Nuclear Safety Network (NSnet)
Otemachi Building #437
1-6-1 Ote-machi, Chiyoda-ku, Tokyo 100-0004
Tel: +81-3-5220-2666 Fax: +81-3-5220-2665
URL: http://www.nsnet.gr.jp

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Summary Report of Peer Review

(Provisional Translation)

Place of Review:	**Tokai Works, JAPAN NUCLEAR CYCLE DEVELOPMENT INSTITUTE (Tokai-mura, Naka-gun, Ibaraki)**
Date of Review:	**November 13-16, 2001**
Publisher:	**Nuclear Safety Network**

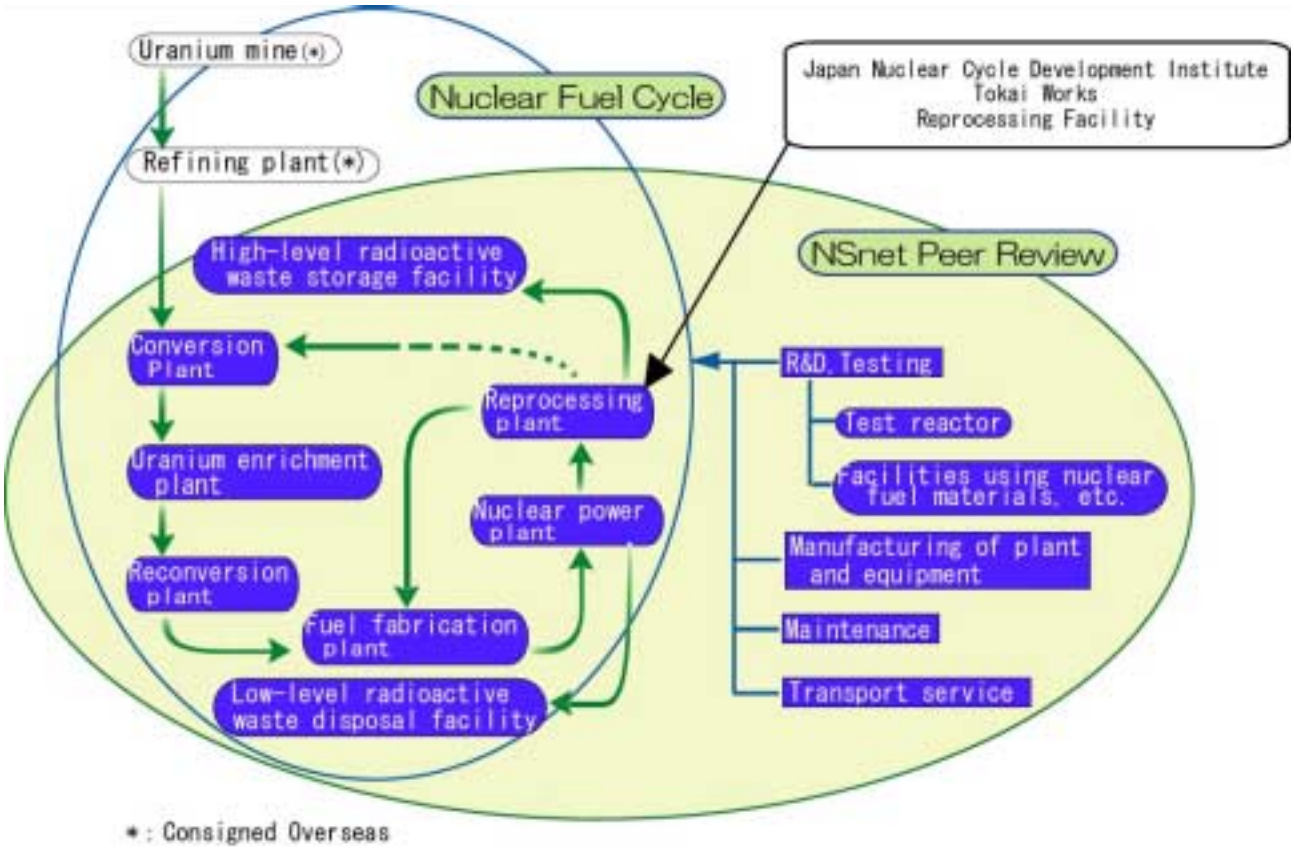
Contents

1. Objectives

The purpose of the NSnet peer review (hereafter referred to as the "review") is to achieve an improvement in the "safety culture" of the entire nuclear power industry by sending review teams of specialists to member facilities, where they conduct reciprocal evaluations on common nuclear safety subjects among members and share mutual knowledge of good practices as well as subjects that have been singled out.

2. Summary of Facility Operations

Japan Nuclear Cycle Development Institute (hereafter referred to as "JNC") was established in 1998 as an institute that plays a central role in technological development in establishing Japan's nuclear fuel cycle, as the successor to the operations of the Power Reactor and Nuclear Fuel Development Corporation established in 1967.



The position of Tokai Works in the nuclear fuel cycle

The Tokai Works, which was subjected to the review, has as a site area of approximately 1.11 million m^2. Its organization consists of the "Plutonium Fuel Center" that develops and manufactures plutonium fuel, the "Reprocessing Center" that develops the spent fuel reprocessing technology, the "Environmental Preservation, Research and Development Center" that develops fast reactor fuel recycling technology and radioactive waste treatment and disposal technology, and technical support departments in charge of safety and radiation control. There are approximately 1,000 employees. In addition, approximately 1,800 employees of cooperating companies are stationed here on a full-time basis.

The reprocessing facility, which was subjected to the review, started testing spent fuel in September 1977 followed by full-scale operation in January 1981 as Japan's first reprocessing plant. The operation of the plant, which was suspended because of the fire and explosion accident that occurred at the asphalt solidification facility on the same site in March 1993 (hereafter referred to as the "fire and explosion accident at the asphalt solidification facility"[i]), resumed in November 2000 after conducting comprehensive safety inspections.

The amount of spent fuel processed at this reprocessing plant reached approximately 980 tons (in terms of metallic uranium) as of the end of November 2001. This includes spent fuel from the test power reactor of the Japan Atomic Energy Research Institute (JAERI), domestic boiling water and pressurized water reactors, and the JNC's advanced thermal reactor "Fugen." (See the table below).

Major Performance of the Reprocessing Plant (as of the end of November 2001)	
Spent fuel accepted	Approximately 1,058 tons
Spent fuel processed	Approximately 980 tons
Uranium collected	Approximately 930 tons
Plutonium collected	Approximately 7 tons
Waste vitrified	123 pieces

JNC also provide the technology developed at the Tokai Reprocessing Plant to Japan Nuclear Fuel Limited, which is now constructing private reprocessing facilities, so as to incorporate it into extensive technological cooperation by providing technical information and design support and dispatching engineers, and through research and development collaboration. JNC also plans to conduct research and development to achieve higher fuel burn-up[ii] for light water reactors and plutonium-thermal[iii] utilization.

3. Points of Review

When conducting the review of the Tokai Works, the following items were focused on in view of the characteristics of a reprocessing plant that is a chemical processing plant handling a large amount of nuclear fuel materials and fission products as well as the occurrence of the fire and explosion accident at the asphalt solidification facility and the criticality accident at the conversion test building of JCO (hereafter referred to as the "JCO accident") in the past:

(1) Efforts to prevent the recurrence of fire and explosion accidents

It is necessary to consider fire and explosion accidents because it is a chemical processing plant. Extensive efforts for the prevention of any recurrence should be being made and have taken root in view of the fire and explosion accident at the asphalt solidification facility.

(2) Efforts to prevent criticality accidents (Criticality safety management)

It is necessary to consider preventing, detecting, and mitigating the effects of criticality accidents because a large amount of nuclear fuel materials (uranium and plutonium) are used in the state of solution. Voluntary safety confirmation activities in connection with the criticality safety control of reprocessing facilities should be being carried out and have taken root in view of the occurrence of the JCO accident.

(3) Efforts to reduce workers' exposure to radiation

It is necessary to consider workers' internal[iv] and external radiation exposure[v] (in particular, excessive exposure) caused by the confinement of radioactive substances because a large amount of solution containing highly concentrated fission products (FP)[vi] and transuranium (TRU) elements[vii] is handled.

(4) Management of a variety of radioactive waste

It is necessary to consider the optimal treatment and control of radioactive waste according to the properties and radiation levels of such waste because a large amount of waste

solution containing highly concentrated fission products and transuranium elements is handled.

Other points of importance in each review area were set, with reference to other facilities and nuclear power plants with nuclear fuel facilities (e.g. fuel processing and enriching facilities) that have been reviewed and considering something they have in common with the reprocessing plant.

Typical review items are as follows:
- System, responsibility, and objective of the organization
- Activities to promote nuclear safety culture (including those of cooperating companies)
- Activities to promote acceptance by communities
- Emergency organizational systems and plans
- Implementation of education and training (improving skills and technology transfer)
- Documents and procedures concerning operation and maintenance and compliance with them
- Maintenance plans and control (including relationships with cooperating companies)
- Mechanism to incorporate past problems
- Activities to prevent human errors

4. Performing of the Review

① Date

November 13 (Tuesday) to November 16 (Friday), 2001

② Formation of Review Teams

1st group : The Chugoku Electric Power Company, Inc.; Mitsubishi Nuclear Fuel Co., Ltd.
2nd group : Hitachi, Ltd.; Japan Nuclear Fuel Limited
3rd group : The Kansai Electric Power Company, Inc.; NSnet Office
Coordinators: NSnet Office

③ Fields of Responsibility

1st group : Organization/administration, emergency measures, education/training
2nd group : Operation/maintenance
3rd group : Radiation protection/ Control of chemical substances , Serious accident prevention and Addressing important issues

④ Facilities subjected to the review

The review focused on activities of the Tokai Works in areas of “Organization and Administration” and “Emergency Measures” and those of the Reprocessing Center that controls the reprocessing facilities in areas of “Education and Training,” “Operation and Maintenance,” “Radiation Protection and Chemical Control,” and “Preventing Serious Accidents and Addressing Important Issues.”

⑤ Others

Considering the fact that the fire that occurred in the maintenance building of “Joyo,” a experimental fast breeder reactor of the JNC Oharai Engineering Center on October 31, 2001, occurred in one of the facilities of JNC, activities of the Tokai Works in connection with the fire was also reviewed. This review was conducted in Section 6. (See Section 6.2).

5. Review Schedule

The review was conducted by individual groups over a period of four days according to the schedule shown in the table below.

<table>
<tr><th colspan="2"></th><th>1st Group</th><th>2nd Group</th><th>3rd Group</th></tr>
<tr><td rowspan="5">13th
(Tue.)</td><td rowspan="3">AM</td><td colspan="3">Opening (greetings, introduction of members and explanation of the outline of the facilities)</td></tr>
<tr><td colspan="3">Inspecting emergency control systems, etc.</td></tr>
<tr><td colspan="3">Introducing safety and quality assurance activities (by the reviewer from Hitachi Ltd.)</td></tr>
<tr><td rowspan="2">PM</td><td rowspan="2">Document Confirmation
(1. Organization and Administration)</td><td>Document Confirmation
(4 (1) Effective Operation Administration)</td><td>Document Confirmation
(5. Radiation Protection and Control of chemical substances)</td></tr>
<tr><td>Interviews (operation and maintenance personnel)
[Managers]
[Responsible personnel]</td><td>Document Confirmation
(6 (3) Human Error Prevention Activities)
(6 (4) Incorporating Past Problem Instances)
(6 (5) Risk Assessment)
(6 (6) Superannuated Facilities)</td></tr>
<tr><td rowspan="5">14th
(Wed.)</td><td rowspan="2">AM</td><td>Document Confirmation
(2. Emergency Measures)</td><td rowspan="2">Document Confirmation
(4 (2) Effective Maintenance Administration)
(4 (3) Confinement)
(4 (4) Nuclear Fuel Materials Management)</td><td>Document Confirmation
(6 (1) Criticality Safety)</td></tr>
<tr><td>Interviews (Operation and Administration)
[Superintendent of the Tokai Works]</td><td>Interviews (Criticality Safety Control)
[Responsible personnel]</td></tr>
<tr><td rowspan="3">PM</td><td>Interviews (Operation and Administration)
[Superintendent of the Reprocessing Center]</td><td rowspan="3">Document Confirmation
(4 (5) Radioactive Waste Management)</td><td rowspan="3">Document Confirmation
(6 (2) Fire and Explosion Accident Prevention)</td></tr>
<tr><td>Plant observation
[Disaster Prevention Control Building, etc.]</td></tr>
<tr><td>Interviews (Emergency Response Personnel)
[Responsible personnel]</td></tr>
<tr><td rowspan="2">15th
(Thu.)</td><td>AM</td><td>Document Confirmation
(3. Education and Training)
Fact confirmation</td><td>Plant observation
[Third uranium storage warehouse]
[Second low-level radioactive solid waste storage]
[Decontamination spots (places in which maintenance is conducted)]</td><td>Plant observation (Criticality Safety, etc.)
[Main process central control room]
[Second asphalt solidified waste storage facility]</td></tr>
<tr><td>PM</td><td>Verification of Facts</td><td>Verification of Facts</td><td>Verification of Facts</td></tr>
<tr><td>16th
(Fri.)</td><td>AM</td><td colspan="3">Verification of Facts</td></tr>
<tr><td></td><td></td><td colspan="3">Closing</td></tr>
</table>

6. Procedures and Items of Review

6.1 Review Procedures

The review was conducted with respect to various activities to improve plant safety as outlined below. Good practices and suggestions for improvement were identified through field observations of such activities, Confirmation of the documents presented by the plant, and interviews with the personnel.

During the review, the review teams also introduced useful examples of activities, such as activities of safety/quality assurance by the companies and organizations to which the reviewers belong. This facilitated nuclear cultural exchange.

6.1.1 Review methods

(1) Field Observations

Direct observation was made of actual activities to check whether they corresponded to items listed in documents and interviews. Findings were compared with reviewers' knowledge and experience.

(2) Document Confirmation

With regard to each review item, documents were examined while receiving explanation on them and requesting relevant documents as the need arose. In-depth examination was conducted, asking for relevant documents after observing field facilities and activities.

(3) Interviews

Interviews were conducted with directors, managers, operators, and maintenance personnel with the following objectives:

a. Understanding the attitude and awareness toward nuclear safety
b. Collecting additional information that could not be confirmed through documents
c. Questions and answers on problems identified during Document Confirmation
d. Grasping the degree of understanding of determined items and responsibilities imposed on each individual
e. Understanding the compliance status of determined items and whether such items have not been ruined.

6.1.2 Good Practices and Suggestions for Improvement

(1) Good Practices

"Information on good practices incorporating appropriate, effective, and unique methods into activities to ensure safety should be widely distributed to the members of the NSnet and the nuclear industry"

(2) Suggestions for Improvement

"After comparing the station's practices with the best in the nuclear industry, suggestions to improve and enhance safety activities should be recommended for further improvement so as to achieve the highest level of nuclear safety."

Even if current activities are equal to or higher than general standards in the nuclear industry, there is still room for improvement.

6.2 Items of Review

Based on the following review items identified and developed in "3. Points of Review," field

observations, document confirmation, and interviews were conducted, and the results were summarized into "**7. Major Conclusions**."

Section 1: Organization/Administration

To ensure nuclear safety, it was reviewed whether the personnel necessary for safe operation have been secured, whether safety culture always giving safety the highest priority is sufficiently promoted, whether effective communication with cooperating companies is striven for, and whether efforts are made to attain public acceptance in communities. It was also considered whether voluntary safety activities to improve safety, particularly in view of fire and explosion accidents, are widely promoted and have taken root.

(Review Items)

(1) Effective organization management
   a. Clear line organizations and responsibilities
   b. Securing adequate personnel
   c. Setting organizational goals
   d. Managers' leadership

(2) Activities to promote safety culture and improve morale
   a. Activities to improve safety in view of fire and explosion accidents
   b. Activities to promote specific safety culture
   c. Activities to promote specific morale
   d. Activities promote public acceptance in communities

(3) Quality Control
   a. Effective audit system

Section 2: Emergency Measures

Emergencies here means the events described in the Special Measures Law for Nuclear Disasters (hereafter referred to as the "Nuclear Disaster Law") and other events defined as emergency and abnormal in the Safety Rules. In the review, we focused on activities based on the Nuclear Disaster Law and Safety Rules.

(Review Items)

(1) Emergency plans
   a. Drawing up emergency plans
   b. Establishment of emergency organizations (including notification and liaison systems)
   c. Establishment of emergency procedures
   d. Education of emergency procedures to the employees and well known

(2) Emergency equipment, tools and resources
   a. Inspection and maintenance of equipment, tools, and resources

(3) Emergency training
   a. Implementation of training (results)

Section 3: Education/Training

Based on the idea that improving technical skills and safety awareness among employees contributes to improving nuclear safety, the review was conducted to examine whether effective education and training systems, including the systems of cooperating companies, have been established, whether credential certification systems have been introduced, and whether they have been implemented responsibly.

It was also included in the review items how the accumulation and transfer (including technology transfer to the private sector) of technical know-how from the past is incorporated into

the education and training systems.

(Review Items)

(1) Credential certification

a. Credential certification system and criteria

(2) Training Plans and Implementation

a. Education and training plans

b. Education and training implementation (to improve skills and technology transfer)

Section 4: Operation/Maintenance

Regarding various items in connection with operation administration and maintenance administration, organizational management, development and compliance with documents and procedures, observation of operational restrictions, work plans and control, management of cooperating companies, and so on were reviewed to examine whether a high-level of safety is ensured. In addition, the confinement of radioactive substances and the control of nuclear fuel materials were also reviewed, focusing on the appropriate treatment and control of radioactive waste according to the properties and radiation levels of such waste.

(Review Items)

(1) Effective operation administration

a. Operation organization

b. Documents and procedures regarding to the operation, and compliance with them

c. Design management

(2) Effective maintenance administration

a. Maintenance organization

b. Maintenance documents and procedures, and compliance with them

c. Maintenance equipment

d. Work plans and administration

(3) Confinement of radioactive substances

(4) Nuclear fuel materials (Uranium, Plutonium) management

(5) Radioactive waste management

a. Treatment and control of the radioactive wastes

b. Reduction the amount of radioactive wastes

Section 5: Radiation Protection/ Control of chemical substances

Focusing on radiation protection to reduce workers' internal and external exposure to radiation and prevent excessive exposure, workers' dose control measures and implementation status were reviewed. In addition, the monitoring of radiation inside and outside controlled areas and the control of chemical substances were also reviewed.

(Review Items)

(1) Workers' dose control

(2) Monitoring radiation, etc.

(3) Control of chemical substances

Section 6: Serious accident prevention and Addressing Important Issues

In view of the characteristics of reprocessing facilities and past accidents at the reprocessing facilities of the Tokai Works or other domestic nuclear fuel facilities, the review was

conducted focusing on criticality safety control (including preventing, detecting, and mitigating the effects of criticality accidents) and serious accident prevention, such as measures to prevent fire and explosion accidents.

In addition, as part of the efforts to address important issues in connection with serious accident prevention, activities to prevent human errors, incorporating past problem instances, risk assessment, and efforts to cope with aged facilities were also reviewed.

(Review Items)

(1) Criticality safety control
   a. Staff education and knowledge concerning criticality safety control
   b. Processes, systems, and equipment that require criticality safety control
   c. Methods for criticality safety control
   d. Voluntary safety activities following the JCO accident

(2) Preventing fire and explosion accidents
   (including "Response to Fires at the Oarai Engineering Center")

(3) Activities to prevent human errors

(4) Incorporating past problem instances

(5) Efforts concerning risk assessment

(6) Efforts to cope with aged facilities

7. Major Conclusions

Summarizing the results from the review of the JNC Tokai Works, no items were identified that may lead to the occurrence of serious accidents unless immediate improvement measures in terms of nuclear safety were taken.

It was confirmed that at the Tokai Works, serious efforts are being made to continue and enhance nuclear safety, including those of cooperating companies, by taking diverse safety measures, learning from various accidents and problems, such as the fire and explosion accident at the asphalt solidification facilities and problems regarding waste.

In particular, regarding the operation of the reprocessing plant that is one of the most important operations of JNC, it was confirmed that the plant delivers messages to its personnel on a daily basis to practice "Safety First" by thoroughly instructing them to "immediately stop and communicate with one another when noticing something unusual."

Externally, on the other hand, it was confirmed that the plant is endeavoring to "disclose sufficient information and fulfill its accountability as an operator" based on its recognition, "No Disclosure, No Safety."

In the future, it is desirable for the Tokai Works to continue voluntary safety efforts, aiming to further improve its safety culture.

It is also expected that the fruitful results from the review will be deployed horizontally in other facilities of the Tokai Works, other JNC plants, and cooperating companies.

The following major good practices were identified during the review, which should be introduced extensively to other members of the NSnet and the nuclear industry:

- Active information exchange with communities by establishing the Risk Communication Study Group

  The Risk Communication Study Group was established and started its activities in January 2001 to receive local residents' anxieties and concerns about nuclear risks through two-way communication, thereby developing a new relationship of mutual trust with local residents. This study group studies instances of domestic risk communications and overseas literature and collects and analyzes information about local residents' anxieties and concerns. These risk communication activities are thought to greatly contribute to gaining trust in nuclear

energy by local residents.

- Efforts to obtain international certifications including the labor safety and health management system

  The Tokai Works is making plant-wide efforts to obtain international certifications for its environmental management system (ISO14001) and occupational health and safety management system (OHSAS18001)[viii]. In particular, with regard to OHSAS18001, efforts are being made for risk reductions and improvements by evaluating risks involved with all work processes at all facilities. This is the first attempt by a nuclear operator.

- Improving the check-system including external specialists when developing, preparing, and revising operation procedures

  When newly preparing or revising the "Operation Procedures," the approval of the Superintendent of the Reprocessing Center is required after being discussed by the Special Committee on the Safety of Reprocessing Facilities. Since December 2000, two or three specialists external to JNC have joined the Special Committee, which has led to discussions from wider perspectives and improved awareness and discussions among the members. The Reprocessing Facility Safety Regulations expressly provide that the Chief Engineer for the Handling of Nuclear Fuel shall be included among the members. At present, the Chief Engineer for the Handling of Nuclear Fuel chairs the committee.

- Activities to prevent fire and explosion accidents respecting the sense of practice by HAZOP[ix], etc.

  As a method for evaluating fire and explosion accidents, HAZOP and FMEA[x], which are used for the safety evaluation of nuclear fuel facilities and ordinary chemical plants in Europe, are used to extract abnormal events. Event development flows are prepared starting from the originating event, taking into account response operations by operators and relevant instruments. These flows are classified by severity and are incorporated into prevention measures by expressly providing response operations in the Operation Procedures or modifying instruments and equipment, as appropriate. In addition, important operations and equipment are underlined and severity classifications are expressly stated in the Operation Procedures. This serves to rouse attention to operation and as guidance to response operation in the event of emergencies.

On the other hand, several suggestions were made to improve the activities to ensure the safety of the Tokai Works. The major proposals are as follows:

- Preparing guidance to deal with visitors in the event of accidents or problems

  When an accident occurs at the Plant, tour guides are informed of it via the PA system and routine liaison channels so that they can stop the tours, evacuate the visitors to an appropriate place, and explain the status. However, these actions are not found in any documentation. It is desirable to prepare a guidebook titled, for example, "How to deal with visitors in the event of accidents (tentative)" and use it appropriately.

- Updating the structure of documents and procedures in connection with the operation and maintenance of the reprocessing facilities

  A new structure of documents and procedures in connection with the operation and maintenance of the reprocessing facilities was established when obtaining ISO9002. Conventional quality assurance basic procedures also exist, making the relationship between the conventional and new structures unclear. It is desirable to simplify the operation of documents and procedures by unifying them into the new structure.

- Displaying drawings showing fire fighting equipment near communication systems
  It is a good idea to suspend signs from the ceiling to indicate fire-fighting equipment in controlled areas. In the second asphalt solidified waste storage facility, however, in addition to suspended signs, drawings showing fire-fighting equipment in the area are displayed near the telephone and paging machine, so that the fire-fighting equipment can be found quickly after making an initial report. It is desirable to spread this practice throughout the reprocessing facilities.

  Itemized reports are published on the Japanese homepage.

[i] **Fire and explosion accident at the asphalt solidification facility**: On March 11, 1997, a fire and explosion accident occurred at the asphalt solidification facility of the Tokai Reprocessing Plant of Power Reactor and Nuclear Fuel Development Corporation. In this accident, after the occurrence of a fire at about ten o'clock in the morning, an explosion occurred at about eight o'clock in the evening of the same day. Although no one was injured, workers slightly suffered from internal exposure and an insignificant amount of radioactive substances was discharged into the environment. It is assumed that slow reaction involving insubstantial heat generation proceeded inside solidified waste raising the temperature of the solidified waste, resulting in a rapid reaction that caused the fire. It is also assumed that insufficient fire control allowed such reaction inside the solidified waste to continue, resulting in an explosion of combustible substances generated as a result of the continued reaction. This accident was rated Level 3 in the International Nuclear Event Scales (INES). (Excerpted from the Nuclear Energy Encyclopedia ATOMICA).

[ii] **Higher fuel burn-up**: To improve fuel burn-up when extracting nuclear fuel by enriching uranium. Higher burn-up extends the operation cycle of a nuclear reactor. Moreover, if the amount of energy generated per fuel assembly because of higher burn-up, the amount of spent fuel can be reduced, which in turn helps reduce reprocessing costs among other nuclear fuel costs.

[iii] **Plutonium-thermal**: To use plutonium in thermal neutron reactors, such as light water reactors (BWRs and PWRs). The term "thermal" is used because it refers to the thermal neutron.

[iv] **Internal radiation exposure**: Internal radiation exposure means irradiation from radioactive substances taken into a living body. There are three ways for radioactive substances to get into a living body: aspiration, oral ingestion, and through the skin. Radioactive substances taken into a living body may be distributed uniformly all over the body or absorbed by a single specific or several organs or tissues. Radioactive substances taken into a living body leaves the system (body) through metabolism, excretion, and so on. Radiation exposure depends on effective half life (a time period over which radiation reduces to half through natural decay and biological processes). (Excerpted from the Nuclear Energy Encyclopedia ATOMICA).

[v] **External radiation exposure**: To take radiation from outside the body. In this case, while x rays, gamma rays, and neutron rays, which have high transmittance, have a great impact on the whole of body tissues, beta rays, which have low transmittance, have an impact mainly on skin and eyeballs. A majority of the exposure dose among workers engaging in radiation activities in Japan is from external exposure. In addition, natural radiation, such as cosmic rays and gamma rays, causes external exposure. (Excerpted from the Nuclear Energy Encyclopedia ATOMICA).

[vi] **Fission products (FP)**: Referring to nuclides generated as a result of nuclear fission or radioactive decay of such nuclides. They are abbreviated as FP (Fission Products). Major yield curves of nuclides generated as a result of nuclear fission include ^{137}Cs and ^{90}Sr. Fission products remain in nitric acid solution together with some of transuranium elements in the fuel reprocessing process, which becomes a major cause for the generation of radiation and decay heat from high-level radioactive waste. (Excerpted from the Nuclear Energy Encyclopedia ATOMICA).

[vii] **Transuranium (TRU) elements**: Referring to elements exceeding TRU (transuranium): Atomic Number 90, belonging to the actinoid family of the third genre of the periodic table. Each of them is an artificial radioactive nuclide. Those found

to date include neptunium (Np, 93), plutonium (Pu, 94), Americium (Am, 95), and Curium (Cm, 96). Most uranium elements emit alpha rays as a result of alpha disintegration. (Excerpted from the Nuclear Energy Encyclopedia ATOMICA).

[viii] **Occupational health and safety management system (OHSAS18001)**: OHSAS stands for the Occupational Health and Safety Assessment Series. OHSAS 18001 is a standard for occupational health and safety management systems, which was developed for companies to efficiently comply with safety and health obligations required of them.

[ix] **HAZOP**: Standing for Hazard and Operability Study, one of the representative risk assessment methods at chemical plants. In this method, cases in which individual parameters for controlling a system slip off optimal values are assumed and their causes, results, and prevention methods are simulated.

[x] **FMEA**: Standing for Failure Mode and Effect Analysis, one of the representative risk assessment methods at chemical plants. This method lists failure status of all parts that constitute a system and evaluates the impact of individual failures on the system as a whole. This system helps you predict why and where fatal risks occur.