evacuate... How the evacuation area was expanded to 10km diameter in the next phase from 5km diameter in the initial phase... While we only had TV as a source

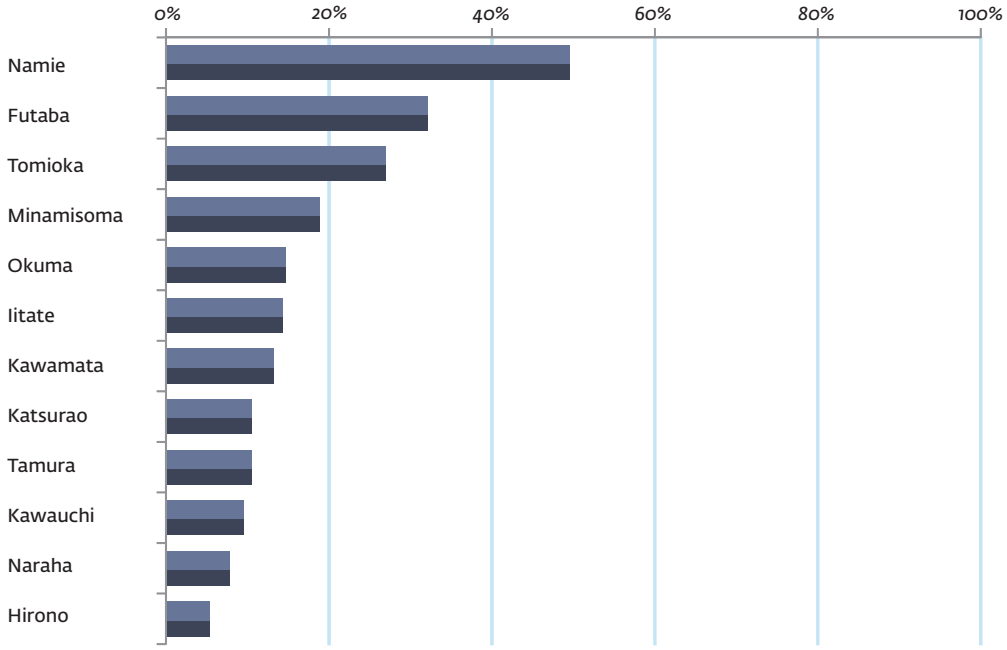
of information without accurate information or an idea of how the accident would develop, the minister in charge kept stating 'it will not affect health immediately...' TEPCO kept talking about the safety and reliability of the reactors... I am disgusted at the low quality of people in charge of this country."

(v) Comment by a resident of Kawamata

"They went on to say that there is no immediate effect, but the evacuation was explained on April 16. If they explained earlier, I could have found a specific place to evacuate. Although it was a large disaster, the response was too slow. The most important initial response based on the facts of the actual situation was not present and no orders based on 'measures in conformity' were given. I demand preparedness for emergency situations. All I saw was the politicians play party politics even though the nation is confronted with an unprecedented disaster. I question the humanity of those people. It is unfortunate that it was the nation who chose those people to be in charge."

Residents who evacuated to areas which later became evacuation zones

- Approximately 50 percent of the residents of Namie temporarily evacuated to areas with high concentrations of radiation..



Percentage of residents who evacuated to areas from which they later had to re-evacuate due to high concentrations of radiation ▶

Dissatisfaction about disclosing information from SPEEDI or monitoring data

- Many comments by the residents of Namie, Minamisoma, and Iitate showed dissatisfaction over disclosure of information from SPEEDI or monitoring data.

(i) Comment by a resident of Namie:

"The fact that I evacuated to an area with the highest radiation dose in the absence of SPEEDI information remains a source of fear for my health for the rest of my life. Why didn't they disclose the SPEEDI information? What do they think about people's lives? Our house is not in a livable condition due to difficulties in rebuilding infrastructure, decontamination and fear of having an interim storage facility nearby. Nuclear power should be stopped. It will cause a second Fukushima and there will be nowhere to live in Japan."

(ii) Comment by a resident of Minamisoma:

"I wish the information had been disclosed much earlier. I understand that the decision by the government not to disclose was intended to prevent a possible panic. But residents were evacuated to areas with high concentrations of radiation because of the lack of information. From now on, causes of the accident should be investigated and a

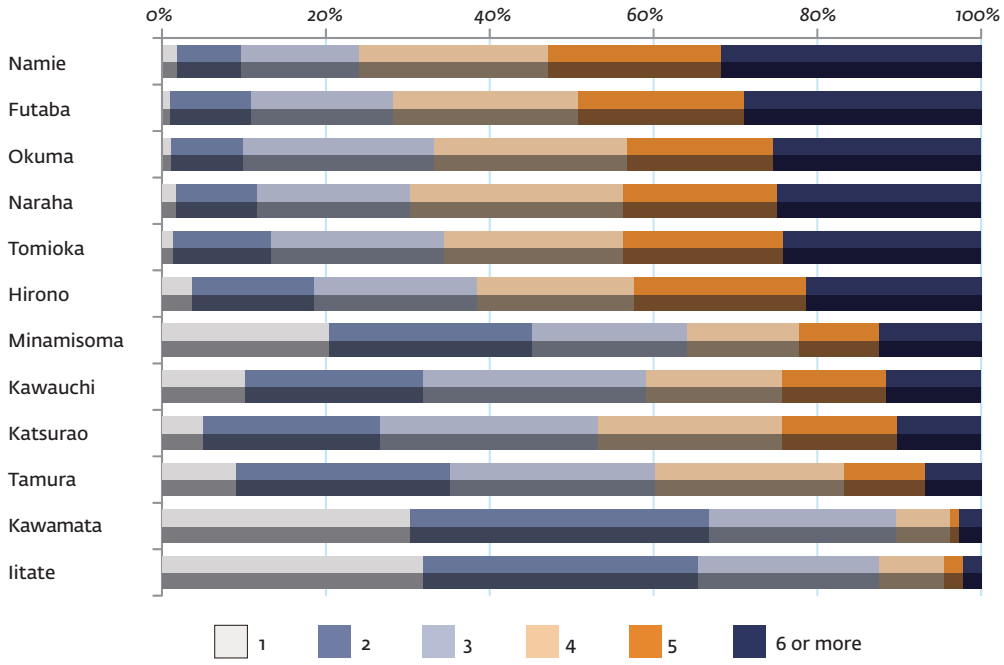
manual for response measures should be established, because we do not know when the next accident will occur. I request methods to minimize damages from the accident to be considered, given that it is hard to prevent it."

(iii) Comment by a resident of Iitate:

"I believe many people were exposed to radiation because of the inadequate accident response by the government and municipality. Data was deleted and deceptive instructions were given even though they were aware of the real situation. Do they really value our lives? Our family plowed snow outside of our house and got wet because we did not know about the radiation. We demand compensation for damages and health issues over the next few decades. What do members of NAIIC think of the lies that are being revealed even after more than a year has passed since the accident?"

Number of evacuations

- In the year after the accidents, the residents nearest the plant had to evacuate a number of times. Approximately 70 percent of the residents of Futaba, Okuma, Tomioka, Naraha and Namie had to evacuate four times or more.
- The government was slow in disclosing monitoring information.



◀ *Number of evacuations prior to end of March 2012*

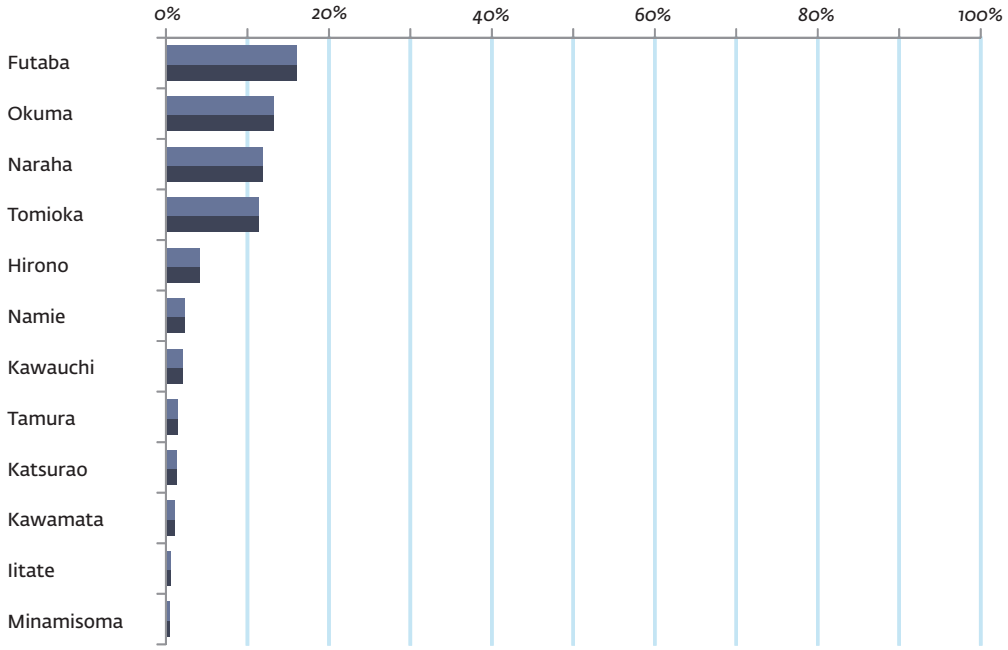
(i) Residents of Namie

"Even if we return to Namie the tiles on our roof have fallen off and radiation contaminated rain comes in. These are not conditions in which we can live. Every time I return, I feel angry. Our younger son also says that it is impossible for us to live here anymore. On the afternoon of March 11, when we were just about to patch the roof we were told to evacuate to the gym of the nearby Tsushima school. We stayed in the school for 3 or 4 days. It was a place with high radiation levels. We moved six places inside and outside of the prefecture and finally stopped after coming here." (Nihonmatsu)

(ii) Comment by a resident of Futaba

"On March 12, our hotel did not have electricity or water. We were allowed to stay in an old hotel and they shared gasoline with us. Our son is in Saitama Prefecture and he let us stay there for four months. Currently, we are living together as a family of four. When we visited our house briefly on March 6, my husband suffered from shock when he realized that he could not return to the house he was born in and is currently in hospital. We are frustrated with the irresponsibility and dishonesty of the politics of this country and TEPCO."

Percentage of residents who experienced evacuation training before the nuclear accident occurred ▶



(iii) Comment by a resident of Tomioka

"We had no clue what was going on but we were told to evacuate to Kawauchi. When we got there, we had to move from place to place and finally arrived at Miharu but we were told that it was full. We were told to go to the evacuation center in Motomiya. We later moved several times after that and are currently staying in a rental in Iwaki. Since then one year has passed but we have no idea of what we are going to do."

Residents who were told about the possibility of an accident or received evacuation training prior to the accident

- Even in locations near the plant, only 10-15 percent of residents reported receiving evacuation training, and less than 10 percent were told of the possibility of a nuclear accident.
- Some reported receiving an explanation that nuclear power plants were safe and secure, and so thought an accident would never occur.

(i) Comment by a resident of Futaba

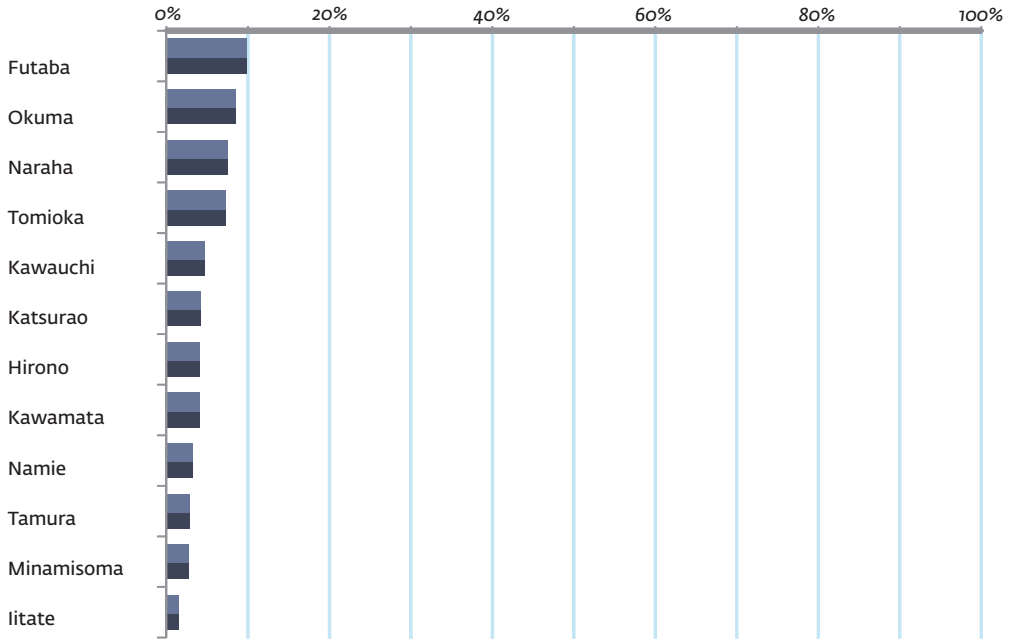
"I attended a lecture by TEPCO once. Raising the example of 9/11 in the U.S., they said that the nuclear power plants are safe no matter what happens. When I asked a question to reconfirm the absolute safety, the attendees at the lecture, many of who are family members of TEPCO employees, looked at me as if I did not understand any of what TEPCO told us. The attitudes and responses of TEPCO and the government, who seem to think so little of us, make me angry rather than sad. I demand a quicker and more sincere response."

(ii) Comment by a resident of Okuma

"I used to work at a nuclear power plant and never thought of such an accident. When I was working as a contract worker for TEPCO on the first floor, I asked a team leader 'what if a tsunami similar to the one in Sumatra hits Japan?' The reply was, 'Impossible! There is no need to think of an impossible situation.' After all, TEPCO, the government, and the municipality did not think seriously enough. Nor did I. . ."

(iii) Comment by a resident of Naraha

"When I attended a lecture for local residents by TEPCO soon after the company hid an accident from the public, TEPCO said they not only had the first 3 layers of protection, but also the 4th and 5th layers of measures for safety, with an attitude that the attending residents would not understand what it means to have so many layers for safety. Now I realize all of what TEPCO explained was lies, and that I was deceived."



◀ *Percentage of residents who had been informed of the possibility of a nuclear accident before 3.11*

(iv) Comment by a resident of Tamura

"They kept saying that the nuclear power plants are absolutely safe, then the accident occurred. If everyone involved thinks of the accident as merely an 'unforseeable accident' then this country must be very careless. The causes must be found and clarified. This accident must never be repeated. I want to give candid advice to the members of the Diet. They are supposed to consider the nation's daily life and rehabilitation, but they are preoccupied by political battles. While the accident investigation needs to be thorough, thorough discussion at the Diet must take place for the nation."

(v) Comment by a resident of Katsurao

"We used to watch TV advertisements every day claiming that nuclear power costs less and is safe and clean energy. With vivid memories of such a message, we could not believe the accident happened, nor could we imagine a tsunami bringing on the tragedy. We still live in cramped temporary housing after more than a year. We have no idea when we can go back to our home. We absolutely oppose the re-commissioning of reactors. No new reactors should be allowed, and we must shift to renewable energy. Laws and regulations for such plans need to be established quickly. The government should accelerate the progress of compensation for accident damage. It is not like compensation for a traffic accident.... I am tired of my current living conditions. I demand that the government step forward to take responsibility and make every effort to compensate the victims. I am counting on the government."

Messages extracted from the free comments ▶

Messages	No.	%
Causes of the accident should be probed ASAP, and outcome of the study fully disclosed. Demand for a thorough investigation in order to never let a similar accident happen again.	1,120	14%
Information issued by and behavior of government are unreliable and not trustworthy.	909	11%
Dissatisfaction or demand for compensation.	876	11%
• *Dissatisfaction or demand regarding timing of compensation (urgent needs, etc.)*	204	3%
• *Dissatisfaction or demand regarding conditions for receiving compensation (discrepancies depending on region, age, employment status, etc.)*	203	3%
• *Dissatisfaction or demand regarding terms of compensation (demand to extend compensation period, grant lifetime compensation, compensation until return, etc.)*	182	2%
• *Dissatisfaction or demand regarding compensation amount.*	93	1%
• *Dissatisfaction or demand regarding compensation coverage (household goods, agricultural crops, costs for evacuation, loss of future profit, etc.)*	46	1%
Demand for decontamination to take place quickly to allow return to our homes and neighborhoods.	858	11%
Need for clarification as to when things will become safe again and when people can return home safely. (Need for indication ASAP whether return will ever *be allowed. Otherwise, there is no way to plan for the future.)*	836	10%
Follow-up of actions taken at emergency is slow. No progress has been made even one year after the accident. Need direction soon.	820	10%
Information issued by and behavior of TEPCO are unreliable and not trustworthy.	628	8%
Demand that the state assumes liability. *Strong resentment toward government.*	610	8%
Demand that TEPCO assumes liability. *Strong resentment toward TEPCO.*	558	7%
The government does not understand the reality and situation of the evacuees. It must learn more about us.	544	7%
No home, no town to return to. Demand for a town elsewhere to be quickly designated as a place to be able to reside in. (No intention to abandon hometown, but there is no longer an option to return there.)	541	6% 7%
Residents were told that nuclear power plants are safe and secure. It was their belief that such an accident would never happen.	482	
I can't help but feel anxious about children and the future. I have no idea how one is supposed to live like this.	445	6%
Evacuation orders were slow, there was no evacuation order, or actual order was inconsistent with what was said by media.	375	5%
Evacuation orders were not specific. We had to run with little more than the clothes on our back and never had thought a nuclear accident was happening.	364	5%
Demand for early and ample compensation for land and house (provision of new house, repair or buyout of existing house).	344	4%
Constantly under stress due to unfamiliar environment, prolonged refugee life, feeling anxious about future, etc. Suffering poor health because of stress.	334	4%
Families are separated. We don't see each other much and miss each other.	290	4%
Wish for quick recovery of the lives we had. *Wish for "restoring" ordinary life.*	278	3%
Demand for a gradual reduction in number of nuclear plants. Wish for eventual elimination of all nuclear plants, and for a shift towards utilizing natural energy. Demand for elimination of nuclear power plants to ensure safe and secure lives.	276	3%
Evacuated to zones where radiation dosage was high. SPEEDI information should have been disclosed immediately.	201	2%
Decontamination will require immense budget and time. It must be performed based on well-planned decisions.	177	2%
Request for clarification of who *is responsible.*	172	2%
Feeling of fear that (adult) health might be negatively affected by radiation, and health may deteriorate once medication or outpatient treatment is stopped.	165	2%
TEPCO does not understand reality and situations of evacuees. It must learn more about us.	162	2%
Need for clarification on what we should do. Demand for a release from the current living situation and to settle down.	161	2%

Fear that health of children and unborn children might be affected by radiation exposure. (Also concerned about the decline in physical strength and the growth of children.)	*154*	*2%*
Relatives, friends and neighbors are separated. Losing contact with them and missing each other.	*137*	*2%*
Unemployed due to loss of workplace. No income and struggling to make a living. (Farming was former livelihood, but now impossible.)	*132*	*2%*
Running out of cash for living. Can't live properly. Urgently in need of compensation to meet living costs.	*121*	*1%*
Evacuation drills had been performed regularly, but were never based on a comparable accident (nuclear accident added onto natural disaster).	*119*	*1%*
Plant design might not have taken a tsunami into account. It had been said repeatedly that multiple layers of safety measures were applied, and that was reassuring.	*116*	*1%*
Very sad to see the familiar homeland contaminated by radiation. Feeling of being bogged down day-to-day, no joy, no hope.	*111*	*1%*
So disappointed not to be able to enjoy a comfortable retirement life after the accident. Frustrating to question why one has to lead such a life.	*97*	*1%*
Poor and uncomfortable facilities (obsolete, small, inconvenient, etc.) at the refugee housing (which are rented or temporarily provided). Want a new environment to be put in place quickly.	*92*	*1%*
Demand for community infrastructure (lifeline, transportation system, facilities and services) to be recovered immediately so people can live there.	*80*	*1%*
Demand for thorough compensation when disease develops as a result of radiation exposure. Also compensation should cover non-economic losses.	*69*	*1%*
Forced to relocate to several refugee sites, and repeatedly forced to evacuate.	*61*	*1%*
Moving to evacuation site took long time due to traffic congestion and road conditions.	*56*	*1%*
Preventative measures were not effectively executed because the events were beyond what was anticipated, and as a result emergency responses, decisions and actions lagged behind what was necessary.	*55*	*1%*
Lack of relief supplies and information was extremely limited after evacuation.	*55*	*1%*
Demand for academia, media and others to take responsibility.	*49*	*1%*
Private car was used to evacuate but scarcity of gasoline made evacuation difficult. Some could not evacuate effectively.	*44*	*1%*
Evacuation was difficult or not possible because of age, sickness, etc.	*41*	*1%*
Demand for prompt search for and provision of a place (land and house) to live safely and securely.	*41*	*0.5%*
Request to know for how long rented or temporary refugee housing is provided. Want to know whether there is another place available if we need to move out.	*36*	*0.4%*
There was no evacuation route. The only path was congested, which hindered smooth evacuation.	*27*	*0.3%*
There should have been effective emergency response measures, risk communication, routine preparedness, attitude, etc. Accurate information and evacuation measures could have prevented panic and confusion.	*24*	*0.3%*
It is difficult to get along with people in the new environment and can't build relationships. Feel isolated and alone at the refugee site.	*24*	*0.3%*
Wish for a "ray of hope" among evacuees. Wish to be engaged in making something for the future.	*24*	*0.3%*
Demand for increased frequency of brief visits home. Want to visit more often (eg, once a month)	*22*	*0.2%*
Lost a family member or a friend because of sickness stemming from fatigue following evacuation or because of the stress of evacuation life.	*18*	*0.2%*
Evacuated via bus because private cars were banned for evacuation purposes, but the reason behind this was never explained.	*17*	*0.2%*
It is sad and hard to be discriminated against, experience prejudice and misunderstanding just on the grounds of being an evacuee (or being someone from Fukushima). Feel ashamed at the refugee site.	*17*	*0.2%*
Demand for compensation to seek future employment or assistance to find a job. (Because of displacement, finding a job is difficult.)	*13*	*0.2%*
There was no instruction to wear a mask or protective gear.	*12*	*0.1%*
Hospitals experienced hardship in evacuating.	*10*	*0.1%*
Request for secure employment/re-employment at hometown once return there is permitted after prolonged evacuation.	*10*	*0.1%*

After we read all the survey responses, we extracted topics and tallied each topic as shown. As some responses contained multiple topics, an aggregate total of counts of all the topics exceeds the number of responses. Also there were responses not included in the data because they could not be categorized.

Survey of the workers at the Fukushima nuclear power plant

- After the accident, many of the TEPCO workers did not evacuate, but they stayed on-site in order to help with the accident response. Most of the subcontracted workers evacuated at 16:00 on March 11. There were problems with the communication of information to the subcontracted workers. On March 11, the subcontracted workers who did remain at the plant did not receive an explanation about the dangerous state of the reactors.
- Efforts to monitor the radiation exposure of those workers who fought to contain the accident at the plant were limited by the emergency conditions and the limited availability of measuring devices on-site. There were no reports on the cumulative radiation dose of individual workers, and no efforts were made to manage internal radiation. Many workers have expressed anxiety and frustration regarding the lack of worker radiation dose checks. This needs to be improved.
- Most of the workers who remained after the earthquake to deal with the accident were registered radiation workers.
- Some workers had to share one dosimeter with several others because the devices were limited. Very few were without a dosimeter at all.
- A system for managing dosimeters was unavailable. Because of this, about 30 percent of the workers were not told of their cumulative dosage, which is a problem.
- No significant difference in the response between TEPCO employees and its subcontracted workers over how measures against radiation were managed has been observed.
- Most of the workers who dealt with the accident were not told in advance that they would have to do so if one broke out. Some had to work without consent. There were problems with how employees were briefed on preparations against a nuclear disaster.
- Approximately 80 percent of the workers received an explanation about the radiation dosage in their operation areas, or were made aware of the radiation dosage of the site through dosage maps prior to working. Approximately 20 percent of the workers stated that they received no explanation about the radiation dosage in their operation area. Although it is necessary to have workers on-site to deal with the crisis, an explanation of the radiation levels and the risk should always be given.

Summary of the methodology of the workers survey

- This survey was conducted on the workers who were at Fukushima Daiichi Nuclear Power Plant on March 11, 2011.
- *Objective:* To understand the reality of the communication of information, evacuations, and health monitoring that went on inside the nuclear power plant.
- *Method*: Postal survey.
- *Duration*: April 27 to May 18, 2012
- *Targeted respondents*: Approximately 5,500 workers who were at Fukushima Daiichi Nuclear Power Plant on March 11, 2011, and are/were employees of TEPCO or subcontracted companies (*) which agreed to cooperate with our survey.
- *Total respondents*: 2,415 (Approximately 44% of the targeted respondents.)
- Of the 2,415 respondents, 1,060 respondents (44%) wrote in the free space for comments. Furthermore, 41 respondents wrote on the front and back of the survey sheet or provided further comments on envelopes and separate papers. We sensed their strong will to be heard.

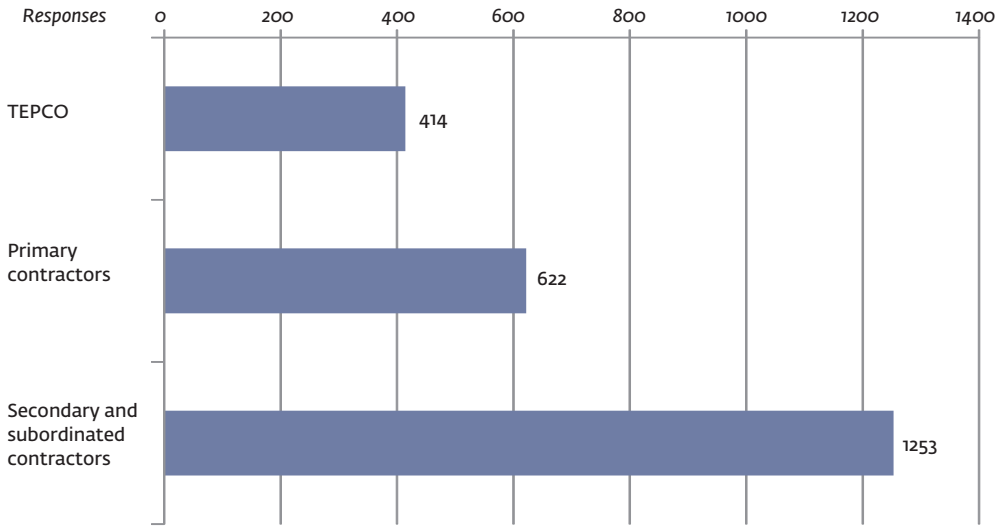
Distribution of respondent sample according to location

- Most respondents were working in radiation controlled areas on March 11.

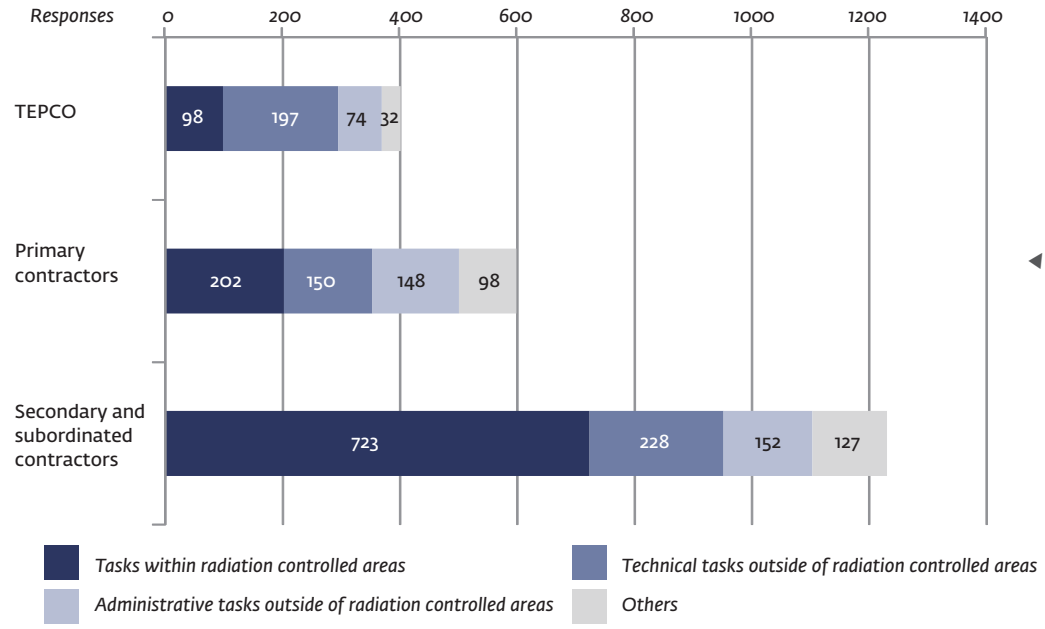
Communication of information to the workers during the accident

- Approximately 40 percent of TEPCO workers received a warning that the reactors were or could be in a dangerous state. On the other hand, hardly any workers from the subcontracted companies said that they received such a warning.

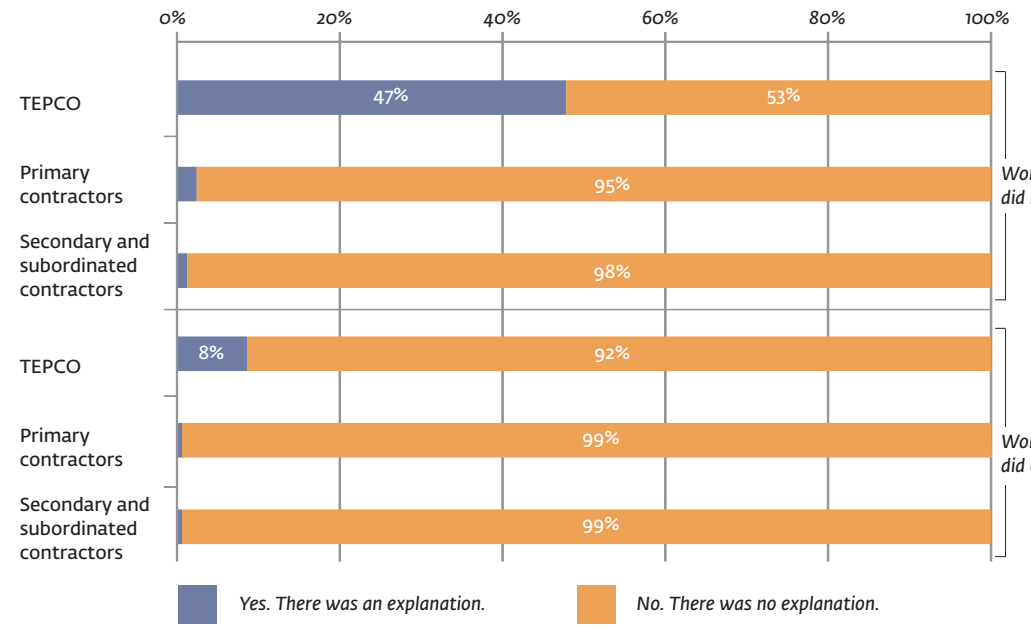
(*) Note: As we could not conduct the survey on the employees of companies that did not wish to cooperate with our survey, this sample does not accurately represent all the workers and is to a certain degree incomplete. Additionally, this Commission asked TEPCO subcontractors for the current addresses of the employees who worked at the Fukushima Daiichi Nuclear Power Plant on March 11, 2011, but some of them provided the addresses of employees who started working at the plant after March 11, 2011. These workers are included in the 5,500 targeted respondents. For this reason, it cannot be said that the samples taken through this survey give an accurate statistical analysis of the workers at Fukushima Daiichi on March 11, 2011. Therefore, please note that the responses may not be statistically reliable except for those from the employees of TEPCO, which provided the contact information of almost all its employees.



◀ *Total responses*



◀ *Survey responses by job type*



◀ *After the earthquake on March 11, was there an explanation from TEPCO about hazardous conditions in the reactors or the possibility of such a situation?*

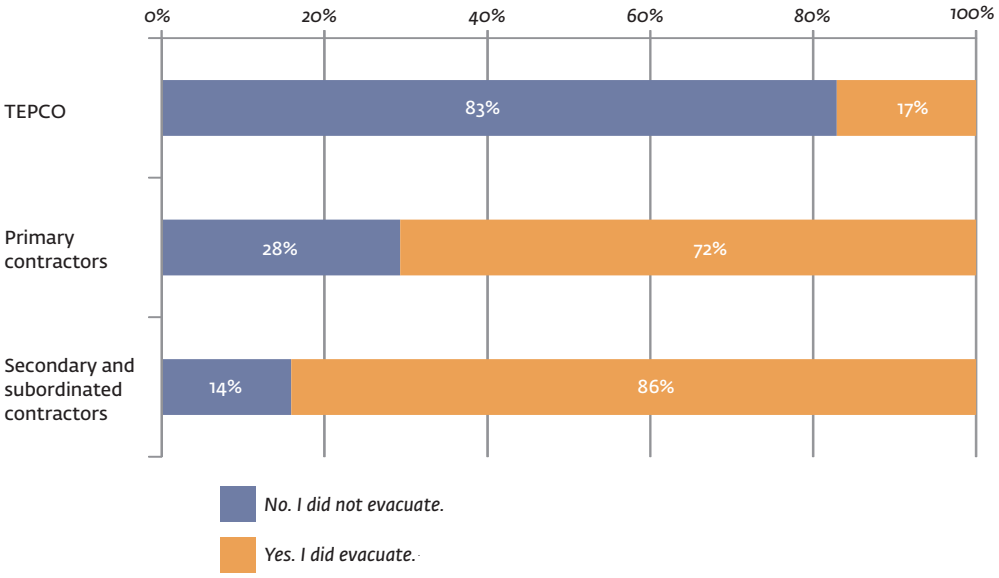
State of evacuation after the earthquake

- Over 80 percent of TEPCO workers did not evacuate after the earthquake and stayed on-site. Many of the subtracted workers evacuated from the plant facility at least temporarily.
- Almost all of the workers who evacuated on March 11 did so at around 16:00.
- Over half of the subcontracted workers who evacuated answered that they did not receive orders to evacuate. (This includes workers who answered that they went home because they received orders related to the earthquake, not because of the accident at the power plant.)
- Approximately 30 percent of primary subcontracted workers and 15 percent of the subordinated subcontracted workers remained on-site to deal with the accident.

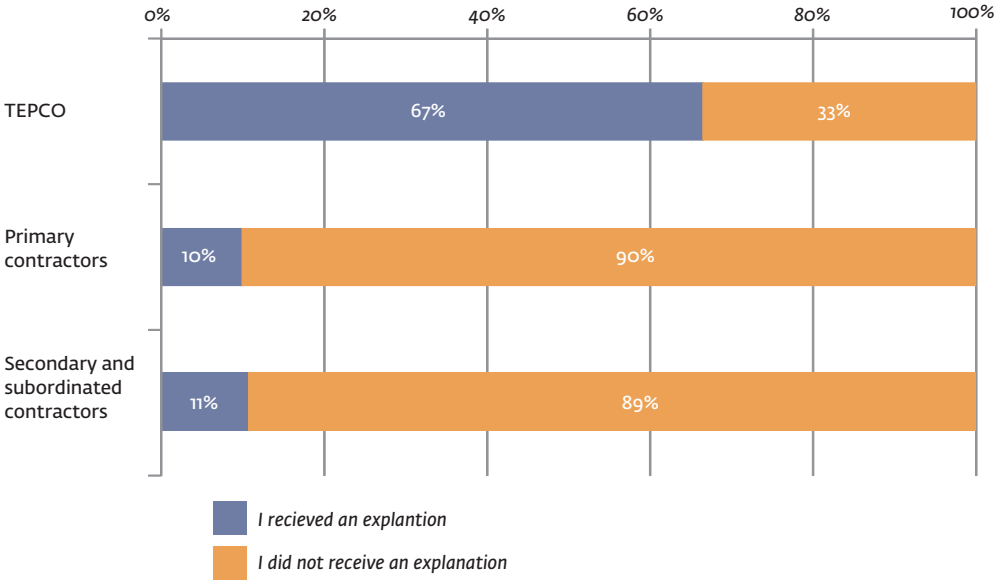
Workers involved in containing the accident

- Almost all of the workers who were involved in containing the accident were

On March 11, 2011, did you evacuate from within the the Fukushima Daiichi site (including temporary evacuation)? ▶



Before the accident, were you given an explanation of the possible response tasks you might be assigned to in the event of an accident? ▶

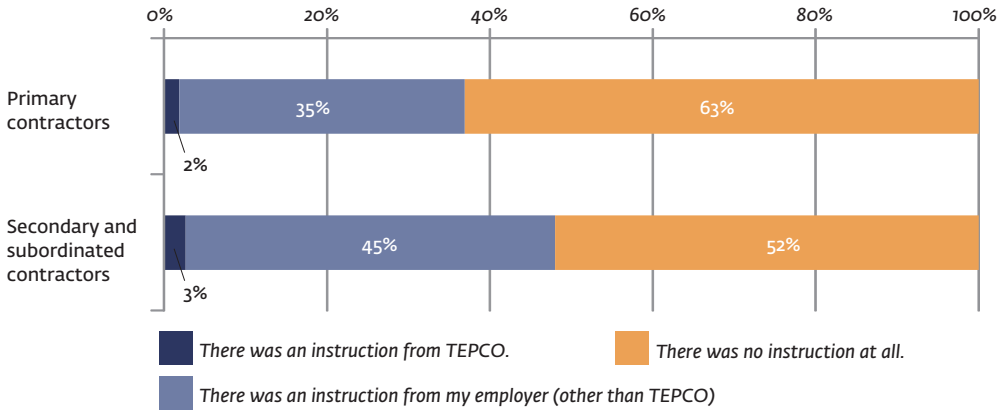


registered radiation workers.

- Only around 10 percent of the subcontracted workers who were involved in dealing with the accident received an explanation in advance about the possibility of the plant having a nuclear accident.
- Approximately 30 percent of TEPCO workers and 40 percent of subcontracted workers had not agreed to deal with such an accident.

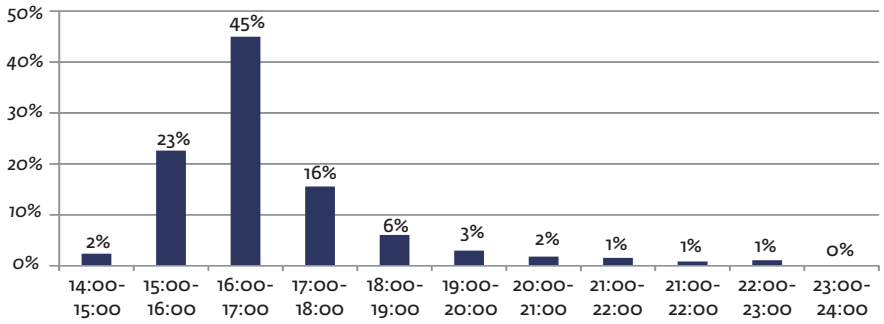
Management of radiation

- As there was a lack of dosimeters due to the tsunami, TEPCO let multiple workers in areas with low radiation levels share dosimeters immediately after the accident. As a result, the percentage of workers who did not have any dosimeters was kept to 5 percent. No significant difference in the distribution of dosimeters among TEPCO workers and subcontracted workers was observed.



◀ *Did you receive instructions regarding the evacuation? (For workers who evacuated on March 11)*

◀ *Ratio of occupational radiation workers to other workers engaged in accident response tasks*



◀ *If you evacuated from the Fukushima Daiichi site on March 11, 2011, at what time did you do so?*

- TEPCO manually tracked the workers' radiation dosage because the system of measuring and managing cumulative radiation became unavailable. However, around 30 percent of the workers said that they were never told of their cumulative radiation dosage. There is no major discrepancy between the TEPCO workers and subcontracted workers over the level of information given on dose exposure.
- As the accident evolved, radiation levels heightened outside the anti-earthquake building, even outside of the radiation controlled area. In response to this, TEPCO explained to workers engaged in tasks outside the anti-earthquake building about the radiation dose at the work sites and about the increased possibility of irradiation. While about 40 percent of the workers responded that they were briefed each time, 20 percent said that they were never given such information. No significant difference among TEPCO employees and subcontracted workers was observed regarding how and to what extent workers were informed of the exposure risks during their operations.
- Management of worker radiation exposure was conducted to the extent possible given the limitations and limited availability of the devices on-site. However, many workers stated that cumulative and internal radiation management and testing was insufficient.

Comment by a TEPCO employee

"There was no explanation at all about how dangerous it was until the early morning of March 15. I understand that it was a difficult situation and there was limited time to give explanations, but at least we wanted to be informed."

"We were supposed to manage our cumulative radiation exposure level on our own, perhaps because the database became unavailable due to the earthquake. But we didn't even have pen or paper. We had no way to accurately keep track."

"My cumulative radiation exposure level reached around 0.08 millisieverts as of the end of March, So I asked for a whole body counter check. The company refused, saying that I was not eligible for the test unless I reached 0.1 millisieverts. I was working in the main anti-earthquake building for two weeks from March 11, and I spent at least five to six hours a day there. I'm sure that I was internally exposed. In mid-May, I went through the WBC (white blood cell) check, but the results showed that I was less exposed than people who spent fewer hours in that building than I did."

Comment by a TEPCO employee

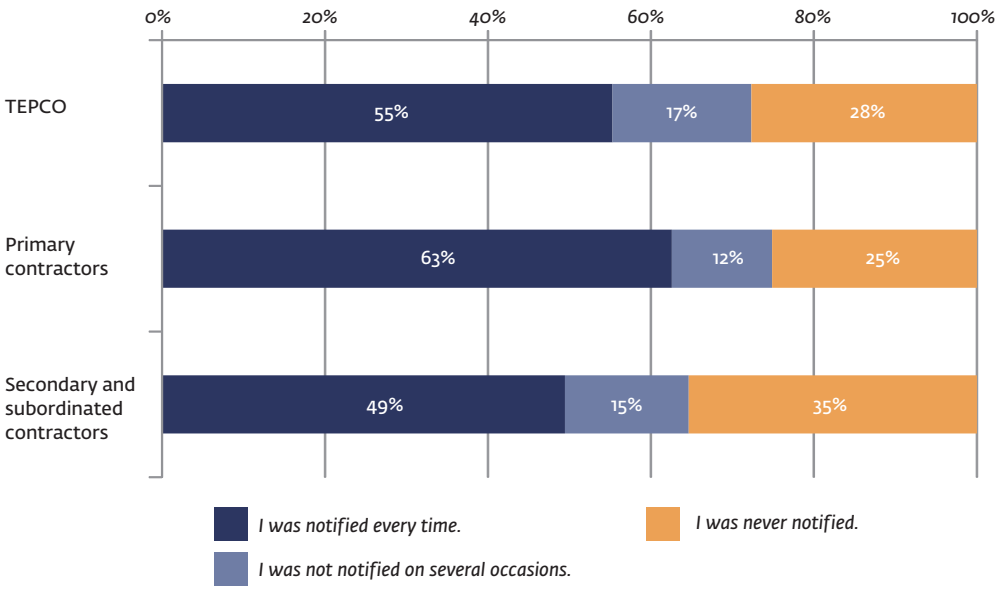
"I strongly call for a thorough follow-up, especially with the younger generation of workers, who are probably feeling abandoned. Some have been temporarily relieved of their jobs due to receiving their legal annual limit of radiation exposure. TEPCO executives are saying that this accident is not another Chernobyl, despite its scale, but I see no difference in terms of the suffering of the residents, especially the loss of their homelands. I don't want the executives to be so dismissive of this accident."

Comment by a TEPCO employee

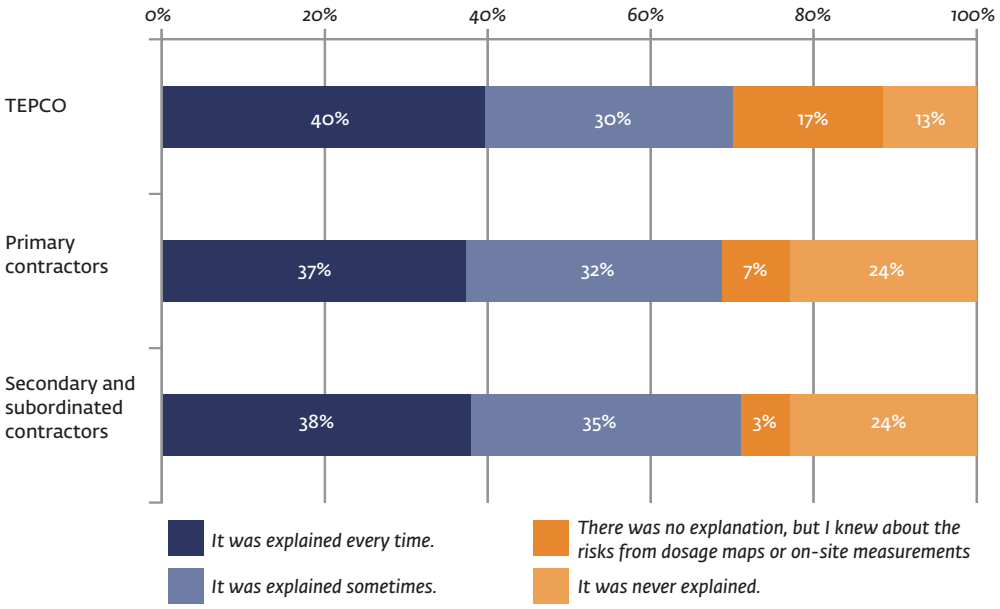
"Workers in the main anti-earthquake building were laboring under conditions where they couldn't trust anyone but themselves, and they were the only ones responsible for their own safety. Don't all of these problems stem from a fundamental lack of preparedness for disaster? I don't want to hear that this event occurred because it was 'unanticipated.' The government and the power company are accountable for the preexisting problems that led to the disaster. Isn't it also NAIIC's responsibility to reveal these problems and report them?"

Comment by a subcontractor employee

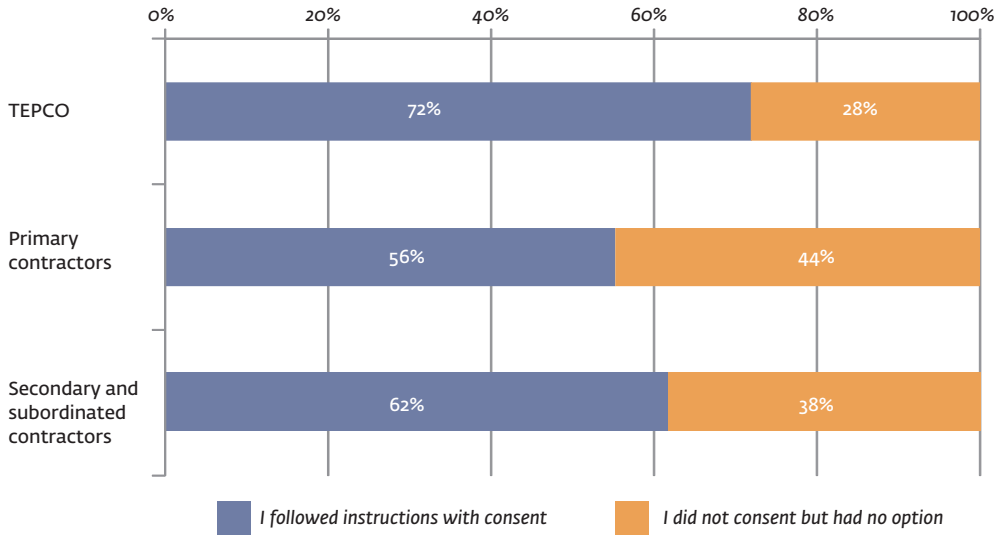
"No information whatsoever about the station blackout was delivered to the end-workers like us. I had to learn about the emergency evacuation orders for residents within 20km of the plant from TV. Though I was a subcontracted worker, I had to work on a 24 hour shift based on my existing contract. My employer knew there were several employees like me staying in the main anti-earthquake building. However, the company's managing director, deputy managing director and radiation protection supervisor all evacuated with their families. I finally managed to call our Tokyo head office on March 14, but they were not aware that there were still employees working in the main anti-earthquake building. I asked to evacuate, but they declined my request. I hardly ate or slept and I



◀ *Between the time of the accident and the end of March, did your employer notify you about your cumulative radiation exposure level every time you worked?*



◀ *Between the time of the accident and the end of March, did anyone explain about radiation levels or the possibility of exposure to radiation every time you worked outside of the main anti-earthquake building?*



◀ *Did you give your consent to be assigned to response tasks in the event of an accident?*

was reaching my mental and physical limits. I later told a general manager of TEPCO that I wanted to pull out, but it was very hard to get his consent. We found that the company car we were planning to use had been taken by TEPCO employees, but a colleague gave us a ride. I repeatedly requested a whole body check from my employer in late March and April, but my request was always denied. I was assigned to work at Daiichi at the end of April, which I refused to do because of health concerns. As a result I was later subjected to power harassment from my employer and I became mentally unbalanced. Because of this, I had to leave the company in June, which they termed a 'resignation for personal reasons.'"

Comment by a primary contractor employee

"For workers, there were almost no evacuation instructions. There has to be a clearly understood protocol for communicating information. Measures taken in response to the accident were uncoordinated and poor overall. This is also true from the perspective of the residents. Evacuation procedures and destinations were vague and still remain so. All these issues must be clarified. Only then can the recommissioning of the Oi nuclear power plant be discussed. There are workers who go back to their homes at night and try to lead daily lives after being exposed to radiation. This is inconceivable."

Comment by a primary contractor employee

"I was working at Fukushima Daiichi on March 11. When the earthquake happened I tried to go outside, but it took two hours to leave the premises of the plant because there were so many people. The first waves of the tsunami arrived while I was leaving, yet there were no announcements about tsunami. Thinking about it now gives me a chill in my spine."

Comment by a primary contractor employee

"The radiation level in the main anti-earthquake building was so high that under normal circumstances it would have been locked down to prevent entry. I had no choice but to try to estimate my radiation exposure level in my head. The main anti-earthquake building was clearly contaminated and there was a rise in the concentration of dust and iodine. Water was scarce, and I could not wash my hands to eat emergency food. I was clearly exposed to radiation internally. Water and electricity were urgently needed, however there was no supply of either from outside. The plant was completely isolated and I thought I had been abandoned."

Comment by a primary contractor employee

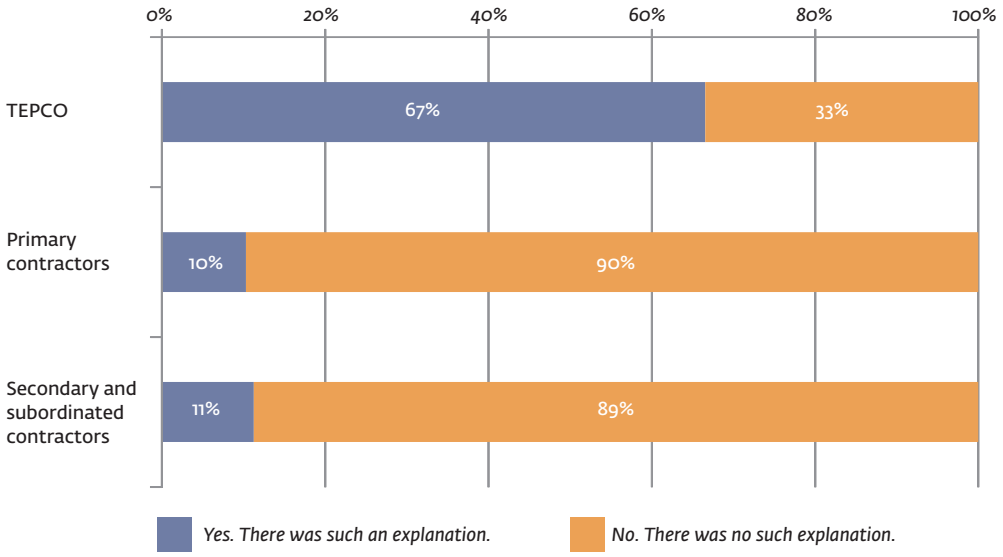
"Because workers were desperately needed, I didn't have time to confirm the well-being of my family, which bothered me so much that I could not concentrate on my duty. Responding to the accident was the priority, yet there was no way for the workers to track their exposure. I felt endangered. There were not enough dosimeters, so workers had to share them. Workers in charge of unnecessary tasks evacuated, but we did not. I feared for my life. The main anti-earthquake building survived the earthquake, but it did not protect against radiation. Hotspots in the building were marked with tape. Because the focus was on the accident response meeting between TEPCO headquarters and the plant, information was not transmitted to the surrounding area at all, though there was a radiation dispersion forecast from TEPCO's internal system based on wind direction. Workers who were engaged in accident response at that time deserve to be assigned to another location!

Comments by a primary contractor employee

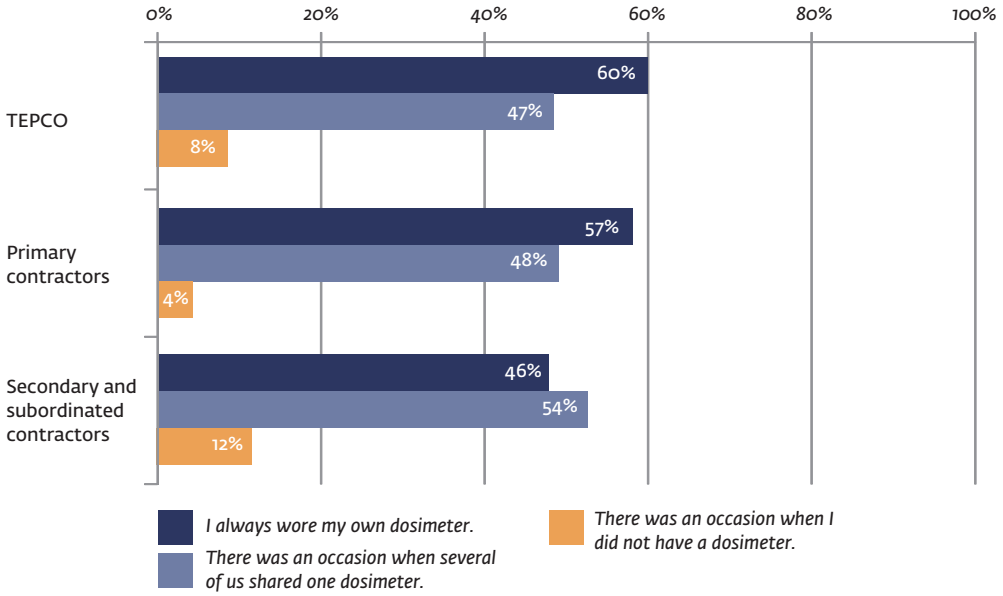
"The radiation dose management was sloppy right after the accident. Annual radiation dose management has been a vague issue for the past 15 years. The worker-to-worker deviation radiation exposure was large. I was over-exposed, about 0.15 milliSv/h external and 0.07 milliSv/h internal exposure, so now I can not work within the controlled area for the next five years.

Comments by a primary contractor employee

"After the accident, there were no whole body counter tests and it was deemed that there



◀ *Prior to March 11, did you receive any notification that you may be tasked with responding to an accident?*



◀ *Between the time of the Unit 1 explosion on March 12 and the end of March, were you wearing a dosimeter when you worked outside the main anti-earthquake* building?*

*(*The only building designated for coordinating the response to an earthquake and from which all crisis responses were staged.)*

was no radiation. (I wonder, could this be the result of orders from the electric companies and primary contractors?)"

"As there was no information disclosed during March 12-13, we did not know in what direction the radiation had dispersed when we evacuated."

"If decontamination is not prioritized, we cannot return to our homes. I hope that the decontamination will be conducted by volunteers from TEPCO and 100 percent TEPCO-related companies (i.e. by people who do not work at nuclear power plants)."

Comments by a primary contractor employee

"I don't think there was much attention paid to the workers who actually dealt with the accident. The first whole body counter was installed in Iwaki city, but only TEPCO employees were allowed to use it. Other workers had to go all the way to Kashiwazaki, and we almost never saw TEPCO people there. TEPCO left everything to the primary contractor. Before assigning blame, the operator should first focus on carrying out the initial response in the event of an accident."

Comments by a primary subcontractor employee

"As a primary subcontracted worker, I had no choice but to be involved in the work after the accident, which involved extremely high radiation levels by normal standards.

I have been worried about my health since March 11. After the accident, I received some compensation for the emergency from my own company, but it was a very small amount. Can we even say that our work was for the country? If it was, we should receive more money. I have suffered from stomach cancer before and if I get it again because of working on this accident and die, it will be unforgivable."

Comments by a primary subcontractor employee

I have worked in a subcontracted company for around four years—during which time I never once experienced evacuation training for a nuclear accident. TEPCO's mindset was that "there is no possibility that an accident will occur," and "we only need to do evacuation training for fires." Because of such irresponsible thinking, I was fired, I have lost my income, and I have had to evacuate far away in order to raise my three children and protect their health. I want our time and livelihoods back."

Comments by a primary subcontractor employee

"I demand to receive sufficient compensation and insurance as soon as possible. We cannot wait for another day to receive our compensation."

"I think that this accident was going to happen eventually. TEPCO is expert at hiding information. Even now, TEPCO has not disclosed all of the information regarding water leakage etc."

"The government and TEPCO should have referred to past accidents such as the one in Chernobyl when formulating their response to this accident. There have not been any apologies to the evacuees. How can this be acceptable?"

Comment by a subordinate contractor employee

"On the news it was reported that the plant workers who were dealing with the accident were prepared to die, but I was watching the news, thinking that there is no way we were ready to die. I did a whole body check for the first time at the end of April, and my radiation dosage was unbelievably high. My heart goes out to the people who are still working to deal with the accident. I hope that the people working at Fukushima Daiichi will take care of their health."

Commission meeting reports

1st Commission Meeting

Location:
The Fukushima View Hotel, Fukushima Pref.
Date:
December 19, 2011

1st Commission Meeting

The Fukushima Nuclear Accident Independent Investigation Commission held its first commission meeting at the Fukushima View Hotel in Fukushima city on December 19, 2011. The Commission approved the draft of the regulations governing its operations, appointed a project manager, decided on the structure of working groups and its office and officially started its activities. There was also a report from commission member Reiko Hachisuka, on the tough conditions the affected people are in today. Ms. Hachisuka, who moved from her home in Okuma, where the Fukushima Daiichi nuclear power plant is located, to live in the temporary residences provided in Aizu Wakamatsu, stated that evacuees now live without any sense of emotional security or stability, despite having been continually assured of the plant's safety for many years by TEPCO and the government.

In order to gain a first-hand grasp of the conditions at the plant and surrounding area, the Commission visited the plant itself on December 18. It also observed the decontamination operations run by Okuma Municipal Office. Upon the closure of the first Commission meeting on Monday, we visited the temporary housing in Kawamata which accomodates evacuees from Yamakiya district of the same town, where radiation levels are high. We heard directly from the town's mayor, Michio Furukawa, and the chair of the temporary residence community association, and saw the operations underway to decontaminate the farmland and forests of Yamakiya district.

2nd Commission Meeting

Location:
Keisei Memorial Hall, Tokyo
Date:
January 16, 2012

Witnesses:
Yotaro Hatamura, Chairman, Cabinet Office Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of TEPCO
Shinji Ogawa, Director General, Cabinet Office Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of TEPCO
Masao Yamazaki, Executive Vice President, TEPCO
Masayuki Ishida, Chief Manager, Nuclear Power Quality Inspection Division, TEPCO
Masayuki Ono, Chief Manager, Nuclear Power Quality and Safety Division, TEPCO
Itaru Watanabe, Senior Deputy Director–General, Science and Technology Policy Division, MEXT
Yoshinari Akeno, Division Manager, Nuclear Safety Division, Science and Technology Policy Division, MEXT
Tadao Kanda, Chief Manager, Evaluation of Policy Division, Minister's Secretariat, MEXT

The Commission appointed its acting chairman and co-chairman of the working group. We received an explanation of the interim and initial reports on the Fukushima nuclear power plant accident from the government accident investigation-verification committee, TEPCO and the Ministry of Education, Culture, Sports, Science & Technology (MEXT), respectively.

3rd Commission Meeting

Location:
Shimin Plaza Kazo, Saitama Pref.
Date:
January 30, 2012

Witness: Katsutaka Idogawa, Mayor of Futaba.

Mayor Katsutaka Idogawa of Futaba explained the status before the plant accident and the conditions at the time of the accident and evacuation. He also exchanged opinions with the Commission. After the Commission meeting, we held a town meeting in order to hear fresh comments from the town residents on the accident and evacuation, as well as on details of life as evacuees.

Idogawa's comments:

- "Ever since I was appointed as the mayor, I kept expressing our concern about the nuclear power plant to TEPCO and NISA. They kept telling us there is no need to worry, that the plant is absolutely safe. But the accident actually happened. They cannot say the reasons for the accident are 'factors beyond their assumptions.'"
- The off-site center was useless because it was too close to the power plant. It needs to be verified what kind of accident the emergency off-site center was designed to deal with.
- It is necessary to clarify the role played by the nuclear regulatory bodies and their relationship with the industry. In regard to TEPCO, we would like investigation into all factors that could have contributed to the accident. We need to know whether frontline concerns were ignored to put business efficiency first, whether appropriate personnel training was conducted and technical skills were properly passed on, and what kind of training was given to the large number of temp staff that got hired for regular inspections. We need to know whether the crisis management division was functioning appropriately.
- In regard to Fukushima Prefecture, investigation is necessary in such areas as whether it disseminated appropriate information to its people and whether the prefecture is now providing protection to the people according to their needs.
- With regard to the level of radiation exposure, there are different explanations and standards, which is very confusing. The maximum cumulative amount of exposure for the general public by law is 1 millisievert per year. The accident has caused us to be exposed to radiation other than natural background radiation. It is outrageous that TEPCO claims the radiation released from its power plant is *bona vacantia*, an ownerless object for which they cannot be held accountable.
- After we evacuated, there were no communications whatsoever from the government. Television was the only source of information.

Katsutaka Idogawa

4th Commission Meeting

Location:
The National Diet of Japan
Date:
February 15, 2012

Witnesses:
Haruki Madarame, Chairman, Nuclear Safety Commission (NSC),
Nobuaki Terasaka, former Chair, Nuclear and Industry Safety Agency (NISA)

1. *Outdated guidelines*: Haruki Madarame, Chairman, Nuclear Safety Commission, admitted that the safety guidelines were defective and expressed his apology. Also, the accident in Fukushima emitted far more radiation than the scenarios done in a "hypothetical accident" set in the guidelines, where the scenarios had assumed a significantly smaller scale than the severe accident scenarios used by many other countries. The Guideline for the Reactor Site Evaluation, which was established in 1964, is still in place regarding construction permits for nuclear power plants. It was called outdated during the hearing, and Madarame's opinion was that the guideline needed to be amended.
2. *Lack of preparation by agencies*: Both the NSC and NISA had mandates to maintain the safety of nuclear power, yet lacked preparation for emergency situations. Moreover, both the NSC and NISA were found to lack an understanding of their fundamental tasks of protecting the surrounding residents and the nation.
3. *Insufficient knowledge*: The hearing revealed a lack of technical knowledge and nuclear engineering skills by the regulating agencies and the leaders of those agencies. The hearing also reminded everyone about the profound importance of independence and how important decisions and suggestions based on scientific facts and analyses are for those agencies to function properly. Obviously, Japan has a clear responsibility to establish safety standards and guidelines that are trustworthy at a global level.

Haruki Madarame

Nobuaki Terasaka

Location:
The National Diet of Japan
Date:
February 27, 2012

5th Commission Meeting

Witness: Richard A Meserve, former Chairman of the U.S. Nuclear Regulatory Commission (NRC), President, Carnegie Institution for Science

Dr. Richard A Meserve

1. *Proactive mindset*: Those responsible must make a continuous effort to raise existing safety standards. The construction and operation companies should not presume the quality of the standards of the regulatory agencies, and should not have a passive mind-set toward security and safety issues.
2. *Operator responsibilities and independency:* The nuclear plant operators have the most clearly defined responsibility to prevent accidents and stop any escalation in consequential damages. In an emergency situation, the operator is required to make decisions, and should avoid asking the government. For this reason, the operators must be competent to do so.
3. *Regulatory agencies responsibilities and independence*: The role of the regulatory agencies is to require sound decisions by the operator and to implement the decisions to prevent any escalation of damages. The agencies must maintain independence from the operators and the government. The agencies should also clarlfy the roles of the operator and the government, and the chain of command. These should be rehearsed repeatedly.
4. *Transparent decision-making*: It is important to maintain transparency in all the decision-making processes, except for those related to national security. It is important for participants to openly provide opinions to gain trust.
5. *The importance of human resources*: Japan should learn from the NRC model, where the majority of employees spend their entire careers on nuclear safety, and provide proper incentives to experts. In Japan, professionals trained in rotational positions within the bureaucratic entities often proved dysfunctional in emergency situations.
6. *Independent and transparent investigations*: The most important essential traits in the investigation of the nuclear accident are independence and transparency.

Location:
National Diet of Japan
Date:
March 14, 2012

6th Commission Meeting

Witness: Sakae Muto, Advisor of Tokyo Electric Power Company (TEPCO) and Former Executive Vice President and General Manager of Nuclear Power & Plant Siting Division of TEPCO

Sakae Muto

1. *Government-operator relations:* We heard unexpected testimony that the cabinet participated in discussions of technical matters regarding the nuclear reactors. Prime Minister Kan asked for the mobile phone number of the head of the plant at Fukushima, leaving the top management of TEPCO out of the loop.
2. *TEPCO competency*: Muto stated that the operator was primarily responsible for the accident, but questions remain about TEPCO's competence in taking on this responsibility.
3. *Lack of accident preparation:* There were ongoing discussions on the safety culture and preventive actions taken against earthquakes. Muto implied that the cause of the accident was due to the unexpected tsunami, but the possibility of a tsunami was estimated in 2002—so TEPCO must have recognized the risks. Muto, however, claimed to have been unaware of such studies. This obviously was a failure of the safety culture within TEPCO.

Location:
The National Diet of Japan
Date:
March 19, 2012

7th Commission Meeting

Witnesses:
Volodymyr Holosha, Head of the State Agency of Ukraine for Exclusion Zone Management,

Ministry of Emergency Situations
Anatoliy Gora, Deputy Head of the Chernobyl Nuclear Power Plant
Leonid Tabachnyi, Vice-Chairman, Geophysical Observation Center of Hydrometeorology Department, Ministry of Emergency Situations of Ukraine

Volodymyr Holosha

Leonid Tabachnyi

1. The Chernobyl accident was different from Fukushima in the various types of radioactive materials released, the weather pattern, the geography and the condition of the reactor containment vessels. However, both received the same level 7 (severe accident) designation on the International Nuclear Event Scale (INES). Chernobyl resulted in a significant emission of radioactive material and affected the environment and the lives of many people. It was valuable to hear about the real experience directly from the people who fought against the spread of damages from the accident. The emitted radioactive material continues to significantly affect public health and the environment even 26 years after the accident.
2. Regarding exposures issues: Many people who worked in the contaminated areas were exposed to radiation in Ukraine. Many infants who were exposed to radiation contracted thyroid cancer. Radiation exposure not only causes thyroid cancer in infants, but affects the whole body. Evacuated people suffered from stress and radiation phobia. Contaminated food items are monitored and controlled separately by type, amount of consumption and so forth.
3. Regarding information disclosure issues: The necessity of disclosing information has been acknowledged by the Ukraine government after the lessons learned from the time of the USSR. Nonetheless, there are many technical measures, such as becquerels, sieverts, and curies, that are unfamiliar to many people. Information to the public can be disclosed in alternative ways regarding levels of contamination.

8th Commission Meeting

Location:
The National Diet of Japan
Date:
March 28, 2012

Witnesses:
Ichiro Takekuro, TEPCO fellow and head of TEPCO's nuclear power business prior to the accident. He was at the Kantei during the accident
Kenkichi Hirose, Special Adviser to the Cabinet Office, in charge of the NSC, former Secretary General of the Nuclear Safety Commission (NSC) and former Director General of the Nuclear and Industry Safety Agency (NISA)

Ichiro Takekuro

Kenkichi Hirose

1. *TEPCO competence:* Despite the fact that TEPCO has the primary obligation to prevent accidents and minimize damages, the company was found to be lacking the self-governance competance to set adequate measures for the prevention of accidents, and the culture to make concerted efforts to improve nuclear safety from the people's point of view. Moreover, TEPCO does not clearly recognize the nuclear safety tasks and obligations that are necessary for an operator of nuclear power. Regarding the defense-in-depth program, Takekuro stated that TEPCO had been focusing on the first three levels of defense-in-depth, implying that TEPCO was not responsible for implementing the fourth and the fifth levels. At the time of accident, TEPCO sent Takekuro to the Prime Minister's office to report in detail on the accident conditions to the Prime Minister. However, it was found that Takekuro was actually sending commands to the accident site on behalf of the Prime Minister. It is obvious that TEPCO's corporate culture has been lacking in efforts to prevent accidents and to improve nuclear safety as a part of their obligation as a nuclear power plant operator. This point is also evident given TEPCO's long history of concealing accidents.
2. *Regulatory agency responsibilities*: The hearing clarified that the nuclear power regulatory agencies such as NISA have not been meeting their first obligation: public safety. Their liability in ignoring the basics of creating a safety culture, such as leaving essential safety measures like backchecks to the operators, and disregarding the recommendations of IAEA, is overwhelming. It is also clear that the double-check feature

between NISA and NSC has not been functioning. The dysfunctional attitudes and irresponsible behavior found in the hearing are not only attributable to Hirose and other leaders. The government also is quite heavily liable, as it was responsible for creating NISA as an administrative organization under METI.

Location:
The National Diet of Japan
Date:
April 18, 2012

9th Commission Meeting

Witness: Hiroyuki Fukano, Director General, Nuclear and Industry Safety Agency (NISA).

Hiroyaki Fukano

1. *Safety Guideline:* The Safety Guideline was revised by the government after the Fukushima accident based on the measures stated in the "Technological Findings" which is a provisional analysis. The accident conditions assumed explicitly in the revised Safety Guideline are narrowly defined as an accident with an event sequence identical to that of the Fukushima accident. There is no measure or definition set for a potential accident beyond the assumed accident scenario in the revised Safety Guideline, and there are few necessary safety measures as stated below.
   • The plan to build earthquake-resistant buildings, which turned out to play a critical emergency role in the Fukushima accident, is defined as a "medium-term task."
   • The plan to implement filtered ventilation, which has been implemented in many European countries, is defined as a "medium-term task."
   • The emergency evacuation plan, which is most important to the safety of residents, is set outside of the scope of discussion in the "Technical Findings" that have been used as the rationale in the revised Safety Guideline.

Location:
Nihonmatsu, Shimia Kaikan, Fukushima Pref.
Date:
April 21, 2012

Location:
University of Aizu, Fukushima Pref.
Date:
April 22, 2012

10th Commission Meeting + Namie town hall
11th Commission Meeting + Okuma town hall

Witnesses:
Mayor Baba of Namiemachi and six other witnesses at the 10th Commission Meeting in Nihonmatsu
Mayor Watanabe and four other witnesses at the 11th Commission Meeting in Aizu Wakamatsu. After each Commission meeting, Commission Members heard from the residents during town hall meetings.

Mayor Baba

Mayor Watanabe

1. *The anger of the evacuees*: We felt the raw anger of the residents as shown by the following comments: "We had to evacuate without any information from the government, the prefecture, or TEPCO about the accident itself, instructions on the evacuation, or in which direction we should evacuate." "There should have been someone, such as a TEPCO employee, providing information at earlier stage." We recognized once again the importance of easy-to-understand and timely information communication processes.
2. *Assuring the safety of residents*: A local government official commented that he is asking himself "whether the local government fulfilled its role to assure the safety of the residents." Others said "Emergency evacuation drills turned out to be training for the sake of doing training. It was for the self-satisfaction of the organizer—shouldn't the training have been done under more realistic assumptions?" The findings from our previous commission meetings suggest that the regulators completely lacked the mindset to safeguard the residents.
3. *Message from the towns hosting nuclear power plants*: We heard important opinions, especially from the people of Okuma. Notable comments included: "The people from the towns hosting nuclear power plants were so used to hearing 'how safe the plants are.' We had been brainwashed." "I had never thought that a nuclear power plant could become a problem." "There was no communication about potential issues which are

out of human control." These comments can be very important to people in all towns that host nuclear power plants.

4. *Relationship with and confidence in the government*: We heard feedback regarding the government, specifically that it failed to provide the necessary information at the time of the accident: "I still cannot trust the government," "I am not confident about the information provided by the government on the current condition of Unit 4 and the radiation dose level."
5. *Evacuee life and the future*: We realized fully that the belated or indefinite evacuation instructions, as represented by the use of the phrase "just to be sure," affected the residents severely. A participant called for the need "to install a system in which the government continues to monitor the health conditions of the people from generation to generation." Moreover, many residents repeatedly expressed their shared earnest desire "to not let other municipalities hosting other nuclear power plants experience what we experienced."

Namie town hall meeting

Okuma town hall meeting

12th Commission Meeting

Location:
The National Diet of Japan
Date:
May 14, 2012

Witness: Tsunehisa Katsumata, Chairman of Tokyo Electric Power Company (TEPCO) and former Chairman of the Foundation of Electric Power Companies of Japan (FEPC). Katsumata was president of TEPCO from October 2002 and has been chairman since February 2008

1. *Accountability of a nuclear facility operator and the Prime Minister*: While he mentioned that "electric companies are unambiguously responsible for the safety of nuclear power plants," he stated that "it was the Prime Minister who was the director-general of the emergency response headquarters, where judgment at the plant site needed to be prioritized." Also the top three management members (president, chairman, and vice president) were unavailable when the accident broke out. Katsumata only found out that the President had been away after the accident happened. A lack of a sense of impeding crisis was obvious from the fact that he made no contact with the president after the president's return from abroad until his return to the head office.
2. *Critical facts about tsunami*: The causes of the accident, according to his statement, are "under investigation at TEPCO." However his assertion that the unanticipated tsunami was the primary cause was disorienting. It revealed that the risk posed by unanticipated potential tsunami had not been communicated internally to the president. It turned out that Katsumata had determined that "such tsunami would not happen in reality." It seems that the risk of tsunami had not been considered probabilistically.
3. *Regulatory environment*: He emphasized the simplification of regulations, but the measures which operators carry out independently, including earthquake-resistant backcheck and severe accident responses, had not been taken by TEPCO and other operators. Serious doubt remains about the implication between the call for simplified regulations and the delayed actions by TEPCO. The Commission also learned the little-known fact that the FEPC had been the forum for lobbying.
4. *General overview*: Katsumata admitted that he can look back and think of a number of measures that should have been implemented—such as anti-tsunami measures and severe accident responses, but he declined to specify further. The public should determine through today's discussion if he was sufficiently competent to be the top manager of a giant power company that utilizes nuclear power.

Tsunehisa Katsumata

Location:
The National Diet of Japan
Date:
May 16, 2012

13th Commission Meeting

Witness: Kazuo Matsunaga, Vice-Minister of Economy, Trade and Industry (METI) at the time of the accident and Director General of the Nuclear and Industry Safety Agency (NISA) from June 2004 to September 2005.

Kazuo Matsunaga

1. *Decisions made as Director General of Nuclear and Industry Safety Agency (NISA)* : The witness stated that he could not spare time for the implementation of the new anti-quake guideline because he was too busy dealing with responses to the accident at the Mihama nuclear plant. He avoided explaining his own involvement in the stress tests and stated that any discussion on introducing B.5.b was not his business. As such, he was not directly a part of the important aspects of nuclear safety, and he avoided clearly defining his own accomplishment and responsibilities.
2. *Judgments regarding nuclear safety in re-operation of nuclear power plants:* The question still remains whether informed, appropriate decisions about energy policy and nuclear safety are being made by the top authorities. If METI is making judgments about the safety and re-operation of nuclear plants prior to the completion of the accident investigations by the government, they may not be in full possession of the facts. This point was also made by the METI minister, Banri Kaieda, on June 18, 2011.
3. *Responsibility for maintaining sufficient supply of electricity*: Matsunaga was asked if he knew whether TEPCO was releasing all the correct information about its power supply capabilities to the public. But he claimed to be unaware of any failure on TEPCO's part.
4. *About introduction of plutonium thermal use*: We found that the government may have rushed the regional government to make a decision on the implementation of plutonium thermal use in Unit 3 of Fukushima Daiichi by presenting the benefits of government subsidy, while there was not enough time to thoroughly perform a possible anti-quake backcheck.
5. *Competency in emergency response engagement*: METI was probably inadequately prepared, as was NISA. In light of the findings from this hearing, we need to profoundly consider whether the current organizational structure surrounding nuclear regulatory agencies, including METI, which plays the roles of both promotion of nuclear power and maintaining nuclear safety, can be improved to function more properly.

Location:
The National Diet of Japan
Date:
May 17, 2012

14th Commission Meeting

Witness: Banri Kaieda, a member of the House of Representatives and Minister of Economy, Trade and Industry (METI) at the time of the accident.

1. *Witness' understanding of facts at the time of accident :*
   a) Kaieda stated that he feels responsible for the delay in declaring a Nuclear Emergency Situation and that it was because convincing the Prime Minister to do so took time.
   b) He did not know the reasons for then Prime Minister Kan's visit to Fukushima Daiichi nor its purpose.
   c) Kaieda received a phone call about evacuation directly from Shimizu, TEPCO president at the time of the accident. The witness recalls, "Daiichi Power Plant," "Daini Power Plant," and "evacuation," but not "full withdrawal." Furthermore, Kaieda understood the direct phone call from Shimizu to have significant meaning.
   d) Kaieda stated that he felt TEPCO was hesitant to make a decision to ventilate, as well as to decommission Units 5 and 6. Also stated was the reason for issuing an order to ventilate in accordance with the Nuclear Reactor Regulation Law—to prod TEPCO into doing the venting. This revealed ambiguity in the definition of the responsibilities of the government and operators.
   e) Kaieda mentioned that from immediately after the breakout of the accident, communicating and sharing information among the accident site, the Kantei, and TEPCO

headquarters was like the telephone game "whispering down the lane". He went on to state that "the government has to think this issue over."

f) The preparedness by the government was "not enough," the witness said. In addition, he stated that "the trainings should have included use of SPEEDI."

g) The witness made a critical statement about the hydrogen explosions—"nobody had ever thought of a possible hydrogen explosion at that time." Also he expressed his regrets that he was unable to prevent the hydrogen explosion. He felt the lessons from Three Mile Island were not utilized.

2. *Regarding the Stress Tests*: In consideration of use of the stress tests as a requirement to restart nuclear plants, Kaieda stated that he did not even consider mandating back-checks as a possible alternative to speed up the process of the operators.
3. *Ideal regulatory organization and emergency response organization:*

a) Kaieda said that the emergency response organization should be lean with all members understanding their own roles clearly. He thought NISA did not meet the expectations of the people in performing its role.

b) He encouraged the regulatory agencies to be independent and to be safety-oriented. The regulatory organization should include experts on radioactive materials with the proper knowledge and equipments to respond in emergency situations.

Banri Kaieda

15th Commission Meeting

Location:
The National Diet of Japan
Date:
May 27, 2012

Witnesses: Yukio Edano, Minister of Economy, Trade and Industry. He was the Chief Cabinet Secretary at the time of the accident.

1. *Edano and Shimizu on full-withdrawal:* Edano does not recall the exact words used with respect to the plans for withdrawal. However, he remembers that he conveyed his view that if a full withdrawal of staff from the plant were to take place, deterioration of the state of the plant could not be stopped. In response to Edano, Shimizu (President, TEPCO) could not find the words to respond, and said nothing. Based on this reaction, Edano further stated that "it was clear that the intent of the proposal (by Shimizu) was not for a partial withdrawal." During a phone call, Yoshida, the General Manager of Fukushima Daiichi, replied to Edano's question about withdrawal, saying, that "there are still actions to be taken here. We'll do our best."
2. *Notification of public disclosure of information*: Edano directed TEPCO to notify the Prime Minister's office of any information disclosed to the public at the time of the disclosure, but the direction was not intended to require TEPCO to obtain approval from the Prime Minister's office prior to the disclosure.
3. *Accepting international support:* The Prime Minister's office had been directing ministries to accept any international support offered, even if they might be required to overcome legal issues to do so.

Yukio Edano

Edano then added the following statements in light of his experience:

1. *Insufficient information distribution*: Based on the discussions today he recognized that information had not been communicated sufficiently from the viewpoint of the public and residents of the area. At the time he thought it sufficient. He recognized that communication concerning personal risk needed to be improved.
2. *Problems in information handling*: He pointed out problems in gathering, predicting and anticipating information. As an example, he stated that the term "precautions" used in public releases was not founded on clear grounds.
3. *Need to separate roles of Chief Cabinet Secretary and Spokesperson*: Edano noted that in the absence of a stand-alone government spokesperson, the Chief Cabinet Secretary acts as a secondary or dual role. He thinks that particularly in times of an emergency, these two important roles should be separated. A spokesperson should be specially trained.

Location:
The National Diet of Japan
Date:
May 28, 2012

16th Commission Meeting

Witness: Naoto Kan, a member of the House of Representatives; Prime Minister of Japan at the time of the accident

Former prime minister Naoto Kan

Pre-accident conditions

1. The accident occurred at a nuclear power plant which had been built and operated as part of national nuclear policy, and thus the government bears the greatest share of the responsibility for the accident. Kan, who was the leader of the government at the time of the accident, apologized once again for being unable to stop the accident from evolving.
2. With regard to the nuclear accident response, neither the authority of the Prime Minister nor that of the director general of the emergency response headquarters had ever been explained to Kan in detail prior to the accident.
3. The authority of the director general of the emergency response headquarters had not necessarily been fully recognized by Kan when the comprehensive emergency response drill was conducted.

During the accident

1. Visiting the plant managers on site was considered helpful for Kan to understand the situation, as he could not obtain any meaningful information from the members of NISA, the NSC, or the technical advisor from TEPCO regarding what needed to be done at Fukushima Daiichi.
2. There was no awareness that the plant would reach its re-criticality as a result of injecting seawater instead of freshwater, although Madarame (Chairperson, NSC) had indicated that such a possibility was not zero. Kan also stated that although it has been reported that decisions (to suspend seawater injection) came from the Kantei, it could have been a statement made by the TEPCO personnel who were then at the Kantei.
3. There were two calls from Yoshida (the General Manager, Fukushima Daiichi) to Hosono (Special Advisor to Prime Minister, Cabinet Office) on matters relating to the full withdrawal. In the first call Yoshida said that the situation was "extremely intense," and in the second call that "water injection has begun, and that it looked okay." Kan recalls that he called back once but does not remember the details of that conversation. Then, early on March 15, the minister of METI woke Kan and it was then that Kan first heard about TEPCO's proposal to withdraw, which he thought was absurd.

Responses by the government and the Kantei (Prime Minister's Office):

1. With the largest ever double disasters—earthquake and tsunami—and a nuclear accident at the same time, it was difficult for the off-site crisis control center located in the Kantei to function sufficiently as a control room.
2. The Act on Special Measures Concerning Nuclear Emergency Preparedness (Nuclear Emergency Response Act) was ineffective, and the Kantei had to act as commander in chief.
3. Calling the accident site was an extraordinary action, which Kan believes could have been possibly avoided if information had been appropriately provided to him by TEPCO and/or NISA in a timely manner.
4. It was Edano (Chief Cabinet Secretary at the time of the accident) who declined the offer to station non-Japanese experts at the Prime Minister's office. Kan was not informed about this decision.
5. Kan was not aware that overseas assistance was declined by NSC. It is a big problem if it is true.
6. Kan took diverse advice, even from beyond official channels.
7. Kan requested support from several specific Diet members, but the request was not intended to make them act as an advisory team.

Future tasks: Kan recognizes that the March 11 disaster has brought attention to some fundamental problems of Japan. He believes that the first step to reforming the nuclear pol-

icy is to dissolve the organizational structure of the nuclear community in Japan, controlled mainly by TEPCO and the Federation of Electric Power Companies of Japan (FEPC). Furthermore, inviting experts from abroad may become a catalyst to restructuring the nuclear community in Japan. He expressed his position that Japan should aim at becoming free of nuclear power plants. Kan expressed his respect and appreciation to the people who worked hard on-site to address the nuclear power plant accident.

17th Commission Meeting

Location:
Fukushima Terrsa, Fukushima Pref.
Date:
May 29, 2012

Witness: Yuhei Sato, Governor of Fukushima Prefecture at the time of the accident.

Pre-accident conditions:

1. The central government and TEPCO stated that risks relating to nuclear disasters were appropriately mitigated and that the area was protected under the defense-in-depth philosophy.
2. Evacuation from the 2-kilometer zone was a decision made by the prefectural government on its own, because the central government had not acted swiftly enough. However, the evacuation order was not properly disseminated due to disruption of communications systems. Later, the evacuation orders issued by the central government were shared through the media, and the prefectural government received no concrete directives from the central government. As a result, residents were forced to experience an extremely difficult and disruptive evacuation.

Yuhei Sato

Implementation of plutonium-thermal at the plant

1. One of the three conditions the prefectural government presented to the central government on making a decision on plutonium-thermal use in Unit 3 of Fukushima Daiichi was that it must achieve the same level of earthquake-proof safety as the interim report of backchecks performed for Unit 5. However, Sato claims that when plutonium-thermal was implemented in Unit 3, he did not know that the backcheck did not include anti-tsunami measures like those for Unit 5.
2. Sato further claims that he did not know about the special subsidy that was part of the plutonium-thermal project even though he implemented it,

Future tasks:

1. Sato pointed out that having divided administrative functions is detrimental to securing nuclear safety, and stated his opinion that unifying multiple functions is strongly desired.
2. There was conflicting information, including information about SPEEDI. Also information sharing and communication at the emergency response center was not sufficient, and the prefectural government had organizational issues. Sato said that he wants to reconsider crisis management. He commented that it is crucial that communication of insights, organization, and reliable individuals all act in close concert to prevent future accidents.
3. National support has been broadly extended to Fukushina and its people since the disaster. To reciprocate, Sato said that he wants to contribute by building a community with the promise not to let a similar disaster ever happen again.

18th Commission Meeting

Location:
The National Diet of Japan
Date:
June 8, 2012

Witnesses: Masataka Shimizu, president of TEPCO at the time of the accident.

Miscommunication:

1. President Shimizu was "not aware that the Kantei did not trust TEPCO's response

regarding venting" when he returned from his business trip. Also he "found out" that the Prime Minister had interpreted the proposal regarding withdrawal as "full withdrawal" only after the Prime Minister said so. It seems that Shimizu lacked an understanding of the gap between how the Kantei perceived the situation and how TEPCO perceived it. The Kantei and TEPCO misunderstood each other and there was mutual mistrust, resulting in discrepancy over the interpretation of the word "evacuation."

2. In addition to his testimony, the Commission's investigation has confirmed the fact that the staff was on the ground striving hard to resolve problems with the reactors, and had not thought about withdrawing from the site. No evidence has been found either that TEPCO had made a decision to "fully withdraw."
3. Based on what the Commission has found, nuclear reactors in serious states were ultimately kept under control because of the people on the ground, who had a good grasp of the reactor conditions, as well as a sense of responsibility to remain on-site throughout the crisis.
4. To this end, TEPCO should not have turned to the Kantei for instructions. Instead, people on the ground or someone qualified to make technical judgments about the situation should have made decisions, as exemplified by the decision to inject seawater.
5. This raises an important argument over the position of the operator and the legitimacy of the intervention by the Kantei, which lacked the nuclear expertise.
6. Shimizu highlighted the significance of having earthquake-resistant buildings by mentioning that "it is frightening to think what would have happened if TEPCO did not have it." Various preparations assuming an even worse case are needed. The importance of protecting the safety of workers at nuclear power plants in order to protect the lives of the public is now clear.

Location:
The National Diet of Japan
Date:
June 9, 2012

19th Commission Meeting

Summary of survey results: The survey results showed that the government's delay in transmission and communication of information concerning the accident led to the subsequent confusion. From the perspectives of the evacuees, ad-hoc instructions caused many people to evacuate multiple times, in some cases to areas with high radiation doses, and/or with only barest necessities. The voices and thoughts of evacuated residents who do not have other places to turn to were very clear. The issues are not resolved yet. Proper measures should be considered as soon as possible. We will communicate this message to the Diet.

Glossary of terms

Acute radiation disorder An acute illness resulting from a high dose usually exceeding 500mSV to most or all of the body in a short period of time.

B.5.b The section of the 2002 NRC Security Order that addresses damage from fire or explosion such as could occur from the impact of a large commercial aircraft.

Backcheck A review of the safety of a nuclear power plant—a term peculiar to the Japanese nuclear industry.

Backfit The modification of or addition to systems, structures, components, or design of a plant or a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct, or operate a plant or a facility.

Becquerel Bq The unit of radioactivity in which one nucleus decays per second.

Condensate storage tank A tank containing water used for a reactor's cooling systems.

Condensate water transfer pump The pump for water from the condensate storage tank.

Containment vessel The gas-tight shell around a nuclear reactor.

Core damage Damage to the central part of the reactor that contains the fuel and produces heat.

Defense-in-depth The practice of having multiple, redundant, and independent layers of safety systems to safeguard the reactor core.

ECCS Emergency Core Cooling System

ERSS Emergency Response Support System – a system of information sharing between nuclear power plants and government agencies designed to facilitate a coordinated and effective response from the national government.

FEPC Federation of Electric Power Companies (Hokkaido Electric Power Co., Hokuriku Electric Power Co., Chubu Electric Power Co., The Chugoku Electric Power Co., The Okinawa Electric Power Co., Kyushu Electric Power Co., Shikoku Electric Power Co., The Kansai Electric Power Co., Tokyo Electric Power Co. and Tohoku Electric Power Co.) – A federation of the ten privately owned electric power utilities created in 1952 to facilitate communication and cooperation between them.

Filtrate tank Part of the water injection backup line of the plant, connected by a pump to the water tank that draws from Sakashita dam.

gal A unit of acceleration defined as one centimeter per second squared.

hardened vent A separate vent pipe designed to withstand higher loads during an accident such as a station blackout, and routed to an elevated point outside the reactor building.

HPCI High pressure coolant injection system - the first line of defense in the emergency core cooling system. HPCI is designed to inject substantial quantities of water into the reactor while it is at high pressure so as to prevent the activation of the automatic depressurization, core spray, and low pressure coolant injection systems.

IAEA International Atomic Energy Agency - an international organization that seeks to promote the peaceful use of nuclear energy, and to inhibit its use for any military purpose, including nuclear weapons.

IC Isolation condenser – a heat exchanger located above containment in a pool of water open to atmosphere. In operation, decay heat boils steam, which is drawn into the heat exchanger and condensed; then it falls back into the reactor.

INES International Nuclear and Radiological Event Scale – a seven-level scale for assessing and communicating safety information regarding nuclear and radiological incidents.

JNES Japan Nuclear Energy Safety Organization – an incorporated administrative agency established to ensure safety in the use of nuclear energy, which works in conjunction with NISA.

Kantei The Prime Minister's Office - The building housing both the Prime Minister's official office and residence. In this report, "Kantei" most often refers to the Prime Minister and the ad hoc group on the 5th floor, which was responsible for the government's response to the accident.

LOCA loss of coolant accident – a mode of failure for a nuclear reactor that can result in core damage, unless it is mitigated by ECCS.

Make-up system A system used to add water to the reactor coolant system under normal operating conditions.

M/C High voltage metal-clad type switchgear - In an electric power system, switchgear is the combination of electrical switches, fuses or circuit breakers used to control, protect and isolate electrical equipment.

METI Ministry of Economy, Trade & Industry

MEXT Ministry of Education, Culture, Sports, Science, and Technology.
Millisievert mSv A unit of equivalent radiation dose.
NAIIC Nuclear Accident Independent Investigation Commission
NISA Nuclear and Industrial Safety Agency – a government regulatory agency under METI.
NSC Nuclear Safety Commission of Japan – a government administrative body under the Cabinet Administration Office (CAO) that oversees the regulators and the operators.
PBq PetaBecquerel. 10^{15} Bqs.
Reactor A device in which a fission chain reaction can be initiated, sustained and controlled.
RCIC Reactor core isolation cooling system – RCIC is a feedwater pump meant for emergency use. It is able to inject cooling water into the reactor at high pressure.
SBO Station blackout – a complete loss of alternating current electric power to the station.
SCRAM Safety Control Rod Axe Man – Rapid shutdown of a nuclear reactor where fission is halted by inserting control rods into the core.
Shelter-in-place order An order to take immediate shelter in a location readily accessible by sealing it off from outside contaminants and shutting off all air circulation systems. For many residents this meant their own houses.
SPEEDI System for Prediction of Environmental Emergency Dose Information
SR Safety relief valve – a safety device designed to protect a pressurized vessel or system during an overpressure event.
TEPCO Tokyo Electric Power Company, the operator of the Fukushima Daiichi Nuclear Power Plant
Venting A system designed to vent accumulated hydrogen gas in the reactor buildings.
Yield strength Yield strength is the stress beyond which a specified amount of permanent deformation of a material occurs.
480V bus cross-tie breaker A cross-tie breaker is a connection between electric power systems by means of which each can interchange power with the other.

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Notes

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Fukushima Nuclear Accident
Independent Investigation Commission

Notes

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