Collection of Lessons Learned from the Fukushima Daiichi Accident

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Japan Nuclear Safety Institute

Contents

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Reclassification of Lessons and Other Wisdom Gained from the Fukushima Daiichi Nuclear Power Station Accident and Construction of a Search System

－Focusing on Facility Operation－

1. Introduction

It has been 10 years since the Fukushima Daiichi Nuclear Power Station accident (“the accident”) and nuclear power stations have been striving to make many improvements not only to their facilities, but also in their operations.

JANSI was established in 2012 with the purpose of encouraging operators’ efforts to voluntarily and continually engage in safety enhancement activities. JANSI has worked to reflect lessons that we have learned so far from the accident in voluntary safety efforts.

In marking the 10th year since the accident, JANSI decided to prepare this publication, which is based on lessons extracted so far, to help users easily verify and utilize relevant cases and matters indicated among the tremendous volume of reports compiled about the accident. This will allow operators to routinely learn and actually apply the lessons of the accident. JANSI has reclassified the lessons from the various reports and other publications, which were released after the accident, and constructed a search system that traces back to the actual events and facts upon which the lessons are based.

In this reclassification of lessons learned, JANSI has drawn upon the seven areas presented in the Chairperson’s Remarks of the Final Report of the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company (“Japanese Government’s Investigation Committee Report”) that serve here as seven facets of knowledge for re-examining what has been learned from a broader perspective. These seven facets of knowledge apply not only to nuclear power, but may also be regarded as an arrangement of universal elemental knowledge. It is hoped that use and application of the seven facets will have the following effects.

① To serve as a foundation when reclassifying lessons relating to facility operation.

② To provide a uniform organization no matter what lessons or matters have been pointed out in any report.

③ To enable a systematic arrangement in a manner current not only for the nuclear industry, but other industries as well.

JANSI has reclassified and organized all available material and data into seven facets of knowledge (classified for convenience into eight categories), 23 lessons learned, 71 precepts, as well as 175 related attachments and 7 appendices compiled into a database on the accident.

In addition, two search guides were prepared: one that enables users not only to find the knowledge, lessons, and precepts, but also go back to pinpoint the events and facts upon which these are based, and another allowing users to identify the actual relevant documentation. The former is searchable using the No. or keyword of the relevant Q, knowledge, etc.. The latter is searchable by document title to find the actual document (both

full text and excerpts).

As progress is made in clarifying facts, additional lessons will likely be learned. It is also conceivable that, as we take a fresh perspective in examining documents referenced here as well as other documentation, we may discover additional lessons to be learned. The search system will need to be continually improved as well.

2. Overview

Based on the 7+1 facets of knowledge, 71 precepts were extracted. These 71 precepts have been classified and organized into 23 lessons.

Looking at these 23 lessons and 71 precepts, one again realizes that each and every one of these is reasonable, natural, proper, and familiar. In the process of arranging these lessons and precepts, a solid realization emerged that “if ordinary tasks or work are not performed on a daily basis, then ordinary tasks or work can never be executed in an emergency.” The solution is “to simply practice the ordinary on a daily basis and continually train to carry out such work in preparation for an emergency.” Still, many barriers are present in organizations to doing ordinary things. It should be clearly understood that it is difficult to establish such a practice unless the organization’s top leader, executives, mid-level management, and practitioners share a common understanding that ordinary tasks should be properly done.

While it is a given that the Fukushima Daiichi Nuclear Power Station accident must never be repeated, the lessons learned from this accident are not necessarily specific to nuclear power. Again, there is a sense that everyone engaged in any of the many industries working with hazardous materials should find these values worthy of consideration.

When using this collection of lessons for training power station personnel, it should be kept in mind that staff must not memorize these lessons in the belief they are correct as dictated. Even though lessons appropriate to a variety of circumstances have been arranged in a searchable format and it is hoped that progress will be made in utilizing these lessons, it is important for individuals to think for themselves about what course of action should be taken so that they can acquire and demonstrate resilience and adaptability during an emergency. JANSI asks users to consider combining this collection of lessons with a variety of other training materials so that the lessons may be utilized in a balanced and unbiased manner.

3. Knowledge

Knowledge 1. Things that are possible happen. Things that are thought not possible also happen.

Commentary

Japanese Government's Investigation Committee Report (Final) Chairperson's Remarks pp. 444-445

(1) Things that are possible happen. Things that are thought not possible also happen.

【Excerpt】

The direct cause of this accident can be traced back to the fact that everything was built and operated based on the premise that "an extended station blackout will not happen." The mindset should be that "things that are possible happen." Furthermore, there is a need to be aware at the same time that phenomena that are not even adequately recognized – in the sense that "we consider it impossible" – can happen as well. To put it another way: "Phenomena that have never even been thought about can also happen."

【Full text】

The direct cause of this accident can be traced back to the fact that everything was built and operated based on the premise that "an extended station blackout will not happen." However, by rights the mindset should be "things that are possible happen." In February 2012, after this Investigation Committee had compiled its Interim Report, an international meeting with participation of the foreign experts was held. At that meeting, experts from France and other countries pointed out that in the nuclear power sector "you have to think that the improbable may also happen (improbable est possible)." In considering what sorts of things should be thought about, the most important point is to think based on experience and logic. This involves learning about incidents and experiences that have taken place in the past both at home and abroad and considering all the elements involved, to discover the things that could logically occur. The fact that something has a low probability of occurrence does not mean it will not occur. It is a mistake to believe that events with a low probability of occurrence or events that are not established as knowledge do not need to be considered and that responses to them do not have to be made.

Furthermore, there is a need to be aware at the same time that phenomena that are not even adequately recognized – in the sense that "we consider it impossible" – can happen as well. To put it another way: "Phenomena that have never even been thought about can also happen."

□ **Key sentences**

□□ The direct cause of this accident can be traced back to the fact that everything was built and operated based on the premise that "an extended station blackout will not happen."

□□ This involves learning about incidents and experiences that have taken place in the past both at home and abroad.

□□ and considering all the elements involved, to discover the things that could logically occur.

□□ It is a mistake to believe that events with a low probability of occurrence or events that are not established as knowledge do not need to be considered and that responses to them do not have to be made.

Knowledge 2. You cannot see things you do not wish to see. You can see what you wish to see.

Commentary

Japanese Government's Investigation Committee Report (Final) Chairperson's Remarks p. 445

(2) You cannot see things you do not wish to see. You can see what you wish to see.

【Excerpt】

When people see and think about things, they tend to view only what they themselves consider agreeable and only the course they are trying to take; they cannot see things they do not want to see or things that are inconvenient. There is a need to be constantly self-aware that one's views are biased not only by one's own interests but by the various influences of the organization, society and the times that surround one, and to be conscious that something is always overlooked.

【Full text】

When people see and think about things, they tend to view only what they themselves consider agreeable and only the course they are trying to take; they cannot see things they do not want to see or things that are inconvenient*. The impact of this kind of human psychology can be glimpsed in TEPCO's natural disaster preparedness, which were not outfitted with AM measures for tsunami, and did not provide for a situation involving a simultaneous and complete loss of power at several reactor facilities. To prevent situations like this, there is a need to be constantly self-aware that one's views are biased not only by one's own interests but by the various influences of the organization, society and the times that surround one, and to be conscious that something is always overlooked.

This is even applicable to this Investigation Committee's reports. This Committee has not shed light on the complete picture of the Fukushima NPS accident – it is simply one milestone on the road to clarifying the facts of the accident. I do urge that the people striving to clarify the causes of the Fukushima NPS accident carry out follow-up checks from here on to see if there were omissions or errors, and based on those findings make ongoing efforts toward further clarifying the facts and preventing accidents.

* In Volume III, Chapter 18 of the "The Gallic Wars," Julius Caesar's account of the successful ploy waged by his legate Sabinus against the Veneti, Caesar wrote that "fere libenter homines id quod volunt credunt" ("Men readily believe what they want to believe"). This phrase has been liberally translated as "people only see what they themselves want to see" or "people only see what they desire and want to see" and has come to be known as one of Caesar's maxims.

[Supplement] AM: Accident management

□ Key sentences

 [t]hey tend to view only what they themselves consider agreeable and only the course they are trying to take; they cannot see things they do not want to see or things that are inconvenient*.

 …there is a need to be constantly self-aware that one's views are biased…and to be conscious that something is always overlooked.

Knowledge 3. Assume to the extent possible and make full preparations.

Commentary

 Japanese Government's Investigation Committee Report (Final) Chairperson's Remarks pp. 445-446

(3) Assume to the extent possible and make full preparations.

【Excerpt】

It is vital to take preventative measures for accidents and disasters by constantly reviewing what is possibly assumable, without adhering tenaciously to assumptions made at a previous point in time. It is likewise essential to make adequate preparations based on the mindset that circumstances that have not even been thought of up to now can occur.

【Full text】

It is important to assume to the extent possible and to prepare fully. It is also necessary to acknowledge the possibility that things may happen that have not even been thought of and make provisions so that they do not reach the point of becoming worst-case scenarios. In the Fukushima NPS accident, the result of investigations show that substantial provisions had been made against earthquakes and it was not possible to confirm that key facilities had stopped functioning as a result of the earthquake itself, but it is conceivable that because preparations were not in place for a scenario in which the site was struck by a tsunami that exceeded assumptions, responses to the situation could not be made, and this resulted in the major accident. If new knowledge – even if not fully confirmed – had been taken on board, with tsunami assumptions revised and adequate preparations made accordingly, or if adequate preparations had been made for the advent of unforeseen circumstances, there is a possibility the situation would not have escalated into a major accident of this level.

It is easy to say things like this in hindsight, but extremely difficult to adopt this mindset at a time when nothing is actually happening. Nonetheless, it is vital to take preventative measures for accidents and disasters by constantly reviewing what is possibly assumable, without adhering tenaciously to assumptions made at a previous point in time, such as at the design stage. It is likewise essential to make adequate preparations based on the mindset that circumstances that have not even been thought of up to now can occur.

- Key sentences
  - It is important to assume to the extent possible and to prepare fully. It is also necessary to acknowledge the possibility that things may happen that have not even been thought of and make provisions so that they do not reach the point of becoming worst-case scenarios.

Knowledge 4. Creating a framework alone does not mean it will function. Frameworks can be constructed but goals not collectively shared.

Commentary

Japanese Government's Investigation Committee Report (Final) Chairperson's Remarks

(4) Creating a framework alone does not mean it will function. Frameworks can be constructed but goals not collectively shared.

【Excerpt】

Operators, regulatory-related institutions and regional municipalities had each created frameworks to respond to nuclear accidents in a formal sense, but when an accident ultimately occurred those responses were found to be flawed in places. Conceivably, that was because the members of those organizations were not fully conscious of what those frameworks' goals were, and what they had been entrusted with by society. It is necessary to create an atmosphere in which each member of an organization is constantly thinking about what they have been entrusted with by society, what position they occupy in the organization overall, and how their job affects the organization overall.

【Full text】

Operators, regulatory-related institutions and regional municipalities had each created frameworks to respond to nuclear accidents in a formal sense, but when an accident ultimately occurred those responses were found to be flawed in places. Conceivably, that was because the members of those organizations were not fully conscious of what those frameworks' goals were, and what they had been entrusted with by society. Without creating an environment in which each member is conscious of what they have to do as a personal issue, even if a framework is created it will not function as one whole. That is because its goals are not collectively shared. The fact that SPEEDI's system, constructed for times of emergency, was not used for the evacuation strategy is most certainly an example of this.

In order to ensure sharing goals by all members of an organization, it is necessary to create an atmosphere in which each member is constantly thinking about what they have been entrusted with by society, what position they occupy in the organization overall, and how their job affects the organization overall. Furthermore, education and training are needed in order to maintain that atmosphere. Social management must be undertaken to ensure that each member is precisely aware of the matters that society has entrusted them with.

Key sentences

- Without creating an environment in which each member is conscious of what they have to do as a personal issue, even if a framework is created it will not function as one whole. That is because its goals are not collectively shared.
- In order to ensure sharing goals by all members of an organization, it is necessary to create an atmosphere in which each member is constantly thinking about what they have been entrusted with by society, what position they occupy in the organization overall, and how their job affects the organization overall.
- Furthermore, education and training are needed in order to maintain that atmosphere. Social management must be undertaken to ensure that each member is precisely aware of the

matters that society has entrusted them with.

Knowledge 5. Everything changes, respond flexibly to changes.

Commentary

Japanese Government's Investigation Committee Report (Final) Chairperson's Remarks pp. 446-447

(5) Everything changes, respond flexibly to changes.

【Excerpt】

When given conditions are considered to be fixed, then detailed and (superficially at least) commendable responses are possible. However, given conditions are constantly changing, and unless responses that meet those changes are constantly sought out, they become inconsistent with the actual circumstances. The only way is to consider that all matters will change, pay scrupulous attention to observation, show humility in being open to external ideas, and continue to respond appropriately.

【Full text】

When given conditions are considered to be fixed, then detailed and (superficially at least) commendable responses are possible. However, given conditions are constantly changing, and unless responses that meet those changes are constantly sought out, they become inconsistent with the actual circumstances. For example, as a result of progress that had been made in investigative research on earthquakes and tsunami, a theory had emerged that it was possible an earthquake and tsunami on a larger scale than had previously been considered could occur off the coast of Fukushima Prefecture. Those concerned were aware of this new theory, and had taken measures of sorts, but from the standpoint of preventing the disaster, ultimately those measures came up short. From here on, the only way to stop situations such as this from happening is to consider that all matters will change, pay scrupulous attention to observation, show humility in being open to external ideas, and continue to respond appropriately.

- Key sentences

  - [G]iven conditions are constantly changing, and unless responses that meet those changes are constantly sought out, they become inconsistent with the actual circumstances.
  - [T]o consider that all matters will change, pay scrupulous attention to observation, show humility in being open to external ideas, and continue to respond appropriately.

Knowledge 6. Acknowledge that risks exist, and create a culture in which it is possible to debate the risks head on.

Commentary

Japanese Government's Investigation Committee Report (Final) Chairperson's Remarks p. 447

(6) Acknowledge that risks exist, and create a culture in which it is possible to debate the risks head on.

【Excerpt】

Asserting that risks should be completely excluded despite the fact that no-one is capable of foreseeing completely what type of situations may arise is dangerous in that it may lead to creating “a safety myth” in which the existence of unlikely risks is ruled out. Without creating a culture in which risks are acknowledged as risks, and in which it is possible to debate those risks head on, major risks end up being shrouded in a veil of safety and left unresolved.

【Full text】

Refusing to permit the existence of risks and reasoning that they should be completely excluded seems at a glance a sincere way of thinking, but on occasions this does not match reality. Asserting that risks should be completely excluded despite the fact that no-one is capable of foreseeing completely what type of situations may arise is dangerous in that it may lead to creating “a safety myth” in which the existence of unlikely risks is ruled out. Nuclear power has an extremely high energy density, and is essentially dangerous, yet it cannot be denied that in spite of that, attempts have been made to promote the use of nuclear power as an energy source with no risks in order to dispel society’s unease. Nuclear emergency response manuals were not equipped to deal with a large-scale disaster such as this one, and emergency response drills prior to the event were also insufficient, and in this and other ways the nuclear emergency preparedness was inadequate. There is no denying that the misguided perception that a major accident in which large quantities of radioactive material would be released could not happen at Japan’s nuclear power stations formed a backdrop to that inadequacy.

Denying the existence of risks will not only lead to a rigid mindset that becomes out of sync with the actual situation, it also makes it impossible to take the disaster-prevention and disaster-mitigation measures truly necessary. Trying to exclude risks completely generates unnecessary costs, and it also becomes impossible to discuss and carry out disaster-management measures in order to prevent damages from growing and alleviate their impact once risks end up becoming actualized. Without creating a culture in which risks are acknowledged as risks, and in which it is possible to debate those risks head on, major risks end up being shrouded in a veil of safety and left unresolved, and this is a pattern not limited to nuclear power.

That being the case, when examining one matter it becomes necessary to look directly and simultaneously at the benefits and risks it brings, and to make a judgment while undertaking a balanced consideration of those factors. At that point, if opposing ideas are negated and the matter in question is dealt with based on one side’s ideas alone without genuine debate taking place, the worst path will be followed. This severe accident demands that we Japanese change our mindset.

Key sentences

□□ Asserting that risks should be completely excluded…is dangerous in that it may lead to creating “a safety myth” in which the existence of unlikely risks is ruled out.

□□ There is no denying that the misguided perception that a major accident in which large quantities of radioactive material would be released could not happen at Japan’s nuclear power stations formed a backdrop to that inadequacy.

□□ Denying the existence of risks will not only lead to a rigid mindset that becomes out of sync with the actual situation, it also makes it impossible to take the disaster-prevention and disaster-mitigation measures truly necessary.

□□ Without creating a culture in which risks are acknowledged as risks, and in which it is possible to debate those risks head on, major risks end up being shrouded in a veil of safety and left unresolved, and this is a pattern not limited to nuclear power.

□□ [I]t becomes necessary to look directly and simultaneously at the benefits and risks it brings, and to make a judgment while undertaking a balanced consideration of those factors.

Knowledge 7. It is vital to be conscious of the importance of making decisions and taking action while seeing with your own eyes and thinking with your own head, , and vital to cultivate such faculties.

Commentary

Japanese Government's Investigation Committee Report (Final) Chairperson's Remarks pp. 447-448

(7) It is vital to be conscious of the importance of making decisions and taking action while seeing with your own eyes and thinking with your own head, and vital to cultivate such faculties.

【Excerpt】

In dealing with an accident or disaster that is beyond the scope of assumption, it is necessary to have an attitude of thinking for yourself in order to face up to a situation, and a flexible and active way of thinking. It will be important to undertake organizational management to boost qualities and faculties such as these during ordinary (non-emergency) times, along with carrying out training and drills.

【Full text】

In dealing with an accident or disaster that is beyond the scope of assumption and for which there is no manual to rely upon, the people concerned must consider the various possibilities based on the information each has at-hand, decide how they should deal with those possibilities, and take action. In this accident there were many cases in which inappropriate action was taken, but at the same time there were also a large number of cases in which people strove to overcome the situation using ingenuity and on-the-spot judgment, such as gathering together the batteries of cars in the vicinity and using them as an emergency source of power for operating measuring instruments in order to collect the minimum data in need. Responses such as this were made possible as a result of the people concerned thinking for themselves, making judgments and taking actions directed toward the outcomes they wanted to achieve. To make the optimum actions possible in a situation in which there is nothing to rely on, it is necessary to have an attitude of thinking for yourself in order to face up to a situation, and a flexible and active way of thinking. It will be important to undertake organizational management to boost qualities and faculties such as these during ordinary (non-emergency) times, along with carrying out training and drills.

□ Key sentences

□□ In dealing with an accident or disaster that is beyond the scope of assumption and for which there is no manual to rely upon, the people concerned must consider the various possibilities based on the information each has at-hand, decide how they should deal with those possibilities, and take action.

□□ To make the optimum actions possible in a situation in which there is nothing to rely on, it is necessary to have an attitude of thinking for yourself in order to face up to a situation, and a flexible and active way of thinking.

□□ It will be important to undertake organizational management to boost qualities and faculties such as these during ordinary (non-emergency) times, along with carrying out training and drills.

Knowledge 8. Other: Create an environment for employees to respond in an emergency. Make appropriate public statements and engage in appropriate public relations, and take care also when responding to overseas inquiries.

Commentary

This facet of knowledge could also have been incorporated into any of the preceding chapters. However, it is of a somewhat different nature from the perspective assumed in areas of technical expertise on-site. So, out of concern the significance of this knowledge might be lost in the details of the preceding chapters, it has been compiled into a separate Chapter 8.

4. Lessons

Lesson 1-1 (Preconditions, occurrence probability, and establishment of knowledge) (Serial no. 1)

Do not equate regulatory values and design values as conditions sufficient for ensuring safety, but verify design assumptions and history of the location site, and bear in mind that events exceeding the given conditions, events having a low probability of occurrence, and events for which knowledge has yet to be established may also occur.

Precepts

1-1-1 Periodically verify plant design requirements in relation to natural phenomena as well as preconditions about natural phenomena. (Precept 1)

Commentary: In order to understand the plant's safety limits, periodically verify design requirements of the plant in relation to natural phenomena as well as preconditions for natural phenomena used in design. In doing so, conduct an extensive and thoughtful exchange of views among specialized areas about the preconditions, relationship to hazards, and other aspects so as to share recognition of risks and link that to continuous improvement. Without realizing it, one might unexpectedly and at any time fall into the trap of assuming that the plant is safe. The operator bears primary responsibility for any accident and must not believe regulatory or design values to be conditions sufficient for ensuring safety.

1-1-2 Confirm the pre-plant construction topography and foundation as well as history of any disasters. (Precept 2)

Commentary: The pre-plant construction topography and history of the site has a considerable effect on plant design. Confirm the pre-plant construction topography and foundation as well as the history of any disasters to understand any environmental weaknesses of the location where the plant is built as well as gain greater insight into responses to natural phenomena.

1-1-3 Events with a low probability of occurrence as well as uncertain events do occur. (Precept 3)

Commentary: Events with a low probability of occurrence as well as uncertain events are things that actually do occur. If you close your eyes thinking that such events will not happen, that shuts down the thought process. It is important to consider what will happen if such an event arises. It is particularly necessary to bear in mind that natural phenomena entail tremendous uncertainty. Be aware of the uncertainties and anticipate cases where events with a low probability of occurrence or uncertain events happen so as to verify not only the frequency of core damage, but also whether or not there is potential for cliff edge effects. With regard to natural phenomena, superposition phenomenon needs to be fully understood. It is necessary to confirm whether it is possible that common factors in an internal event may simultaneously result in the loss of function of multiple components.

Lesson 1-2 (Learning from incidents and experiences) (Serial no. 2)

In order to respond to a variety of events, actively learn about past incidents and experiences, and analyze these on the assumption that they may also happen at your own plant. In addition, always pay attention to international trends as well as the latest knowledge, and link this information to safety improvements.

Precepts

1-2-1 Endeavor to acquire cutting-edge information about research relating to safety. (Precept 4)

Commentary: Endeavor to acquire cutting-edge information about research relating to safety. If opinions are divided, make a judgment about whether the matter is important from the perspective of safety. Although it is difficult to verify everything that is produced including research papers published by scholarly associations and other groups, it may be possible to efficiently obtain valuable information by forming tie-ups with research institutes.

1-2-2 Verify the appropriateness of recurrence prevention measures from multiple aspects. (Precept 5)

Commentary: Verify the appropriateness of recurrence prevention measures without being restricted only to the event in question, but by considering safety assurances from multiple aspects. Unless recurrence prevention measures are confirmed to be appropriate, reliably function, and lead to an overall reduction in risk for all conceivable assumptions, they may instead become a hindrance. One effective step is also to research international trends or, if necessary, conduct extensive discussions about important issues during international forums and on other occasions.

1-2-3 Extensively utilize your own company's experiences, other companies' experiences, and international safety trends in improvement activities. (Precept 6)

Commentary: In improvement activities, make extensive use of not only your own company's operating experiences, but also the operating experiences of other companies, including those in other countries and other industries as well as international safety trends. Nevertheless, it should be kept in mind that there are limits to disaster prevention measures that only take the form of preventing events from recurring.

1-2-4 Discern essential threats from cases experienced by other companies and analyze these realistically as if they may also happen at your own plant. (Precept 7)

Commentary: Discern essential threats to safety from among events that have occurred at your own company as well as other companies, and analyze these on the premise that they may also occur at your own plant. The essence of the Fukushima Daiichi accident was the loss of all power sources, which was caused by inundation due to the tsunami. When events occurred in other countries where flooding led to inundation that caused power supplied to be lost, it was believed that a tsunami exceeding expectations would not actually strike in Japan. Therefore, attention was unable to be turned toward looking for vulnerabilities that might result from inundation.

Lesson 1-3 (Assess risks logically) (Serial no. 3)

Endeavor to consider all sorts of elements about your own plant and logically detect possible risks.

Precepts

1-3-1 Employ workable assessment methods and conduct no-holds-barred comprehensive risk assessments. (Precept 8)

Commentary: Actively utilize assessment methods which are feasible at the current stage and conduct comprehensive risk assessments in which nothing is considered off-limits. Comprehensive risk assessments are a means of finding vulnerabilities in a plant and linking those to safety and disaster prevention measures, but comprehensive risk assessments are not used to promote the idea that risks are low. Also, safety goals are necessary for risk management. Confronting all risks, formulating safety and disaster prevention measures particularly in cases where these risks may bring about severe damage, and training to implement these measures may be able to eliminate or mitigate damage. This is risk management and it ultimately protects not just the organization and its members, but also the lives of residents in the community.

Lesson 2-1 (Attitude of confronting that which you do not want to see) (Serial no. 4)

Confirm what the limits of safety are in regard to uncertain events and those with a low probability of occurrence, including terrorism, and honestly accept the results of such assessments. Give priority to incidents where there might be significant damage, prepare effective countermeasures, and link those to preventing or reducing any damage that occurs.

Precepts

2-1-1 Confirm the limits of safety in relation to uncertain events and those with a low probability of occurrence, and implement countermeasures. (Precept 9)

Commentary: Confirm the limits of safety in relation to events involving uncertainty as well as those with a low probability of occurrence, and, if safety limits are exceeded, adopt some sort of countermeasures from the perspective of defense in depth. Uncertainty is inherent in natural phenomena and new knowledge, but, even so, it is important to discern the potential for a cliff edge effect. Performance goals need to be part of the quantitative safety targets for verifying safety limits and, in addition to core damage frequency, limits need to be also placed on radioactive material release amounts. Although everyone recognizes there is no assurance that incidents with a low probability of occurrence will not rise, human beings tend to think that such events will not happen.

2-1-2 Give priority to the extent of the damage and prepare effective impact mitigation measures. (Precept 10)

Commentary: Impact mitigation measures are effective for responding to a variety of unforeseen severe situations. Do not be inflexible in making determinations by turning on and off the reasoning typified in the statement: “Financially, the situation is difficult, so we are unable to afford the cost of paying for something that might never happen, or even if it does, is impossible to forecast the timing of.” Give priority to incidents where there is likely significant damage and consider effective impact mitigation measures. With impact mitigation measures, there are also cases where cost is not a substantial burden.

2-1-3 Honestly accept assessment results and link these to preventing and reducing any damage that might occur. (Precept 11)

Commentary: Honestly accept assessment results, and link these to preventing or reducing any damage that might occur rather than looking for reasons not to do anything. The effort of trying to find a variety of reasons to fit the results within the current safety assessment framework might turn out to be something that puts your organization’s very existence in question. In cases where assessment results are harsh, impact mitigation measures should, at the very minimum, be taken. From the perspective of disaster prevention as well as protecting the organization, it is important to confirm the limits of safety, prioritize incidents in terms of the magnitude of damage and difficulty of responding, and then make efforts to prevent or reduce any damage that might occur.

2-1-4 Coordinate safety and security measures to prepare for a terrorist attack. (Precept 12)

Commentary: The Fukushima Daiichi accident revealed the vulnerability of a nuclear

power plant to terrorism. Terrorism should be regarded as a reality, and dealing with internal threats is even more serious. Safety and security need to be coordinated and practical joint training also needs to be conducted with security authorities.

Lesson 2-2 (Development of a system for reducing omissions) (Serial no. 5)

Assume to the extent possible and, based on the concept of defense in depth, arrange systems, response procedures, facilities, and other aspects incrementally according to the assumed progression. Systematically develop practical procedures for responding as necessary during an emergency and construct an education and training system for shift crews and emergency responders to acquire emergency response knowledge and skills.

Precepts

2-2-1 Systematically prepare systems, response procedures, facilities and other elements based on the concept of defense in depth. (Precept 13)

Commentary: Even though a severe event may occur under any circumstances, anticipate its progression and systematically prepare systems, response procedures, facilities, and other elements in an incremental manner. Design basis events entail uncertainty involved in any assumptions, and preparations are needed to address events deviating from these. For management of a severe accident (Level 4), countermeasures need to be considered from a standpoint independent of Level 3 (design). Even though assumptions are made to the extent possible, there is the chance that these assumptions may be exceeded. However, practical applications will be feasible if we anticipate situations to the extent that they entail very severe assumptions.

2-2-2 Develop practical procedures systematically for responding as necessary during an emergency. (Precept 14)

Commentary: Systematically prepare practical procedures that are closely integrated with facility design for responding as necessary during an emergency. A system of practical procedures will serve as preparation for responding to events exceeding the design basis.

2-2-3 Construct a systematic education and training framework so that personnel may acquire knowledge and skills for emergency response. (Precept 15)

Commentary: Construct a systematic education and training framework for shift personnel and emergency responders to acquire emergency response knowledge and skills. The preparation of training materials as well as provision of training and exercises using a systematic approach will make it possible for personnel to develop the ability to respond to a variety of situations.

Lesson3-1 (Improvement of facility and system reliability) (Serial no. 6)

Improve the reliability of important facilities as well as telecommunication equipment so that, even if an unforeseen situation occurs, it will not turn into a worst-case scenario. Also, assess from multiple perspectives whether interlocks and other safety systems might not conversely increase risk.

Precepts

3-1-1 Consider waterproofing measures and inundation countermeasures when installing power sources and other important facilities. (Precept 16)

Commentary: Consider waterproofing measures and inundation countermeasures when installing power sources and other important facilities. At Fukushima Daiichi, despite being on a belowground level, power distribution panels, which had been installed in the basement and subbasement, as well as air intake louvers which were inundation pathways, and other facilities escaped being flooded if they had been installed higher than the flood level height. Also, do not forget the installation of waterproofing measures, portable power supplies, and other such measures and devices. When not only tsunami but also typhoons, storm surge, and other such severe natural phenomena are considered, inundation countermeasures are essential in cases where power supplies and other important facilities of a plant located along the coastline are installed on a belowground level. Also, just because something is on the first level (ground level) is not reason to feel at ease.

3-1-2 Enhance reliability by improving seismic performance, multiplexing, diversifying, ensuring independence, and other measures. (Precept 17)

Commentary: Enhance the reliability of systems, facilities, and equipment necessary during an emergency by improving seismic performance, multiplexing, diversifying, ensuring independence, and other measures. When enhancing reliability, improve the reliability of the system including related equipment as well. When multiplexing systems, there is a tendency to arrange the systems in positions subject to similar conditions. Placing equipment in similar conditions means creating vulnerabilities to common factors. Reliability is enhanced just by changing the level on which the facility or equipment is installed.

3-1-3 Diversify telecommunication systems and also consider measures for recovery of such systems. (Precept 18)

Commentary: Diversify telecommunications systems. Also, consider measures for restoring telecommunication systems during an emergency disaster. Ensuring the means to communicate during a disaster is a top priority. Telecommunication systems may be diversified using pagers, landline telephones, mobile phones, PHS, VHS radio handsets, and other tools, but we tend to forget to consider recovery methods. It is also necessary to develop communication systems and other tools for use when wearing full face masks.

3-1-4 From multiple perspectives, assess whether any risks are present in safety systems. (Precept 19)

Commentary: Assess safety systems from multiple perspectives, considering whether there are any blind spots in safety systems as well as whether interlocks, valves, and

other features installed for the benefit of safety conversely increase risk. Verify premises assumed in safety systems and prepare the necessary impact mitigation measures along with multiplexing and diversifying.

Lesson3-2 (Meticulous formation of facilities in preparation for the worst) (Serial no. 7)

Ensure a diverse range of options for emergency response by securing a full complement of spare parts, preparing various adapters for effectively utilizing support facilities, arranging facility formations in which the operation of key systems as well as checking of key parameters is possible by human power, among other efforts.

Precepts

3-2-1 Provide a full complement of spare parts and prepare various adapters for effectively utilizing support facilities. (Precept 20)

Commentary: Put in place procedures to present requests early on with outside entities for assistance. Along with securing a full complement of spare parts, ensure versatility by also preparing adapters for electrical, water, air and other connections to efficiently utilize support equipment provided from outside. It would be very regrettable if such equipment is provided by external support but is unable to be used because no connecters are available. It is important to make sure diverse options are available during an emergency. Also, appropriately implement maintenance management, even for facilities and components used during emergencies.

3-2-2 Establish a structure so that human beings are able to operate important valves and monitor key parameters during an emergency. (Precept 21)

Commentary: Develop a structure so that human beings are able to operate important safety solenoid valves, air-operated valves, as well as monitor key parameters, and take measures, such as placing air cylinders and other necessary equipment and materials nearby. Properly keep in mind that, in the end, there will be no choice but to have these items operated manually by human beings. Also, structure a facility formation that is equipped with functions such as maintaining equipment open or closed. Training also needs to be continuously conducted using emergency scenarios in order to decrease human error.

Lesson3-3 (External monitoring as well as firm securing and decentralized management/control of external facilities) (Serial no. 8)

Be able to quickly verify any external abnormalities. Also, decentralize the management of and firmly secure fire engines, portable equipment, heavy equipment, and other items necessary during an emergency as well as facilities outdoors.

Precepts

3-3-1 Strengthen the emergency response headquarters' external monitoring functions and functions for verifying media coverage. (Precept 22)

Commentary: The emergency response headquarters is a sealed room, so install ITV cameras capable of confirming tsunami arrival and other situations as well as TVs allowing for confirmation of media coverage. The ability to directly verify the arrival of a tsunami is effective in an environment cut off from the outside world. Also, if personnel are unable to go out of the headquarters, it may also be possible that they learn about damage for the first time through TV broadcasts.

3-3-2 Securely fasten outdoor facilities and decentralize management of heavy machinery and other items outdoors. (Precept 23)

Commentary: Anchor equipment outdoors securely to prevent it from falling over due to earthquake or floating away in a tsunami. So that fire trucks, portable facilities, heavy equipment, and other items, which are set up outdoors and necessary during an emergency, can be accessed by multiple routes, do not assemble all such items in one location, but distribute and manage them in a decentralized manner. Also, take measures for resupplying fuel.

Lesson3-4 (Training to be able to respond to unforeseen situations) (Serial no. 9)

Conduct training in difficult scenarios and severe conditions. Also, establish a support system in advance with relevant institutions so that support may be effectively utilized.

Precepts

3-4-1 For training, make use of severe scenarios, such as complex disasters, multiple simultaneous disasters, etc. (Precept 24)

Commentary: Plan training using complex disasters, multiple simultaneous disasters, and other severe scenarios, and verify to what extent such disasters can be responded to using human power. It is also conceivable that there may be a failure or loss of function due not to a single failure, but to multiple simultaneous failures or common factors. Also, experts and real-time updatable predictive analytics tools are also necessary for training in order to correctly comprehend and predict conditions in severe situations.

3-4-2 For training, develop rigorous configurations, such as a station blackout, loss of computer function, etc. (Precept 25)

Commentary: Conduct training in rigorous environmental conditions, such as in the dark cut off from AC and DC power, as well as scenarios where computers are unable to be used. Also, conduct training that entails a high degree of difficulty, such as intentionally conveying inaccurate conditions. At ordinary times, using computers is akin to breathing air. There may also be cases where personnel do not even realize how dependent they are on computers.

3-4-3 In training, assume a variety of obstacles arise during an emergency. (Precept 26)

Commentary: Although emergency work is necessary to bring a severe accident to resolution, a variety of obstacles develop that hinder emergency work when a natural disaster or a large-scale accident occurs. To overcome various obstacles to executing and performing emergency work, there is no other way but to repeatedly conduct training using scenarios in which impediments are configured, such as intentionally conveying confusing information, and incorporating delays due to such obstacles.

3-4-4 If part of an organization does not function in the emergency response framework, replace the missing entity. (Precept 27)

Commentary: During the Fukushima Daiichi accident, off-site centers did not function and this created considerable confusion. In responding during an emergency on-site, crises are thoroughly managed so that the members of each team of the emergency response system are able to assemble without fail in the day-to-day management structure. But, in preparation for a situation where part of the organization goes missing, select personnel, coordinate, and train continuously so that backup teams may be formed and respond by creating flexibility in the membership of each team.

3-4-5 Agree on a support structure with relevant organizations that includes the specific details of support to be provided during an emergency, support procedures, transport processes, and other elements. (Precept 28)

Commentary: In the case of a nuclear accident, there is a risk of obstacles arising, such

as the refusal to transport goods to areas contaminated by radiation as well as the inability to exit contaminated areas. Form agreements with relevant organizations about a support structure, including the specific support to be provided during an emergency, support procedures, transport processes, and other elements. Nevertheless, in cases where an accident is combined with a natural disaster, situations may be anticipated that make it difficult to bring in equipment and materials for support from outside the area, and training is necessary assuming scenarios of isolation and helplessness where, from the onset of the accident, support is unable to be expected from outside or public fire departments.

3-4-6 Construct a system for receipt of relief supplies that sorts necessary materials and delivers them to local sites. (Precept 29)

Commentary: During an emergency, there is a rush of relief materials and support accepted from both inside and outside the country. A system for receiving relief supplies needs to be constructed that does the work of declaring what is needed, sorting necessary items from the relief supplies, and making sure these are delivered to local sites. It is important that this type of work is coordinated with local sites, so such a framework needs to be constructed in advance, which will allow personnel responding to the accident to concentrate on bringing the accident under control.

Lesson3-5 (Operations with crisis management in mind) (Serial no. 10)

During an emergency situation, anticipate crisis management even for one operation and ensure alternative measures. In addition, understand the significance of procedures and do not follow written procedures blindly, but appropriately apply the procedures and take action.

Precepts

3-5-1 Conduct training where alternative measures are first secured and then the switchover operation executed. (Precept 30)

Commentary: Predict that an unforeseen situation might occur and conduct training where alternative measures are first secured and then a switchover operation carefully executed. Executing a switchover operation is a means, not an objective. It is important that the objective be achieved even if an unforeseen situation occurs and securing alternative measures is significant.

3-5-2 Even in normal times, understand the significance of procedures and operations, appropriately apply these, and take action during an emergency. (Precept 31)

Commentary: Not understanding the significance of operations and implementing steps according to the procedures during an emergency is likely to lead to a major error. Even in normal times, conduct education and training that anticipates emergencies. If operators are familiar with operations during normal times, they may be able to perform the same operation even during an emergency. In situations where presuppositions are completely different from those held during normal times, the result could be fatal.

Lesson 4-1 (Members' awareness) (Serial no. 11)

Construct a system for training the personnel in whom society places its trust and increase incentives for improving skills. Each member also needs to be aware of his or her own role during an emergency, share objectives and basic policies, and take responsibility for responding.

Precepts

4-1-1 Conduct training in which trainees cope with scenarios while sharing objectives and confirming basic policies. (Precept 32)

Commentary: An emergency situation where a variety of events take place one after another is a situation where responders are overwhelmed with the work right in front of them. Training is necessary in which personnel deal with scenarios while sharing objectives and confirming basic policies so that they are able to make judgments and act calmly even during an emergency. If responders are aware of objectives and policies, the likelihood is lessened that they will confuse priorities or degrees of importance even if external disturbance arises.

4-1-2 Training and competency evaluation systems are needed for understanding facilities and systems. (Precept 33)

Commentary: So that personnel are able to properly understand plant behavior as well as properly apply that knowledge and take action during an emergency, training systems are needed for them to gain an essential understanding of facility and system functions. In addition, it is necessary to have transparency in guidelines used in training as well as the qualification system under which operator personnel are commonly evaluated (for station superintendent, operations officer, chief reactor engineer, etc.).

4-1-3 Understand your own obligations, be aware of the weight of the responsibility, and take responsibility for your duties. (Precept 34)

Commentary: Build awareness so that all personnel in the emergency response system maintain a strong sense of responsibility for fulfilling their duties. All personnel should understand their own obligations, be aware of the weight of that responsibility, and maintain a strong sense of responsibility in executing their duties. Also, if people who have not undergone training join the emergency response headquarters, it is necessary to teach them what their minimum obligations are.

4-1-4 Each functional team surveys the situation to gain an overall understanding and executes the necessary support operations in coordination with other teams. (**Precept 35**)

Commentary: Each functional team of the emergency response framework endeavors to perform its duties, and surveys the situation to gain an overall understanding, arrays the role of its own team within that context, and executes necessary support operations. Although there are inevitably organizational aspects that must be differentiated according to specialization, when the top leader issues directions not specified in provisions during an emergency, that individual shall make clear not just the details, but also the division of responsibility, and each functional team shall actively cooperate and coordinate so that no weaknesses manifest in the vertical compartmentalized structure of specialization.

Lesson4-2 (Division of roles between on-site headquarters and support organizations) (Serial no. 12)

In making judgments relating to matters concerning the on-site response, give high regard to the judgment of on-site personnel. The roles played by the head office and other support organizations are to respond to requests for support from the field, and, from a relatively calm perspective, monitor and assess changes and developments, as well as provide appropriate advice and support.

Precepts

4-2-1 Clarify that judgments about matters concerning the on-site response are to be entrusted to on-site personnel. (Precept 36)

Commentary: Put in place a framework that expressly specifies judgments about matters extremely relevant to the on-site response shall be entrusted to on-site personnel. Support organizations away from the site must not act in a way that holds back the on-site teams. Only in cases where the head office or another support organization deems the on-site response to be inappropriate or inefficient should such organizations communicate necessary measures to the site. Otherwise, these organizations will cause confusion on-site in a way that serves no purpose.

4-2-2 In good faith, on-site personnel shall judge the situation and execute actions to be taken. (Precept 37)

Commentary: Only personnel on-site have the capability to comprehend conditions in the field. Share the recognition that the site calmly grasps the degree of urgency, makes judgments in good faith about the situation, and, while sharing that recognition with support organizations as needed, executes the actions that should be taken. The personnel on-site need the firm conviction to simply dismiss irresponsible intervention from outsiders.

4-2-3 Clearly define the roles of support organizations. (Precept 38)

Commentary: Clarify that the roles of support organizations are to respond to requests for support from the site, take an overall bird’s-eye view of the response carried out by on-site teams, monitor and assess changes and developments from a comparatively calmer perspective, as well as provide appropriate advice and support. If support organizations try to do everything as the personnel on-site are doing, then the support organizations will be unable to fulfill their primary duty. In addition, a support framework is needed that reviews predictions about how the accident might escalate and subsequent countermeasures in a manner separate from on-site teams and the head office response headquarters.

Lesson4-3 (The job of the top individual in the hierarchy) (Serial no. 13)

The top leader and executives establish an effective accident response base, and promptly implement measures in emergency situations that enable the organization to function in accordance with priorities. Also, when multiple emergency events occur, authority is delegated, dividing up the chain of command to put in place a flexible system that allows the top leader to think broadly about the situation and circumstances. The effectiveness of such a system is verified through training.

Precepts

4-3-1 The top leader and executives give priority to measures that enable the organization to function during an emergency situation. (Precept 39)

Commentary: The top leader and executives should clearly understand the standards based upon which the organization is committed to accident management and make their top priority enabling the organization to function once the shift is made to accident management. They must not be concerned with their own sense of personal satisfaction, nor overlook any stagnation in measures that allow the organization to function. When an emergency arises, there tends to be a lack of information, but matters that need to be prioritized must be properly implemented.

4-3-2 The base/stronghold for the emergency response is to be effective in terms of both personnel and environment. (Precept 40)

Commentary: When an actual event occurs, there is no other option but to respond with the most effective system. The organization will simply not be able to do that when form is emphasized over substance, so construct a system that is realistic for times of emergency. The base from which the emergency response is deployed needs to be a location near the site. It must also be a location from which it is easy to find out what is happening on-site and information is easily attainable to the greatest extent possible. Also, people are needed who are understand actual conditions. It is necessary to employ this perspective to verify whether the emergency response system is realistic.

4-3-3 Authority is to be delegated to divide up the chain of command and allow the top leader to think. (Precept 41)

Commentary: When multiple emergency events take place, if responsibility is centered on one person, this presents limitations in the response as important matters will be missed. Delegate authority to flexibly divide the chain of command so as to construct a system that allows the top leader to think. Train repeatedly to verify the effectiveness of this system. Also, the authority and roles played by the chief reactor engineer need to be reassessed so that the station superintendent is able to make full use of the chief reactor engineer from a technical and specialized vantage point.

Lesson4-4 (Communication during an emergency) (Serial no. 14)

Personnel on-site and the emergency response headquarters share a consistent recognition by, among other efforts, utilizing common templates and communication tools. The teams on-site check with the emergency response headquarters about important safety operations that they will perform.

Precepts

4-4-1 Teams on-site check with the emergency response headquarters about operations that are very important in terms of safety. (Precept 42)

Commentary: Even with operations where judgments are left to the main control room, on-site teams check with the emergency response headquarters during an emergency situation about operations that are very important in terms of safety. There is the possibility a very important safety operation may determine the subsequent direction of the response, so such response needs to be prudent.

4-4-2 The on-site team (main control room) and on-site headquarters properly share their recognition and understanding. (Precept 43)

Commentary: In an emergency, the on-site team (main control room) and on-site headquarters share a consistent recognition and understanding. If a misunderstanding emerges about how an important safety facility is perceived, this could result in a serious situation. Effectively using templates and embedding outside responders in the shift teams are regarded as ways to share recognition. If an outside responder is there, the shift supervisor is able to concentrate on supervising the operators, and this ensures a timely, accurate, and continuous flow of information.

4-4-3 Be sure to utilize communication tools during an emergency. (Precept 44)

Commentary: Reliably perform basic communication actions during an emergency. Always try to engage in two-way communication at a minimum or add even more parties to communication channels during an emergency. This applies to responding by telephone, reporting, as well as checking on whether any faxes have arrived. Also, personnel should make it a point in their daily routine not to use misleading terms. As an example, a Japanese pronunciation of the term manual expressed as “shudo” as used to refer to a manual shutdown (“shudo teishi”) may be easily confused with the Japanese pronunciation of the term automatic “jido” as used in automatic shutdown (“jido teishi”), so personnel should make it a point to use the pronunciation “tedo” for manual rather than “shudo.”

Lesson 5-1 (Attitude toward accommodating new knowledge and environmental changes) (Serial no. 15)

To appropriately respond to and accommodate new knowledge and environmental changes, the top leader spearheads the commitment to fostering a safety culture. If a safety culture is created, personnel will pay close attention, watching for the discovery of new knowledge and changes in the environment, humbly listening to what others are saying, and responding appropriately.

Precepts

5-1-1 In cases where the impact of the latest knowledge or a change in environment is considerable, promptly link that to continuous improvements. (Precept 45)

Commentary: Strive to collect new knowledge and information about changes in the environment, assess the new knowledge and environmental changes from a holistic perspective, and, if the impact is considerable, do not put off implementing temporary or mitigating measures. After that, set about considering permanent measures. Even if new knowledge is gained, it will turn out to be meaningless if reasons are sought for not accommodating such new knowledge. Assess the magnitude of impact and link such assessments to continuous improvements in accordance with the level of priority.

5-1-2 The top leader conveys a strong commitment and utilizes reviews and other critiques provided by outside organizations in order to continually enhance safety. (Precept 46)

Commentary: The number one priority of the top leader is to recognize risks inherent in nuclear power and convey values that prioritize safety above all in a way that demonstrates the individual's own strong commitment. Also, since the Fukushima Daiichi accident, the top leader must make everyone throughout the entire organization aware that, since the accident, society has taken a stricter view of operators, and it is essential for operators not to be complacent and simply meet regulatory requirements, but strive to enhance safety and, moreover, incorporate reviews and other critiques by outside organizations into the framework for ensuring safety.

5-1-3 Each individual maintains a stance of questioning and learning, and creates an organization in which there is good communication. (Precept 47)

Commentary: To prevent accidents, build up the level of the safety culture within the organization and individuals. In addition to an organizational perspective, the roles and duties of each individual in the organization are also important for ensuring safety. Each individual maintains a stance of questioning and learning, humbly listens to what others say, and acquires a keen sensitivity to risks. It is important that the individual freely express his or her views within the organization so that those views are shared even with top management and appropriately addressed. Conversely, if you close your eyes to what is happening or try not to look at what is happening, then the company will eventually face a crisis threatening its very survival.

Lesson 6-1 (Culture where discussions can be held facing risks head on) (Serial no. 16)

Share disaster prevention plans and the existence of any risks in handling hazard materials or other such aspects with the community, and continually adopt necessary disaster prevention and reduction measures without succumbing to the safety paradox.

Precepts

6-1-1 Do not get caught up in a safety paradox, but strive to enhance safety. (Precept 48)

Commentary: There is a safety paradox in which the implementation of refinements leads to a negation of past safety. However, if considered from the viewpoint of the victim where one's own family lives in the area, then we find it natural that there be value afforded to enhancing safety rather than getting caught up in the safety paradox. Do not fall for this paradox with regard to safety, but place priority on enhancing safety.

6-1-2 Disaster prevention plans that take the community residents' perspective into account as well as asking the community for its understanding about the control of hazardous materials and other such aspects leads to a sense of satisfaction and security among community residents. (Precept 49)

Commentary: It is necessary to establish monitoring and other systems that are helpful for facilitating residents to safely evacuate. It is also necessary to clearly define the roles relevant organizations play in the community disaster prevention plan and gain the community's understanding. A community disaster prevention plan begins with sharing with the community the risks entailed in controlling hazardous materials. Hazardous materials are not simply confined in containers, but there are also cases where the containers in which such materials are placed rupture, resulting in a much more serious situation. Ask for the community's understanding, if necessary, so that hazardous materials may be properly handled. Discussions with the community lead to a sense of satisfaction and security among community residents.

6-1-3 In discussions about safety, eliminate the logic of numbers and the authority gradient within the organization. (Precept 50)

Commentary: As far as safety is concerned, there must not be a logic of numbers, nor an authority gradient within the organization. If there is an authority gradient or logic of numbers as concerns safety issues, then no one will attempt to consider safety seriously any longer. We should reflect on whether we ourselves have maintained that an authority gradient is a just and proper aspect of our organization.

Lesson7-1 (Adaptability to be able to respond to the unexpected) (Serial no. 17)

It is necessary to thoroughly understand the significance of systems and procedures and become more adaptable so as to quickly and nimbly make judgments and take action in response to unforeseen events, as well as possess the ability to manage that makes it possible to appropriately make use of such adaptability.

Precepts

7-1-1 Enhance inventiveness that goes beyond following procedures step-by-step. (Precept 51)

Commentary: There may also be cases of emergency work where environmental conditions make it such that no manual is able to be used as written. In such cases, adaptability is needed to be able to piece together several manuals to create a new manual. This adaptability needs to be enhanced by thoroughly understanding the significance of systems and the original manual procedures. This adaptability is not developed simply by following manuals and implementing procedures step-by-step.

7-1-2 Think quickly and nimbly, and make use of all available people and things. (Precept 52)

Commentary: In system design, an in-depth design will be required that extends even to the purview of management, and management will be called upon to address all areas of defense in depth. Particularly in cases where permanent systems no longer function, it will be necessary for management to think quickly and nimbly to make use of all available people and things. A comprehensive safety system is necessary that ranges from design to management, even including facility designs and portable equipment, that may be operated with physical strength so as to make use of the flexibility that human beings possess as well as ensuring communication tools and other aspects.

7-1-3 Stipulate in advance workarounds (management) for unexpected work. (Precept 53)

Commentary: Applied operations are naturally not part of procedures, so it is difficult for the on-site teams and emergency response headquarters to develop a common recognition and understanding about such operations. There are also cases where, unless a common understanding is manifest, efforts will also be delayed or become unsustainable. Although it may be sufficient in an emergency situation to use workarounds in responding when unforeseen work arises, the management of such cases needs to be stipulated in advance. Members (particularly the team leaders) of an emergency response framework must understand their own individual roles as well as the entire configuration, and provide appropriate information and support to the person in charge when such management is exercised.

Lesson7-2 (Reinforcement of resilience) (Serial no. 18)

Strengthen resilience by continually raising awareness of safety, arranging facility formations that can utilize the adaptability of people, implementing a system of following up throughout the organization, educating personnel to improve skills and knowledge, training under tense conditions, and other means.

Precepts

7-2-1 Train in a manner that contributes to making proper decisions in extreme situations. (Precept 54)

Commentary: Generally, the training that industry offers does not involve preparation for making life-and-death decisions, but the Fukushima Daiichi accident showed us that there are cases where people are forced to act in such a situation. In addition, even though instructions given in an extreme situation might be correct, there is always the possibility that the receiver may refuse to do what is directed. Decision-makers need the ability to calmly make determinations along with the strength of character to be trusted.

7-2-2 Link safety improvement activities carried out by each and every individual to continuous improvements. (Precept 55)

Commentary: Continuous improvement is what bolsters nuclear safety and each and every individual's awareness of safety needs to be raised to continuously make improvements. To raise each and every individual's awareness of safety, it is important to have activities that encourage employees' awareness of improving safety on a daily basis and make a steady effort no matter how small the measure may be. The Great East Japan Earthquake showed us that there is the slightest of margins between an event turning into a catastrophe or not.

7-2-3 Even in confusing situations, be sure to attend to important facilities within the context of the entire system. (Precept 56)

Commentary: Even though people are normally careful, they may forget things in confusing situations. Such a mistake in relation to an important system may prove to be fatal, and multi-tiered countermeasures are needed. If the main control room forgets, the emergency response headquarters must follow up and attend to the activities at hand, and if the emergency response headquarters forgets as well, the head office headquarters must follow up, too. Sharing the state of important systems within the entire framework and following up for other organizations becomes a solid step toward resolving the situation. Also, there are two ways of thinking about how to rank matters in order of priority: one is to prioritize responses for dealing with matters of great urgency and the other is to be sure to save that which is savable. In actuality, these are combined when responding to situations, but this is done on the assumption that personnel will be sure to keep abreast of important systems.

7-2-4 Bring out people's adaptability and enhance resilience through training. (Precept 57)

Commentary: The ability of human beings to adapt to situations is important when

seeking to address assumptions about the extent of what's possible. In normal times, engage in education and training integrating exercises to develop the ability to adapt so as to augment resilience. For example, it is necessary to establish a framework in which there are systems for delegating responsibility and authority according to how an event escalates, deploy systems including human-machine interface capable of utilizing human adaptability, foster a sense of mission among personnel, train to gain a profound understanding of facilities and the entire system, as well as conduct exercises in demanding scenarios and drills where a variety of obstacles emerge under rigorous conditions.

Lesson7-3 (Develop the temperament and ability to face emergencies) (Serial no. 19)

Develop the temperament and ability to appropriately grasp changing conditions and degrees of priority, and be able to overcome difficulties such as when special work is unexpectedly manifested in the severe and fluid conditions of an emergency.

Precepts

7-3-1 During an emergency, give priority to time factors and adopt a feasible means within the limited time. (Precept 58)

Commentary: If no more water is fed to the reactor, the temperature of the fuel rods will exceed 700°C in 2 to 3 hours and there will be a notable increase in the amount of hydrogen generated in the hydro-zirconium reaction. If water is supplied within 2 to 3 hours after feedwater ceases, it may be possible to prevent a core meltdown. Even if water continues to be fed to the reactor, preparations need to be made as the feedwater may shut down at any time. In such a situation where time is of the essence, it is important that the available means be employed within the limited time even if second-best. Even though a certain means may be functionally optimum, if too much is expected of such a means and time is required to verify conditions and implement the procedures, the situation may turn critical.

7-3-2 Prepare procedures for work that requires special skills and secure operation personnel. (Precept 59)

Commentary: In order to respond properly during an emergency, secure personnel possessing the skills and knowledge to operate heavy equipment and other special equipment by concluding contracts with partner companies, and construct a system for training employees. During a disaster, there are cases where work needs to be performed which employees do not ordinarily carry out. It is necessary to consider what sort of special skills are required to perform such work, prepare procedures for that work, and secure operation personnel.

7-3-3 To improve the ability to manage crises, repeatedly conduct training and verification premised on the assumption that a severe situation will actually arise. (Precept 60)

Commentary: The more severe a situation, the greater the probability for human error, and, without preparation and training, it will be difficult to appropriately respond to such situations. Recognize that the temperament and ability applicable to when a major severe accident arises is not something that may be developed in a short time during typical classroom training. Repeatedly conduct hands-on education, training, and verification that anticipates a severe scenario. Even if a severe situation is envisioned, if the scope is limited or an attitude taken that, for example, such a situation will not actually arise, then training or other activities will not improve the ability to manage crises.

7-3-4 Appropriately grasp changes in the environment and give priority to making sure that relevant personnel (within the company, country, and overseas) share information. (Precept 61)

Commentary: The central government response headquarters, head office headquarters, on-site headquarters and the field need to reliably share important information. Even in poor conditions for communication systems, appropriately grasp changes in the environment and give priority to making sure that information is shared. Sharing information reduces the possibility of misjudgments. Although basic, this is very important. In addition, the governments of other countries have an obligation to tell their own citizens residing in Japan about safety measures, and Japan has an obligation to communicate information to the governments of other countries. No matter what the situation is, the operator should actively endeavor to share information with the central government.

7-3-5 Anticipate changing conditions and prepare a system for sharing information that does not place a greater burden on teams in the field. (Precept 62)

Commentary: In a constantly changing environment, strengthen the monitoring system in anticipation of any changes, deploy liaison personnel for sharing information, and establish other such systems. In a situation where on-site teams are fully engaged in monitoring and operations, there is a tendency to postpone providing information to the response headquarters. Delays in sharing information make it impossible to stay ahead of any changes.

Lesson8-1 (Improvement of the working environment) (Serial no. 20)

Take measures to ensure the safety of employees supporting the emergency response and ascertain the safety of their families. In addition, establish a system that is also equipped for a prolonged response. This will ensure continuity of the recovery work.

Precepts

8-1-1 Protect employees from the disaster and do everything possible to bring the accident to a resolution with a long-term safety and health management framework. (Precept 63)

Commentary: Install handrails towards control panels, anchor furniture, personal computers and other equipment, prevent objects from falling from the ceiling, prepare helmets, and strengthen other countermeasures against earthquakes and other natural disasters as well as enhance the long-term safety and health management of employees. If personnel are critically injured, aspects of the emergency response will become more difficult to perform.

8-1-2 Establish a system in preparation for a prolonged response that includes water, food, hygiene maintenance, health management, and other such elements. (Precept 64)

Commentary: Establish a system in preparation for a prolonged response. For example, give consideration to establishing points where access is controlled for workers and supplies relayed, as well as measures for stockpiling and resupplying extra food and water according to the number of personnel on-site, including those who employed by partner companies. In addition, hygiene management, treatment of illnesses and injuries, and mental health care are also necessary. It needs to kept in mind that, when an emergency actually arises, there will be more people than previously anticipated gathering on-site.

8-1-3 When an emergency arises, ascertain the safety of the families of responders. (Precept 65)

Commentary: Construct a framework that maintains morale, such as ascertaining the safety of the families of responders when an emergency arises. Guidance that includes checking on the safety of families is particularly necessary to maintain morale of emergency responders permanently stationed on-site ever since the emergency arose.

Lesson8-2 (Public announcements) (Serial no. 21)

In public announcements, aim not to “convey information” but for information to “be conveyed” in a timely and accurate manner. Also, stipulate the manner in which prior approval is given in cases where urgency is of the essence.

Precepts

8-2-1 Focus on risk communication on a daily basis and aim, when making public announcements, for information “to be conveyed.” (Precept 66)

Commentary: In an emergency, appropriately communicate the facts so that people have a proper fear of the risks. Choose and supplement your words so that there is no misunderstanding. Think through to how what you say will be understood by the listener before you speak. Expressions that leave judgments up to the receiver are not appropriate. In addition, refraining from making public statements or embellishing facts under an excuse such as “it is necessary to do so in order to avoid confusion” will lead to a loss of trust, which is the most important thing to maintain. It is more important for information “to be conveyed” than “to convey” information, and it is particularly necessary to pay attention to statements that might be interpreted as evading responsibility. It is also important to practice risk communication on a daily basis so that information is properly conveyed.

8-2-2 Reach an agreement within the organization and among relevant organizations on improving the efficiency of preliminary understandings during an emergency. (Precept 67)

Commentary: In cases where conditions change from moment to moment, strive to communicate timely and accurate information. There may also be cases where urgency is of the essence, so efficiently obtain prior understanding internally or with other organizations. It is important to share information with upper organizations and relevant organizations. However, if all press releases need the prior consent of these organizations, there is a danger of creating a situation where urgent information concerning the health and lives of residents is unable to be immediately released publicly.

Lesson 8-3 (Public relations) (Serial no. 22)

Set a policy for accommodating visitors whose visit to the power station during an emergency is unavoidable.

Precepts

8-3-1 Minimize accommodation of visitors that are obligated to come to inspect or enter the station during an emergency. (Precept 68)

Commentary: In cases where inspections or visits during an emergency absolutely cannot be refused, have visitors understand their arrival is preconditioned on the assurance of safety so as to minimize accommodating visitors. In preparation for a visit that is unavoidable during an emergency, verifying in advance that a standard for accommodating such cases has been safety established will be useful in minimizing confusion during actual visits.

8-3-2 In cases of humanitarian public relations, place top priority on ensuring the safety of the visitors. (Precept 69)

Commentary: Cases may also be anticipated where humanitarian public relations are accommodated. In such a case, place top priority on ensuring visitors' safety and accommodate them flexibly. If a variety of scenarios are anticipated, staff will not be rushing around making preparations, so any impact on the emergency response may be minimized.

Lesson 8-4 (International relations) (Serial no. 23)

Understand international rules so that no international friction is created. Also, appropriately provide information to foreign governments.

Precepts

8-4-1 In cases where there are differences between international rules and national rules, ascertain clearly what those differences are. (Precept 70)

Commentary: If there are differences between international and national rules, then ascertain clearly what those differences are. Care needs to be taken as announcements by international institutions have an impact and are broadly cited in media reports as well as other publications and broadcasts.

8-4-2 Ascertain the necessary procedures regarding measures for dealing with hazardous materials and other events that might emerge as an international issue. (Precept 71)

Commentary: Ascertain in advance what sort of procedures are necessary as concerns events that could become an international issue. In normal times, there is a tendency to overlook international arrangements as not posing any particular issues, but a variety of activities will get underway outside Japan when a disaster occurs. Unnecessary confusion may be avoided by ascertaining international frameworks and methods for dealing with the hazardous materials in question.