Medical Guidelines for Radiation Emergencies

October 27, 2008

Nuclear Facility Disaster Prevention Expert Committee, Nuclear Safety Commission

Reference

1. Introduction

The Radiation Medicine Study Group was established under the Expert Subcommittee on Nuclear Disaster Prevention in consideration of medical services provided when a criticality accident occurred at the uranium processing plant of JCO Co., Ltd. on September 30, 1999. The Study Group has discussed Japan's radiation emergency medical system, aiming to make it more practical from the viewpoint of clinical medicine, and has drawn up these "Medical Guidelines for Radiation Emergencies," which were approved by the Nuclear Safety Committee in June 2001

This report summarizes a comprehensive and integrated radiation emergency medicine and practical actions to be taken for its realization, with priority placed on human life.

In other words, considering the possibility that radiation exposure could occur not only in nuclear emergencies but also at any nuclear and radioisotope-handling facilities, we propose comprehensive and practical radiation emergency medicine.

We share a common view that nuclear plant workers and residents around nuclear plants must be equally treated and propose a practical system whereby radiation emergency medicine providers are given educational seminars and training that will help them provide radiation-exposed patients with medical treatment quickly, properly and without anxiety.

As for the radiation emergency medical system in Japan, Chapter 10 of the Disorder Prevention Basic Plans, 'Nuclear Disaster Prevention Measures'(NSC Decisiion, June 1980, Disaster Prevention Guidelines, hereafter), claims that professional and technical experts should be highly esteemed. According to the Disaster Prevention Guideline, the details of the prevention measures should be set aside by the Nuclear Safety Commission. This report is based on this ordinance. The current status of nuclear power around the world has been dramatically changing since "Medical Guidelines for Radiation Emergencies" was released in June 2001. Measures for nuclear emergencies caused by the illegal use of radioactive substances have been discussed on a global scale. This report has been issued, considering events likely to happen in nuclear-related facilities as well as radioactive substance-related emergencies from the viewpoint of radiation medicine. We expect the national government, local governments, operators (including nuclear operators and radioisotope handlers; this shall also apply hereafter) and medical providers to refer sufficiently to this report and to establish a practical radiation emergency medical system.

By the revision of "Guidelines for Emergency Preparedness of Nuclear Facilities" in May 2007,in this revision of the "Medical Guidelines for Radiation Emergencies," we have gathered and reviewed new information obtained from the reports on radiation emergency medicine published after 2001 such as the "Role of Local Tertiary Radiation Emergency Medical

Institutions” (approved by the Nuclear Safety Commission in April 2002) and “Localization of Radiation Emergency Medical Systems,” (approved by the Nuclear Safety Commission in July 2003), and reports published by the International Atomic Energy Agency (IAEA).

Radiation emergency medicine can be useful to a great extent if various existing medical techniques are properly applied. For that, it is important that medical providers have sufficient knowledge of radiation emergency medicine. Radiation emergency medicine is not often used. However, considering the fact that studies on protection from radiation and the biological effects of radiation have contributed greatly to medical progress, medical institutions, especially specialized medical institutions, are expected to conduct more studies, aiming at further technical development and improvement.

We will continue to gather new information on radiation emergency medicine and revise these “Medical Guidelines for Radiation Emergencies” as necessary.

To allow local governmental officials and radiation emergency medical providers to easily refer to this report, we will attach references and glossaries at the end of the report.

2. Basic Policy

Considering the increasing use of nuclear power/radiation in Japan and past accidents caused by radioactive substances and radiation around the world, it is obvious that the establishment of a practical radiation emergency medical system is important. It is also obvious that continuous efforts are necessary for its maintenance and improvement. The national government and local governments, operators and medical providers should try to establish, maintain and improve a radiation emergency medical system in accordance with the following policies.

(1) A radiation emergency medical system is based on the principle of emergency medicine that “anyone can have access to the best medical treatment anywhere anytime” and the principle of disaster medicine of providing “maximum benefits to the maximum number of people” if the number of casualties surpasses medical capacities. For disaster medicine, effective actions, including the long-distance transfer of patients and dispatch of specialist doctors, are necessary.

1) A radiation emergency medical aiming at lifesaving.

With regard to safety assurances in the utilization of nuclear power, human life is the first priority.

2) A radiation emergency medical system needs to be comprehensive and integral.

A radiation emergency medical system is applicable not only when nulcear emergencies occur at nuclear facilities but also when people at or around nuclear/radioisotope-handling facilities are contaminated by radionuclides or exposed to radiation even if nuclear emergencies do not happen.

To establish such a system, cooperation between the following people is necessary.

a. Medical providers including doctors, public health nurses, nurses, health physists, medical technologists and pharmacists

b. Officers from the police department, fire department, Japan Coast Guard and Self-Defense Forces

c. Operators

d. Experts on nucleonics or health physics

e. National and local government officials

To allow a radiation emergency medical system to work effectively, it is important that the people aforementioned have the same awareness of radiation emergencies and related medical care regardless of differences in their background.

(2) A radiation emergency medical system needs to be familiar to emergency medical providers and must not make them anxious.

(3) A radiation emergency medical system needs to be the “safety net” for human health and life in abnormal circumstances.

If medical treatment is necessary outside a nuclear facility site area[*1], first, proper emergency medicine needs to be provided there, and secondly, radiation-exposed patients need to be transferred to the nearest nuclear facility site area for radiation emergency treatment. For this, it is important to establish cooperative systems between nearby nuclear facility site areas.

[*1] In this report, “nuclear facility sites” indicates prefectures that have nuclear facilities and prefectures that include areas where emergency preparedness plans should be enhanced.

3. First-aid Treatment for Radiation-exposed Patients

3-1 Features of radiation medicine

3-1-1 Particularities of radiation medicine

(1) Medicine for infrequent events

Frequency of the incidences of nuclear disasters, contamination from radioactive substances or exposure to radiation are low. However, with proper and daily preparation, the effectiveness of radiation emergency medicine can be ensured.

(2) Anxiety about radioactive substances and radiation

Radiation cannot be detected by human senses, so people are naturally worried about radiation. Compared to infections, however, the effects of radioactive substances and radiation on humans can be measured quantitatively. With sufficient preparation, seminars and training, medical providers can provide radiation emergency medicine without anxiety.

(3) Measurement of radioactive contamination levels and radiation exposure doses

Radioactive contamination levels and radiation exposure doses can be physically measured. Radiation exposure doses during nuclear disasters can be estimated if experts who are sufficiently knowledgeable of radioactive substances, radiation, asessment of radiation dose effect and preventive measures against the spread of radiation (hereafter “health physicists”) and experts on nucleonics work together. Such estimations are useful towards the establishment of therapeutic plans and the prediction of prognoses.

3-1-2 Differences between radiation medicine and general medicine in Hospitals

(1) Measurement of radioactive contamination levels

The presence or absence of contamination with radioactive substances and exposure to radiation needs to be determined by measurement.

(2) Decontamination

If the body surface is contaminated with radioactive substances, decontamination is necessary.

(3) Prevention of expansion of contamination with radioactive substances

To prevent contamination from spreading to medical devices, walls, floors and other medical areas, certain measures are necessary.

(4) Establishment of therapeutic plans based on radiation doses and radiation exposure types

Therapeutic plans can be established in consideration of both symptoms and estimated radiation levels.

(5) Particular pathological conditions after radiation exposure and radiation medicine

Internal radiation exposure and particular pathological conditions after radiation exposure including radiation injury can be treated mostly with existing medical techniques. Cooperation between experts in various medical fields is necessary according to radiation exposure doses.

(6) Protection from radiation for medical providers

It is necessary to control and reduce radiation exposure doses in medical providers [*2].

(7) Cooperation for radiation protection and radiation control

Health physicists need to cooperate in radiation protection and radiation control including decontamination during the transfer of radiation-exposed patients and in medical institutions, and contamination spread prevention.

3-1-3 Mental health [*3]

(1) Importance of measures for mental health

Radiation cannot be detected by human senses, so if unexpected contamination with radioactive substances or unexpected radiation emission occurs at a nuclear facility, residents near the nuclear facility worry about their health even though no particular medical treatment is necessary. This health anxiety includes worries about the negative impacts on their health and their children's health. It is, therefore, very important that medical providers and relevant people take appropriate actions for mental health, for example, by providing residents with accurate information.

(2) Notes on measures

To eliminate resident anxieties associated with the particularities of radiation, it is important to provide visible information, for example, radiation measurement results. It is also important to take appropriate measures, considering their condition, i.e., temporary medical care for their nervousness shortly after an accident and medical care by psychiatrists for their long-term anxieties.

Many residents including radiation exposure-free residents may have health anxieties and visit medical institutions or public health centers for immediately after an accident, so these places need to prepare for such situation. If these places can provide residents with sufficient and accurate information, it will relieve their health anxieties. If residents think that published information is not reliable, their health anxieties may aggravate, so it must be noted to maintain the consistency of information.

It is also important to communicate the risks of nuclear radiation to residents living or working around nuclear facility site areas.

3-1-4 Case where radiation medicine is urgently necessary

If nuclear disasters or radiation accidents occur, radiation medicine needs to be provided urgently to the following persons.

(1) Casualties who are subject to emergency treatment and have been contaminated with radioactive substances

(2) Persons who have internal contamination for which treatment is or is most likely to be necessary

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[*2] When medical providers treat patients contaminated with radioactive substances, they may incur secondary radioactive contamination from the patients. Stable isotopes in the body of patients exposed to high-level neutrons become radioactivated, so when medical providers treat such patients, they may have secondary radioactive contamination as well. However, past experience suggests that appropriate protective measures can reduce radiation to very low levels, so medical providers do not need to worry too much. Meanwhile, measures for preventing any and all radioactive contamination are not necessary when treating patients having only external radiation (exclusing high-level neutron rays). Medical treatment can be applied without specific measures.

[*3] For details, refer to "Measures for Mental Health during Nuclear Disasters."

(3) Casualties who have been subjected to a high dose of radiation exposure that may cause acute radiation syndrome (ARS)

Radiation-exposed patients who have no subjective symptoms in spite of being contaminated with radioactive substances or exposed to radiation at an unspecified radiation source may visit both radiation medical institutions and general medical institutions. If patients having symptoms of unknown etiology including burn-like skin lesions, vomiting or diarrhea visit a hospital, it is important to conduct a differential diagnosis of radiation injury. If patients are suspected of having radiation injury, there is a possibility that other radiation-exposed patients may be present, so it is necessary to share information with other relevant medical institutions and to quickly identify the radiation source.

3-2 Medical care

3-2-1 Basic concept

When medical providers treat radiation-exposed patients, they need something to protect themselves from radiation, quickly investigate the general status and provide lifesaving treatment regardless of the presence or absence of radioactive contamination. They need to treat radiation-exposed patients, in consideration of information from health physicists on the details of the accident and the presence or absence of body surface radioactive contamination and external or internal radiation exposure. (If these are present, the dose and type of radiation and radioactive substances causing radiation injury need to be pinpointed.)

3-2-2 Practical medical care

(1) Protection for medical providers and radiation exposure control of medical providers

When medical providers treat radiation-exposed patients, they need to put on protective clothing and a personal dosimeter.

(2) Treatment according to types of radioactive contamination and radiation exposure

1) Patients having body surface radioactive contamination

When medical providers treat patients having body surface radioactive contamination, they have to consider radiation exposures of medical providers and patients, the patients' internal radiation exposure and the spread of contaminationto medical devices. If patients are wearing clothes, they first have to get them off. Then, radioactivity on body surface is measured, and smear samples are taken from the nasal cavity. General status and complications must then be investigated, and decontamination conducted. If such appropriate handling as decontamination or dispose of medical materials used for treating patients is difficult in hospitals, they should be disposed of by operators.

2) Patients having external radiation exposure

External radiation exposure is categorized into local radiation exposure and whole body radiation exposure [*4]. If there is no radioactive contamination, neither measures against contamination spread nor protection for medical provider from radiation is necessary. General emergency medicine is applied.

3) Patients having internal radiation exposure (internal contamination)

If patients are suspected of having internal radiation exposure (internal contamination) associated with inhalation or swallowing of radioactive substances or uptake of radioactive substances from wounds, it is preferable to quickly treat them to reduce internal radiation exposure doses [*5]. However, medications vary according to the type and chemical forms of radionuclides, so it is preferable to seek expert advice. Urine and feces samples are taken as necessary. Contamination from the samples must be noted.

3-2-3 Role of medical providers

To provide radiation emergency medicine smoothly without delay, cooperation between not only doctors but also the medical providers shown below is necessary. These medical providers are required to have necessary knowledge and a cooperative attitude.

(1) Nurses

Nurses take care of radiation-exposed patients at medical institutions and places where they are dispatched.

(2) Public health nurses

Public health nurses provide residents around nuclear facilities with health guidance.

(3) Radiological technologists, etc.

Radiological technologists measure radioactive contamination levels, provide protection from radiation and assist in screening residents at evacuation areas, as requested by disaster headquarters or on-site disaster headquarters.

(4) Medical technologists, etc.

Medical technologists conduct various tests using blood and urine samples, and assist in transferring test samples.

(5) Pharmacist

Pharmacists supply, dispense and manage drugs at medical institutions and assist doctors in administering medications to patients.

3-2-4 Support/Advice from the National Institute of Radiological Sciences

The National Institute of Radiological Sciences provides radiation emergency medical institutions with essential support and advice. If radiation-exposed patients are found, it will provide medical institutions with essential support and expert advice whatever the cause of a nuclear disaster is.

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*4 The types of radiation estimated from the severity and symptoms of ARS are shown in Reference 2. Seriously radiation-exposed patients are transferred to tertiary radiation emergency medical institutions.

*5: To reduce internal radiation exposure levels in nuclear facility workers, medications need to be stocked in consideration of radioactive substances used in nuclear facilities, mainly plutonium and radioactive cesium. For details, refer to Reference 4. For internal contamination with other radionuclides, also refer to Reference 4.

3-2-5 First response at disaster sites

To properly transfer and treat radiation-exposed patients, essential information must be reported quickly and properly to the institutions in charge of patient transfer (fire department, Japan Coast Guard and Self-defense Forces; hereafter “emergency transportation services”) and medical institutions where patients are transferred. It is also necessary to protect the immediately responsible personnel from exposure to radiation.

If health physicists know the status of radioactive emission and contamination, first response will be taken at disaster sites, as instructed by health physicists. Health physicists take actions to prevent radioactive contamination from spreading to transfer vehicles, as requested by emergency transportation services, and attend patient transfer.

If health physicists do not know anything about the status of radioactive emission and contamination, radiation exposure preventive measures will be taken, on the assumption that there is radioactive emission and contamination, during the first response at disaster sites until experts on radiation protection and radiation doses measurement arrive there. In such cases, it is important that: 1) contaminated areas are classified according to environmental radiation dose rates, and the time during which people are allowed to stay in every contaminated area is specified; and 2) if a number of institutions take first response, the institutions maintain close communications between each other, and the chain of command on contaminated area classifications and permissible staying time is well established. Guidelines for the first response are proposed in Reference 6.

4. Establishment of Radiation Emergency Medical System in Nuclear Facility Site Areas

4-1 Radiation emergency medical system

4-1-1 Outline of radiation emergency medical system

(1) Radiation emergency medical system

A radiation emergency medical system comprises medical facilities and evacuation sites in a nuclear facility, “primary radiation medical institutions” for primary treatment and emergency treatment regardless of the presence or absence of radioactive contamination, “secondary radiation medical institutions” for special medical treatment and “tertiary radiation medical institutions” for high-level medical treatment. To establish a practical radiation medical system, it is important that these facilities and institutions cooperate between each other and support each other according to actual local situations. The basic concept of a radiation emergency medical system is shown in Figure 1.

(2) Combination of emergency medical system and disaster medical system

If a nuclear emergency occurs, it is practically important that both a radiation emergency medical system and a general emergency medical system work as part of a disaster medical system.

Even if nuclear emergencies do not occur, there would be radiation-exposed patients having trauma or burn injuries, so to quickly provide good medical treatment, it is most practical to use a local emergency medical system as usual. It is also necessary to establish a comprehensive and integrated system including the establishment of a chain of command and communication network and securing facilities and equipment, in consideration of various conditions including the frequency of abnormal circumstances, locations of nuclear facilities and features of radiation medicine.

4-1-2 Requirements for and commitments of radiation emergency medical institutions

4-1-2-1 Requirements

Radiation emergency medical institutions preferably fulfill the following requirements.

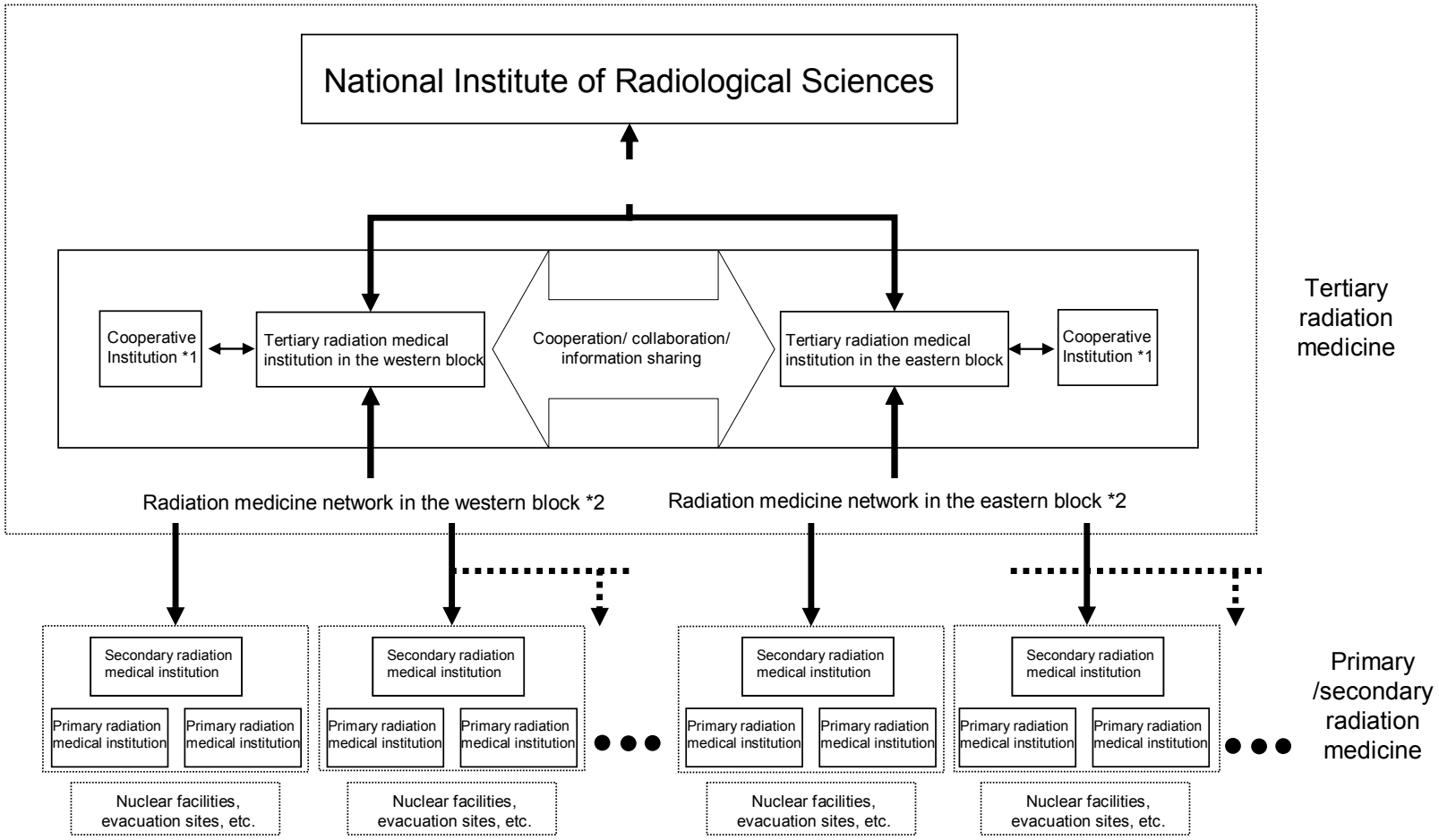
(1) Medical institutions that have accurate knowledge about radiation and protection from radiation

(2) Emergency medical institutions or disaster medical institutions that can provide radiation medicine

(3) Medical institutions to which patients can be easily transferred from a nuclear facility (in consideration of transfer route, distance and time) and from which patients can be easily transferred to other radiation emergency medical institutions

(4) Medical institutions that can allow radiological technologists or persons who know well about radiation to work efficiently and can manage requests from disaster headquarters at nuclear emergencies.

(5) Medical institutions that understand the nature of radiation medicine and intend to join a radiation emergency medicine network



*1Cooperative institutions are referred to as institutions that can cooperate in assessing radiation, protecting from radiation and treating patients.

*2For the network, refer to Section 5-1-1.

Figure 1 Basic Concept of Radiation Emergency Medical System

4-1-2-2 Commitments

(1) Medical care for radiation-exposed patients

1) Radiation emergency medical institutions should develop and maintain their medical practice, in collaboration with nuclear operators, corresponding to the actual status of nuclear facilities and the medical system in the relevant region, under the instructions from local governments.

2) Medical providers in radiation medical institutions should know well about the health risks associated with radiation exposure and provide radiation medicine without anxiety, by taking advantage of educational seminars and training.

(2) Maintenance and effective use of local radiation medical resources

Radiation emergency medical institutions should prepare, maintain and manage equipment necessary for protection from radiation during treatment for radiation-exposed patients. It is desirable for effective preparation that radiation emergency medical institutions should discuss the maintenance and management with local governments and nuclear operators.

For the extensive radiation dose assessment, high-level radiation emergency medical institutions should have a radiation detector and a radionuclide analyzer, and cooperate with experts on health physics and advanced medicine.

To establish an effective system with avoidance of excessive investment, radiation emergency medical institutions need to effectively use existing equipment and facilities, and obtain new equipment and facilities, in consideration of the actual status of relevant nuclear facility site areas.

(3) Cooperation between radiation emergency medical institutions

To properly treat radiation-exposed patients corresponding to emergency and severity levels and effectively use personnel and equipment in medical institutions, cooperation between radiation emergency medical institutions is necessary.

(4) Reporting and sharing of information

Information obtained by medical institutions, including information on radiation dose assessment results and radionuclide identification, is useful for determining the status of a nuclear disaster. Therefore, it must be reported quickly to relevant organization including disaster headquarters. Information useful for radiation medicine must also be reported to medical institutions immediately after being obtained from nuclear operators and on-site disaster headquarters. Treatment for radiation-exposed patients has gained social interest, so in order to respond properly to the mass-media, appropriate preparations are necessary, i.e., the establishment of a public relations section in an administrative department or a clerical department.

4-1-3 Things to do at nuclear facilities and evacuation sites

4-1-3-1 Things to do at nuclear facilities

Along with the first-aid treatment, decontamination and contamination spread prevention, approximate measurement of contamination levels (surveillance) and screening should be done before patients are transferred to radiation emergency medical institutions.

Nuclear operators do the following.

(1) Things to do at nuclear facilities

1) Nuclear operators apply possible first-aid treatment including cardiopulmonary resuscitation and homeostasis to radiation-exposed patients, and ask for cooperation from occupational physicians if they are present at nuclear facilities.
2) Nuclear operators take the patients' clothes off and remove body surface radiation.
3) If possible, nuclear operators treat patients most likely to have internal (thyroid) radioiodine contamination using stable iodine drugs.
4) During the transfer of patients having radioactive contamination, nuclear operators cooperate in preventing contamination from spreading to vehicles, ships, airplanes for transfer and personnel of emergency transportation services.

(2) Things to do outside of nuclear facilities

1) Nuclear operators call health physicists to attend patient transfer and cooperate in protecting personnel of emergency transportation services from contamination, preventing contamination from spreading and assessing contamination in radiation-exposed patients.
2) Nuclear operators cooperate in removing radioactive contamination during the transfer of patients having radioactive contamination.
3) If equipment used for decontamination cannot be disposed of in the site where decontamination is conducted, it will be disposed of by specialized personnel as a general rule.
4) Medical waste contaminated with radioactive substances is disposed of in accordance with related laws and regulations.

4-1-3-2 Things to do at evacuation sites

Local governments assign areas for medical aid, if necessary, and conduct the approximate measurement of contamination levels (surveillance) and screening in residents around nuclear facilities with assistance from associated institutions, and gather the following information. Local governments also provide residents with stable iodine drugs as necessary [*6].

(1) Local governments measure body surface contamination levels and internal (thyroid) contamination levels to find out the status of contamination before patients arrive at evacuation sites.
(2) Local governments register the evacuated residents and residents showing contamination levels higher than a specified screening level.
(3) Local governments explain to the evacuated residents about the health effects of radiation exposure and provide healthcare counseling at their requests.
(4) Local governments conduct preliminary decontamination by wiping and selecting patients to be transferred to medical institutions according to

*6: If radioiodine is emitted into the environment, stable iodine drugs are administered to residents and nuclear disaster workers, as necessary, to reduce internal (thyroid) contamination levels. For details, refer to the "Preventive Use of Stable Iodine Drugs during Nuclear Disasters."

contamination levels.

4-1-4 Things to do in primary radiation medical institutions

Primary radiation medical institutions provide primary treatment to transferred patients, including general emergency treatment of wounds, regardless of the presence or absence of radioactive contamination around nuclear facilities. Primary radiation medical institutions need to have the following medical functions and facilities for emergency treatment and rough decontamination by wiping and undressing if radioactive contamination is detected.

(1) Medical functions in primary radiation medical institutions

1) Primary treatment and emergency treatment for radiation-exposed patients (primary treatment of complications including wounds and burn injuries, and cardiopulmonary resuscitation)

2) The following radiation emergency medical care can be provided in addition to general emergency medical care.

a. Approximate measurement of radioactive contamination levels

b. Removal of radioactive contamination from patients' hair and body surface, and treatment of contaminated wounds

c. Primary treatment including administration of stable iodine drugs

3) Selection of patients to be transferred to secondary or tertiary radiation medical institutions

4) Collection and retention of test samples including nasal cavity/oral angle smears, blood samples and urine samples

(2) Facilities, equipment, materials and drugs in primary radiation medical institutions

1) Medicinal materials for decontamination (wiping) and equipment and materials for contamination spread prevention

2) Radiation counters including survey meters and personal dosimeters

3) Equipment and materials for emergency medicine including emergency treatment and primary treatment of complications

4) Communication lines to nuclear facilities

5) Stable iodine drugs

(3) Increases in effectiveness of primary radiation medical system

1) It is important to establish cooperation systems with each relevant organization in advance, as demanded by actual local situations.

2) Primary radiation medical institutions should ensure that cooperation with other primary radiation medical institutions, secondary and tertiary radiation medical institutions works properly through periodical systematic educational seminars and training for their staff on regular basis, conducted by themselves or other institutions.

4-1-5 Things to do in secondary radiation medical institutions

Secondary radiation medical institutions treat radiation-exposed patients whom primary radiation medical institutions cannot treat. Such patients are hospitalized for the measurement of radioactive contamination levels, decontamination and special medical treatment. In addition to medical functions and facilities that primary radiation medical institutions have, secondary radiation medical institutions need to provide the following

medical functions and facilities.

(1) Medical functions in secondary radiation medical institutions

1) Treatment for patients locally exposed to radiation
2) Assessment of internal exposure level based on such as measurement with a whole body counter in consideration of actual local situations
3) Treatment for patients exposed to high-dose radiation
4) Definitive treatment of complications
5) Decontamination from patients' body using a shower in consideration of actual local situations
6) Treatment for patients most likely to have internal radiation exposure
7) Selection of patients to be transferred to tertiary radiation medical institutions

(2) Facilities, equipment, materials and drugs in secondary radiation medical institutions

1) It is preferable for secondary radiation medical institutions to have a body decontamination facility including a shower and a water drainage/storage tank in consideration of actual local situations.
2) It is preferable for secondary radiation medical institutions to have materials and equipment for the assessment of internal exposure level, such as a whole body counter [*7], as demanded by actual local situations.

(3) Increases in effectiveness of secondary radiation medical system

1) If one secondary radiation medical institution cannot manage the measurement of radiation doses, decontamination or treatment in a bio-clean room, a number of secondary radiation medical institutions must cooperate with each other and share medical functions, as demanded by actual local situations.
2) Secondary radiation medical institutions should establish a system whereby technical support for assessment of status of patients and therapeutic planning can be obtained from tertiary radiation medical institutions, institutions cooperative in radiation protection and treatment and on-site disaster headquarters.
3) Secondary radiation medical institutions should ensure that cooperation with primary radiation medical institutions, other secondary radiation medical institutions and tertiary radiation medical institutions works properly through periodical systematic educational seminars and training for their staff on regular basis, conducted by themselves or other institutions.

4-1-6 Things to do in tertiary radiation medical institutions

For tertiary radiation medicine, high-level medical institutions that can investigate radioactive substances and radiation exposure (tertiary radiation medical institutions) are allocated into two blocks covering the whole country -- eastern and western blocks. In that way, sufficient treatment can be provided to radiation-exposed patients without delay. Tertiary radiation medical institutions in these blocks carry out detailed radiation dose assessments in cooperation with associated institutions for radiation dose assessment, radiation protection and treatment, and play a key role in tertiary radiation medicine

*[7]: A whole body counter is used for assessment of internal exposure levels by such as radioiodines and is usually available for nuclear operators in nuclear facilities. It is preferable for secondary radiation medical institution to have one. However, it is hardly used and needs to be calibrated by specialists. It is difficult to maintain and control it, so it may be a good idea that a number of medical institutions maintain and use it together, in consideration of its practical benefits.

through their cooperation with primary and secondary radiation medical institutions.

Tertiary radiation medical institutions do not need to have the same facilities as the National Institute of Radiological Sciences has. It is rather important for tertiary radiation medical institutions to establish a system whereby advanced medicine and human resources/facilities for radiation dose assessment that major local medical institution and research laboratories have can be applied effectively to radiation medical care.

The National Institute of Radiological Sciences plays a key role in a radiation emergency medical system and is regarded as a nationwide tertiary radiation medical institution. It provides associated institutions with essential support and expert advice, cooperates with high-level medical institutions and carries out high-level decontamination and treatment.

To conduct high-level decontamination, radiation dose assessment and treatment beyond the capacity of primary and secondary radiation medical institutions, tertiary radiation medical institutions need to have the following medical functions and facilities, in addition to those that primary and secondary radiation medical institutions have.

(1) Medical functions in tertiary radiation medical institutions
   1) Treatment for serious external contamination patients
   2) Treatment of serious complications
   3) Treatment for internal contamination patients who need long-term and special treatment. Internal plutonium contamination patients who need treatment and internal contamination patients who are most unlikely to respond to decontamination and may cause secondary contamination are treated by the National Institute of Radiological Sciences.
   4) High-level physical and biological personal radiation dose assessment, including identification of contaminated nuclides by spectrum analysis of test samples, detailed analysis of radioactive substances and chromosome analysis of lymphocytes
   5) High-level intensive care related to various medical fields

(2) Facilities and equipment/materials in tertiary radiation medical institutions
   1) Facilities and equipment/materials for high-level radiation dose assessment
   2) Interdisciplinary high-level medicine (especially hematopoietic stem cell transplantation in a bio-clean room), intensive care, facilities and equipment/materials for burn injury treatment

(3) Increases in effectiveness of tertiary radiation medical system
   1) Educational seminars and training for medical providers

      To treat patients exposed to serious radiation, contamination spread prevention, radiation protection and radiation dose assessment are essential. Tertiary radiation medical institutions need to secure human resources and provide them with educational seminars and training to keep and improve the quality of them.
   2) Establishment of cooperation with institutions for radiation protection and treatment

      It is difficult for tertiary radiation medical institutions to do both treatment for patients exposed to external high-dose radiation and radiation dose assessment, so for radiation dose assessment, radiation protection and treatment, tertiary radiation medical institutions need to establish channels of cooperation with the National Institute of Radiological Sciences, Japan Atomic Energy Agency and other medical institutions (cooperative institutions).
   3) Establishment of cooperation with primary and secondary radiation medical institutions

      To smoothly accept radiation-exposed patients from primary or secondary

radiation medical institutions, tertiary radiation medical institutions need to learn about a nuclear disaster prevention system. Tertiary radiation medical institutions need to establish cooperation not only with primary and secondary radiation medical institutions but also with medical school hospitals that can manage local radiation medicine.

If primary or secondary radiation medical institutions treat radiation-exposed patients, tertiary radiation medical institutions need to cooperate with them in assessing radiation doses, protecting from radiation and determining therapeutic plans.

4) Systematic approach to radiation medicine

The number of radiation-exposed patients who need to be treated in tertiary radiation medical institutions is minimal. To maintain and increase abilities to treat such patients, tertiary radiation medical institutions need to take systematic approach to radiation medicine without relying on specific personnel.

Table 1 Outline of Radiation Emergency Medical Institutions

	Primary radiation medical institution	Secondary radiation medical institution	Tertiary radiation medical institution (eastern and western blocks)
Basic role	Medical institutions that provide emergency treatment regardless of the presence or absence of radioactive contamination, provide primary treatment to radiation-exposed patients and decide on transferring patients to secondary radiation medical institutions	Medical institutions that treat radiation-exposed patients who cannot be treated in primary radiation medical institutions and who need special decontamination and treatment, and decide on transferring patients to tertiary radiation medical institutions	Medical institutions that provide radiation-exposed patients who cannot be treated in either primary or secondary radiation medical institutions with high-level decontamination, radiation dose assessment and treatment
Location	Near nuclear facilities	Places where patients can be transferred from nuclear facilities and primary radiation medical institution using appropriate transportation methods within short periods of time	One each in the eastern and western blocks
Treatment (including decontamination)	- Emergency treatment (primary treatment of complications including wounds and burn injuries, emergency treatment for radiation-exposed patients) - Primary treatment including the administration of stable iodine drugs when the thyroid is exposed to radioiodine - Treatment of contaminated wounds (including decontamination)	In addition to treatment conducted in primary radiation medical institutions, the following treatment is provided. - Treatment for patients exposed to local or whole body high-level radiation - Treatment for patients likely to have internal contamination - Definitive treatment of complications	In addition to treatment conducted in primary and secondary radiation medical institutions, treatment which neither primary nor secondary radiation medical institutions can provide is provided as below. - Patients having serious external contamination - Internal contamination patients who need long-term and special treatment - Treatment of serious complications - High-level intensive care related to various medical fields

	- Rough decontamination of patients' hair and body surface by wiping and undressing - Transfer of patients to secondary or tertiary radiation medical institutions	- Decontamination of patients' body using a shower in consideration of actual local situations - Transfer of patients to tertiary radiation medical institutions	
Radiation dose measurement/assessment (including test sample collection/retention)	- Approximate measurement of radioactive contamination levels - Collection and retention of smears taken from patient body surface, nasal cavity and oral angle, blood samples and urine samples	In addition to radiation dose measurement/assessment conducted in primary radiation medical institutions, radiation dose measurement/assessment is conducted as below. - Assessment of internal exposure levels based on such as measurement with a whole body counter in consideration of actual local situations	In addition to radiation dose measurement/assessment conducted in primary and secondary radiation medical institutions, radiation dose measurement/assessment is conducted as below. - Personal radiation dose assessment using physical and biological methods
Type of medical institution	Medical institutions specified by the Regional Emergency Prevention Plan	Medical institutions specified by the Regional Emergency Prevention Plan	Medical institutions appointed by the national government (National Institute of Radiological Sciences* in the eastern block and Hiroshima University in the western block) *: Treatment is provided in cooperation with the medical institutions that agree to provide treatment.
Equipment/material	- Equipment/materials for the approximate measurement of radiation doses for screening of body surface contamination - Equipment/Materials for emergency treatment and primary treatment of complications - Equipment/Materials for rough decontamination by wiping and contamination spread prevention - Communication lines to nuclear facilities - Stable iodine drugs	In addition to the equipment/materials that primary radiation medical institutions need to have, the following equipment/materials are necessary*. - Equipment/Materials for the treatment for patients exposed to high-dose radiation and mild internal radiation exposure patients - Facilities for decontamination including a shower in consideration of actual local situations *: Equipment/Materials are allocated and used in consideration of cooperation with local medical institutions.	In addition to the equipment/materials that primary and secondary radiation medical institutions need to have, the following equipment/materials are necessary. - Equipment/Materials for interdisciplinary advanced medicine, intensive care and treatment of burn injury - Special equipment/materials for decontamination and radiation dose assessment

4-2 Commitments of national and local governments

To establish a radiation emergency medical system, commitments of the national and local governments are essential.

Their commitments are specified in the Basic Law Concerning Countermeasures Against Disasters, the Special Law on Nuclear Disaster Countermeasures, and related laws and regulations. The national and local governments make commitments as specified by these laws and regulations, and establish a radiation emergency medical system whereby appropriate actions can be taken if nuclear emergencies occur, as well as when nuclear emergencies do not happen and when radiation-exposed patients are found in radioisotope-handling facilities.

To allow radiation emergency medicine to work effectively, the national and local governments need to do the following things.

4-2-1 Commitments of national government

(1) Establishment/Maintenance of laws and regulations including Basic Plans for Emergency Preparedness

The national government makes commitments as specified by the Basic Plans for Emergency Preparedness and the Disaster Prevention Work Plan of Designated Administrative Agency, and also reviews and maintains related laws and regulations to support activities for nuclear disaster prevention including radiation medicine. It also helps local governments establish related laws and regulations as necessary.

(2) Improvement in effectiveness of system/network to support nuclear emergency prevention plans (Basic Plans for Emergency Preparedness, Disaster Prevention Work Plan of Designated Administrative Agency and Regional Emergency Prevention Plan)

The national government establishes the radiation emergency medical system and network (cf.5-1-1 Network for radiation emergency medical system), taking into account opinions from local governments and medical providers.

It also needs to know well about the actual status and necessity of regional measures for nuclear emergency prevention and to help local governments take effective measures.

(3) Seminars and training

Radiation medical providers in a certain region often meet local residents, so they need to have accurate knowledge about radioactive substances and radiation. The national government needs to improve educational seminars and training for them and to cooperate with medical providers in drawing up seminar and training programs.

It also needs to regularly carry out disaster prevention training as specified by the Special Law on Nuclear Disaster Countermeasures and to make efforts to improve the radiation emergency medical system by sending radiation medical providers to disaster prevention training that local governments carry out.

(4) Review of radiation emergency medical system

The national government needs to review and improve the radiation emergency medical system.

4-2-2 Commitments of local governments

(1) Maintenance of regional emergency prevention plans and medical care manuals and improvement in their effectiveness

Local governments need to review Regional Emergency Prevention Plans and medical care manuals as necessary. They also need to cooperate with radiation medical providers, maintain a radiation emergency medical system in consideration of actual local situations and draw up medical care manuals that comply with clinical practices in related medical institutions.

They also help medical providers join primary and secondary radiation medical systems and networks.

(2) Maintenance and management of equipment/materials

Local governments need to maintain and manage equipment/materials for radiation emergency medicine in cooperation with medical providers and nuclear operators, by referring to this report. They need to maintain equipment/materials necessary for their region, referring to Regional Emergency Prevention Plans and taking into consideration the population, geographic features and administrative boundaries of the region where nuclear disaster countermeasures are necessary, nuclear disaster countermeasures necessary for their region and other conditions.

(3) Provision of educational information to medical providers and residents, and disaster prevention training

Local governments need to request local medical providers to comply with medical care manuals. To help residents better understand nuclear power, local governments also need to create a pamphlet about the health effects of radiation and radioactive substances and radiation protection methods, and to distribute it to residents.

Doctors are opinion leaders with regards to the safety of residents, therefore local governments need to provide medical providers with sufficient seminars and training about radiation medicine.

(4) Provision of information on radioactive contamination in radiation medical institutions

Local governments need to quickly investigate the presence or absence of radioactive contamination in cooperation with medical institutions that treat radiation-exposed patients, and publicize results.

Local governments also need to gather and manage such information in cooperation with medical institutions and nuclear operators, and publicize it to residents and the mass-media.

4-3 Commitments of nuclear operators

4-3-1 Responsibility of operators

In preparation for radiation exposure in residents, operators need to do the following.

(1) Nuclear operators draw up Disaster Prevention Work Plans for Nuclear Operators, as specified in the Special Law on Nuclear Disaster Countermeasures, and establish and maintain communication systems including a chain of command.

(2) Nuclear operators need to maintain a close relationship with medical institutions, emergency transportation services, local governments and associated institutions by exchanging information and holding meetings about communication methods and the transfer and reception of radiation-exposed patients.

(3) If medical institutions, emergency transportation services, local governments and associated institutions plan and hold seminars and training, and nuclear operators need to support them by sending lecturers and offering places for seminars and

training, and attend the seminars and training.

It is important to give training on the assumption that there will be radiation-exposed patients who need emergency treatment regardless of the assumed disaster scale.

(4) operators create manuals for radiation emergency medicine, by referring to opinions from occupational physicians and experts on radiation medicine.

(5) operators provide radiation-exposed patients at nuclear facilities with appropriate emergency medicine.

(6) operators hold seminars for health physicists, and maintain and improve their ability.

4-3-2 Cooperation between operators and contractors

If radiation-exposed patients are found, contractors (personnel who work under a contract) responsibly work for emergency treatment, decontamination and patient transfer in cooperation with nuclear operators [*8].

operators need to discuss with contractors about their roles and communication systems including the chain of command when radiation-exposed patients are found.

4-3-3 Facilities for emergency treatment and decontamination in nuclear facility sites

operators establish, maintain and manage facilities for emergency treatment and decontamination of radiation-exposed patients in nuclear facility sites. In principle, nuclear operators provide as much emergency treatment and decontamination as possible to radiation-exposed patients and then transfer them to medical institutions.

4-3-4 Occupational physicians

Occupational physicians need to be deployed at nuclear facilities where there are always 50 workers or more in accordance with the Labor Safety and Sanitation Law. Major tasks of occupational physicians are the management of worker health, work management, work environment management and industrial health education.

If there are radiation-exposed patients, occupational physicians should give advice as follows.

(1) It is the first priority to save the life of radiation-exposed patients, therefore occupational physicians give advice to nuclear operators about treatment in medical institutions and patient transfer, so that patients can be treated quickly.

(2) Considering the systemic conditions of radiation-exposed patients, occupational physicians attend patient transfers or call nurses to attend if emergency transportation services ask for that.

Occupational physicians should establish a close relationship with local medical providers in preparation for abnormal circumstances.

4-3-5 Health physists

(1) Health physists cooperate in investigating body contamination, decontamination, measuring radiation doses, inspecting facilities including medical institutions and vehicles for patient transfer, preventing contamination from spreading to

*8: If humans are exposed to radiation during a small-scale nuclear accident or a periodic inspection, contractors provide emergency treatment, decontamination and patient transfer in cooperation with nuclear operators.

equipment/materials and investigating the contamination of equipment/materials.

(2) Health physists measure the contamination level of radiation-exposed patients to be transferred to medical institutions and take whatever possible actions for preventing contamination spread, in consideration of the condition of patient injuries. They also attend patient transfers, a provide medical institutions where patients are transferred with information on nuclear accidents and radioactive contamination and cooperate in preventing contamination spread. If they cannot attend patient transfers, other persons attend the patient transfers to provide accurate information.

(3) Health physists take actions for radiation control including the prevention of contamination from spreading to other patients, transfer institution workers, medical providers, treatment rooms and vehicles, ships and airplanes for patient transfer, and report the presence or absence of radioactive contamination to associated institutions including nuclear operators, if emergency transportation services and medical institutions ask for that.

(4) Health physists need to attend seminars to obtain sufficient knowledge about the first response to a nuclear accident.

To allow health physists to do the work aforementioned during holidays or nighttime, nuclear operators need to provide health physists with educational seminars and training.

Nuclear operators need to establish a cooperative system whereby health physists can come for support from nearby nuclear facilities in abnormal circumstances.

4-4 Patient transfer system

(1) Emergency transportation services need to establish methods and procedures for communication during patient transfers in cooperation with operators.

(2) operators quickly convey information on the status of a nuclear accident and injuries, and subsequent information to medical institutions where radiation-exposed patients are transferred.

(3) Emergency transportation services, medical institutions and operators should create a communication format in preparation for the transfer of radiation-exposed patients.

The format includes the following items.

1) Brief summary of abnormal circumstances (when, where, what)

2) Number of radiation-exposed patients and the conditions when radiation was released

3) Vital signs of radiation-exposed patients and complications including injuries

4) Status of radioactive contamination and radiation exposure in radiation-exposed patients

(4) operators cooperate with emergency transportation services in patient transfers: i.e., operators call not only health physists but also occupational physicians and nurses to attend patient transfers if emergency transportation services ask for that.

operators need to prepare for the quick loading of equipment/materials for contamination spread prevention on vehicles, ships and airplanes for patient transfer.

(5) In preparation for patient transfer, emergency transportation services, medical institutions and operators should undergo joint training and establish cooperation between them.

(6) Emergency transportation services should take appropriate measures for radiation

protection of their staff such as seminars and trainings for their staff, and assignment and maintainance of necessary equipments. Emergency transportation services should exchange information with associated institutions about equipment/materials to be transferred. In cooperation with associated institutions, emergency transportation services should also establish a system whereby emergency transportation services can obtain expert advice from radiation medical institutions.

(7) The patient transfer route may be cut off due to bad weather or natural disasters, therefore it is preferable to secure a number of patient transfer routes by land, sea and air.

5. Actions for Improvement of Radiation Emergency Medical Systems

5-1 Network

5-1-1 Network for radiation emergency medical system

(1) Features of radiation emergency medical system

The features of a radiation emergency medical system include the following.

1) Cooperation with people in various fields is necessary according to radiation exposure levels.
2) Only a small number of medical institutions have radiation emergency medical providers and they are unevenly distributed.

Considering these features, the establishment of a network between primary, secondary and tertiary radiation medical institutions is necessary for systematic and personnel cooperation.

(2) Network between radiation emergency medical providers

To effectively provide radiation emergency medicine, medical providers and associated people need to know about the importance of radiation emergency medicine, their roles and a cooperative system, and establish a close relationship between them for information exchange.

To establish cooperation between medical providers and people involved in nuclear disaster prevention, the national government needs to carry out the following and promote the expansion of a network between people involved in radiation medicine in cooperation with medical providers and local governments.

1) Establishment of prefectural networks of human resources by promoting information exchange between people involved in radiation medicine and educational seminars
2) Establishment of a cooperative system between primary, secondary and tertiary radiation medical institutions in the eastern and western blocks, and organization of nationwide meetings for information exchange between people involved in radiation medicine
3) Establishment of a nationwide personnel network between associated institutions including the National Institute of Radiological Sciences as a main institution

5-1-2 Collection and transfer of medical information

It is important to establish a system whereby radiation emergency medical providers can obtain knowledge about radioactive substances, radiation and actual examples of radiation medicine. The National Institute of Radiological Sciences needs to establish databases on radiation medicine in cooperation with associated institutions and to collect and convey information on radiation medicine obtained from treatment and follow-up monitoring of radiation-exposed patients.

5-2 Human resource development

(1) Securing of personnel for radiation medicine

1) Human resource development for radiation medicine

Radiation medicine is rarely used, but it must be provided properly when it is necessary. It is, therefore, necessary to secure well-trained personnel who have a

certain level of knowledge and skills for radiation medicine including radiation protection and radiation dose assessment, and know well about the psychological effects of radiation exposure and concerns about radiation exposure. Especially in tertiary radiation emergency medical institutions it is necessary to secure personnel who have knowledge and skills for radiation medicine including radiation dose assessment.

2) Human resource development according to actual local situations

With regards to personnel redeployment in medical institutions, it is necessary to draw up a seminar and training program for human resource development.

3) Cooperation between associated medical fields

The frequency of human exposure to radiation is very low, and the number of medical providers specializing in radiation medicine is small. To secure human resources, it is necessary to develop human resources for radiation medicine by organizing educational seminars and training in the fields of emergency medicine, disaster medicine, radiation medicine, nuclear safety and radiation protection.

4) Training

The national and local governments need to draw up plans for educational seminars and training, and periodically organize them, with the aim of maintaining and improving the knowledge and skills of personnel involved in radiation emergency medicine. Especially for disaster prevention training that the national and local governments periodically conduct, medical providers for radiation emergency should be also proactively encouraged to participate in it from its planning stage, and the role of radiation emergency medicine should be clarified.

(2) Seminar

Educational seminars for radiation medical providers should be held as follows.

1) Practical seminar programs for radiation medicine including radiation protection should be drawn up according to the role of medical providers.
2) Both indoor and field seminars should be conducted and aimed at a certain level of knowledge and skills for radiation medicine.
3) To clearly understand lateral cooperation between medical providers and the role of each medical provider, seminars should be conducted as practically as possible.
4) It is necessary to increase participants' motivation towards the next step by issuing a certificate to participants who complete seminars.

It is also important to conduct radiation medicine seminars as part of disaster medicine seminars for medical providers.

(3) Institutions for seminars

To effectively develop human resources for radiation medicine, institutions for human resource development including the National Institute of Radiological Sciences need to cooperate with each other, with due consideration and accommodation for their roles. Also, expert cooperation in medical institutions for radiation protection and treatment as well as in operators is essential.

(4) Development of instructors

The lack of instructors for radiation medicine seminars and training is problematic. The number of instructors who can give lectures at seminars is limited. It is, therefore, necessary to develop specialist doctors and experts in the radiation medicine field by improving education in graduate schools, and develop and secure instructors who know well about local situations.

(5) Training for radiation emergency medicine

Radiation medical institutions need to establish a system whereby they can share information on radiation-exposed patients to be transferred with the medical group of the Joint Council on Countermeasures against Nuclear Accidents in the off-site emergency center and the medical group at the disaster headquarters of local governments, and medical care can be provided according to the patients' conditions. It is, therefore, important to confirm the status of the radiation medical system during training, including radiation emergency medical teams and the acceptance of patients.

The national government's nuclear disaster prevention training is a training program that the national and local government, operators, emergency transportation services, medical providers and many other people participate in. Therefore, it is important that local medical providers for radiation emergency are encouraged to participate even in training planning and share ideas about the role of radiation emergency medicine in nuclear disaster prevention with other participants.

It is also important that nuclear operators, local governments and medical providers hold regional training as necessary, as well as to give training on the assumption that there are radiation-exposed patients who need emergency treatment regardless of assumed disaster scales.

5-3 Maintenance/Improvement of radiation dose assessment technologies and basic research promotion

(1) Maintenance/Improvement of radiation dose assessment technologies

To properly treat radiation-exposed patients, quick and accurate radiation dose assessment is important. It is, therefore, essential that personnel who assess radiation dose know well about radiation dose measurement methods, features of measurement equipment and histological effects of nuclides, and periodically maintain necessary equipment. Establishment of radiation dose assessment methods, by referring to new findings, and study and development of new radiation dose assessment technologies should be tried.

It is also necessary to carry over physical dosimetry and biodosimetry technique including electron spin resonance (ESR) analysis of teeth and nails, and chromosome analysis, and introduce new technologies.

(2) Promotion of basic research of radiation medicine and application of advanced medicine to radiation medicine

Basic research of the biological effects of radiation is necessary for the progress of

radiation medicine. It is also important to promote basic biological and medical research, including the effects of radiation on cells and DNA, and the health effects of low- and high-dose radiation exposure.

Radiation medical providers should observe the progress of advanced medicine including organ transplantation and regenerative medicine, and apply it to radiation medicine.

(3) Study on internal radiation exposure

The National Institute of Radiological Sciences should continue to study internal radiation exposure, which is necessary for radiation medicine.

5-4 Collection of information on rarely used radiation medicine through international cooperation

The frequency of events for which radiation medicine is necessary is low. The National Institute of Radiological Sciences should gather the latest information from around the world.

The establishment of a radiation emergency medical system is internationally important. In Asian countries, in particular, the use of radioisotopes, including nuclear power generation, has recently been increasing, so that a radiation medical system needs to be established.

Japan has been cooperating with other countries in radiation medicine as part of the programs of the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO). It is important to collect more information on radiation medicine by organizing workshops to share information with Asian countries.

Reference

[Note] This reference has been compiled from reports published in journals of international organizations. However, it has not been officially verified by either the Nuclear Safety Commission of Japan or the Nuclear Facility Disaster Prevention Expert Committee.

1. Emergency Medical System

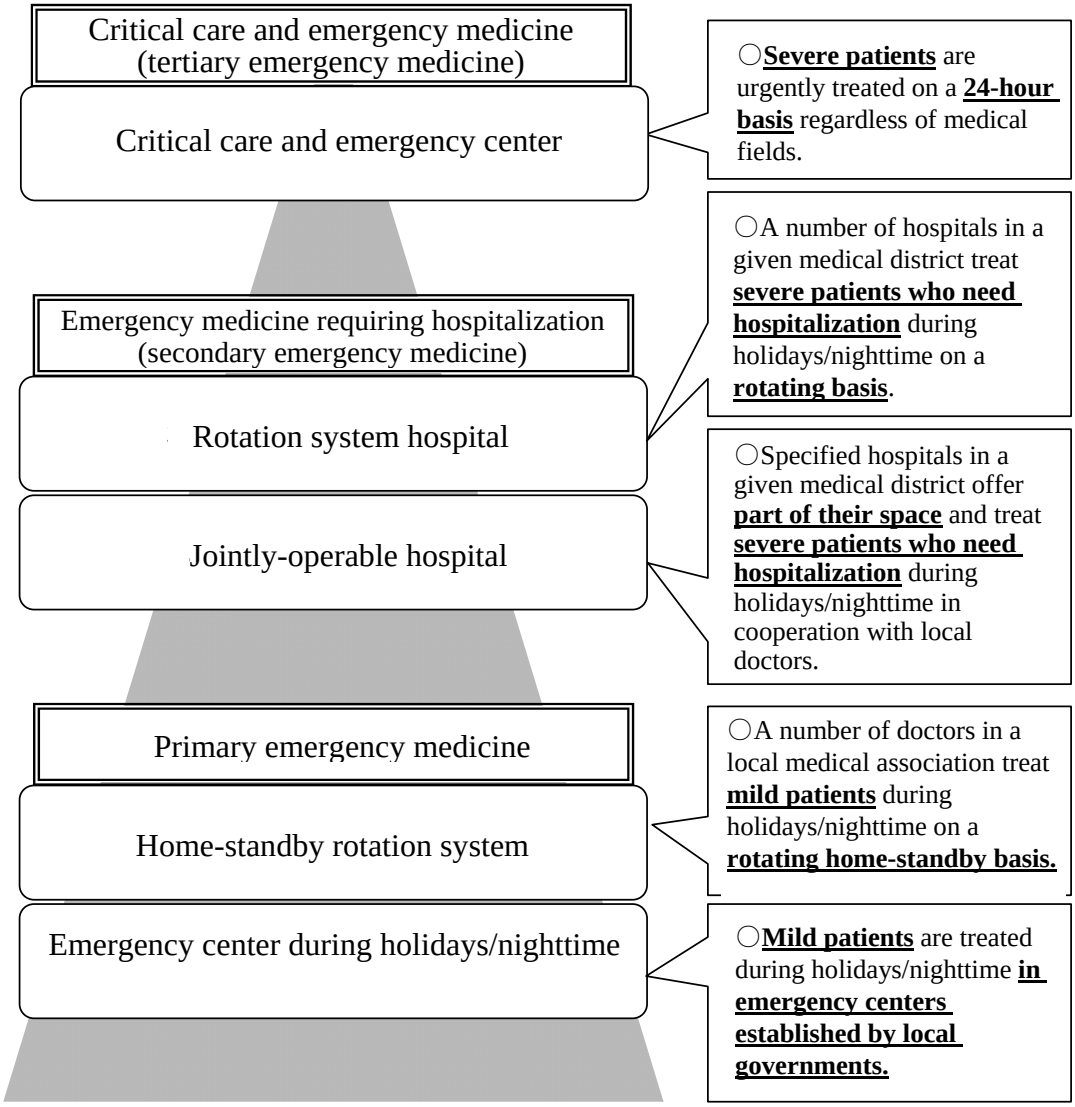


Figure 1-1 Emergency Medical System

2. Classification of Diseases and Injuries

The health effects of radiation exposure vary according to radiation doses and radiation exposure level.

Table 2-1 Major Symptoms Caused by Acute Local High-level Radiation Exposure

Stage	Severity and radiation dose (Gy)			
	Stage I (mild) 8-12 Gy	Stage II (moderate) >12-30 Gy	Stage III (severe) >30-50 Gy	Stage IV (serious) >50 Gy
Initial reaction (initial rash)	Initial reaction is observed for a few hours or is not observed.	Initial reaction is observed for a few hours to a few days.	Initial reaction is observed in all radiation-exposed patients for 2-6 days.	Initial reaction is observed in all radiation-exposed patients until the critical phase.
Latent phase	15-20 days after radiation exposure	10-15 days after radiation exposure	7-14 days after radiation exposure	Nil
Critical phase	Secondary rash	Secondary rash, edema and blister	Secondary rash, edema, pain syndrome, blister, erosion, initial radiation ulcer and purulent infection	Edema, pain syndrome, local hemorrhage and necrosis
Final symptoms of local radiation injury	25-30 days after radiation exposure, dry desquamation	Wet desquamation occurs 1-2 months after radiation exposure. Epithelialization is observed under the desquamated skin layer.	Progression of ulcer and delay of recovery (it takes a few months for recovery). Surgical treatment is necessary for the cure of deep ulcer, including skin transplantation.	Delays are observed in the cure of wounds and skin avulsion. Gangrene causing systemic intoxication and sepsis are observed 3-6 weeks after radiation exposure. For survival, radical treatment needs to be provided urgently.
Late effect (prognosis)	Dry skin and pigmentation	The skin, subcutaneous tissue and muscles may shrink. Radiation-induced late skin ulcer occurs.	Cicatrization and epithalaxia are observed. Proliferative, regressive or sclerotic changes are observed deep under the skin.	Effects of amputation, ulcer relapse and contracture are observed.

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to IAEA EPR-MEDICAL 2005 "Generic Procedures for Medical Response during a Nuclear or Radiological Emergency" on Page 76)

Table 2-2 Severity of Acute Radiation Syndrome (ARS) and Acute Radiation Exposure Level

Symptom and therapeutic method		Mild (1-2 Gy)	Moderate (2-4 Gy)	Severe (4-6 Gy)	Serious (6-8 Gy)	Fatal[(a)] (>8 Gy)
Vomiting	Occurrence time Incidence	2 hours later 10-50%	1-2 hours later 70-90%	Within one hour 100%	Within 30 minutes 100%	Within 10 minutes 100%
Diarrhea	Occurrence time Incidence	Nil — —	Nil — —	Mild 3-8 hours later <10%	Severe 1-3 hours later >10%	Severe Within a few minutes to one hour Near 100%
Headache	Occurrence time Incidence	Very mild — —	Mild — —	Moderate 4-24 hours later 50%	Severe 3-4 hours later 80%	Severe 1-2 hours 80-90%
Consciousness	Occurrence time Incidence	Absence of consciousness disturbance — —	Absence of consciousness disturbance — —	Absence of consciousness disturbance — —	Possibility of consciousness disturbance — —	Unconsciousness Within a few seconds to a few minutes -100% (>50 Gy)
Body temperature	Occurrence time Incidence	Normal — —	Slight fever 1-3 hours later 10-80%	Fever 1-2 hours later 80-100%	High fever Within one hour 100%	High fever Within one hour 100%
Therapeutic method		Outpatient treatment[*1]	Hospitalization in a general hospital or a specialized medical institution if necessary	Treatment in a specialized medical institution	Treatment in a specialized medical institution	Palliative treatment[(a)] advanced medicine including stem cell transplantation

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to IAEA/WHO Safety Reports Series No.2 “Diagnosis and Treatment of Radiation Injuries”, 1998, Vienna)

(a): With appropriate supportive treatment, patients receiving whole body exposure to high-level radiation (12 Gy) reportedly survived for more than three months.

(Note)

*1: Even if ARS is mild, it is necessary to carefully observe time courses and accordingly provide treatment including symptomatic treatment if radiation dose assessment is not conducted sufficiently. Patients should be hospitalized as necessary. If patients are discharged from the hospital, sufficient explanation needs to be provided to reduce their anxieties.

Table 2-3 Latent and Critical Phases of Acute Radiation Syndrome (ARS)

	Severity of ARS and acute radiation exposure level				
	Mild (1-2 Gy)	Moderate (2-4 Gy)	Severe (4-6 Gy)	Serious (6-8 Gy)	Fatal (>8 Gy)
Lymphocyte count ($\times 10^3/mm^3$) (3-6 days after radiation exposure)	0.8-1.5	0.5-0.8	0.3-0.5	0.1-0.3	0.0-0.1
Granulocyte count ($\times 10^3/mm^3$)	>2.0	1.5-2.0	1.0-1.5	≦0.5	≦0.1
Platelet count ($\times 10^3/mm^3$)	60-100 10-25%	30-60 25-40%	25-35 40-80%	15-25 60-80%	<20 80-100%(a)
Diarrhea	Nil	Nil	Very low incidences	6-9 days after radiation exposure	4-5 days after radiation exposure
Hair loss	Nil	Moderate, 15 days or more after radiation exposure	Moderate or total hair loss, 11-21 days after radiation exposure	Total hair loss, within 11 days of radiation exposure	Total hair loss, within 10 days of radiation exposure
Length of latent phase (day)	21-35	18-28	8-18	≦7	Nil
Clinical symptom	Feebleness and weakness	Fever, infection, hemorrhage and weakness	High fever, infection and hemorrhage	High fever, diarrhea, vomiting, vertigo, disorientation and decreased blood pressure	High fever, diarrhea and consciousness disturbance
Mortality Death time(b)	0	0-50% 6-8 weeks later	20-70% 4-8 weeks later	50-100% 1-2 weeks later	100% 1-2 weeks later
Therapeutic policy	Hospitalization is not necessary*1. Preventive treatment is applied.	Hospitalization is necessary. Special preventive treatment is applied after 14-20 days of radiation exposure. Patients are segregated in a bio-clean room after 10-20 days of radiation exposure.	Hospitalization is necessary. Special preventive treatment is applied after 7-10 days of radiation exposure. Patients are segregated in a bio-clean room during hospitalization.	Urgent hospitalization is necessary. Special preventive treatment is applied immediately after radiation exposure. Patients are segregated in a bio-clean room during hospitalization.	Symptomatic treatment only or hematopoietic stem cell transplantation

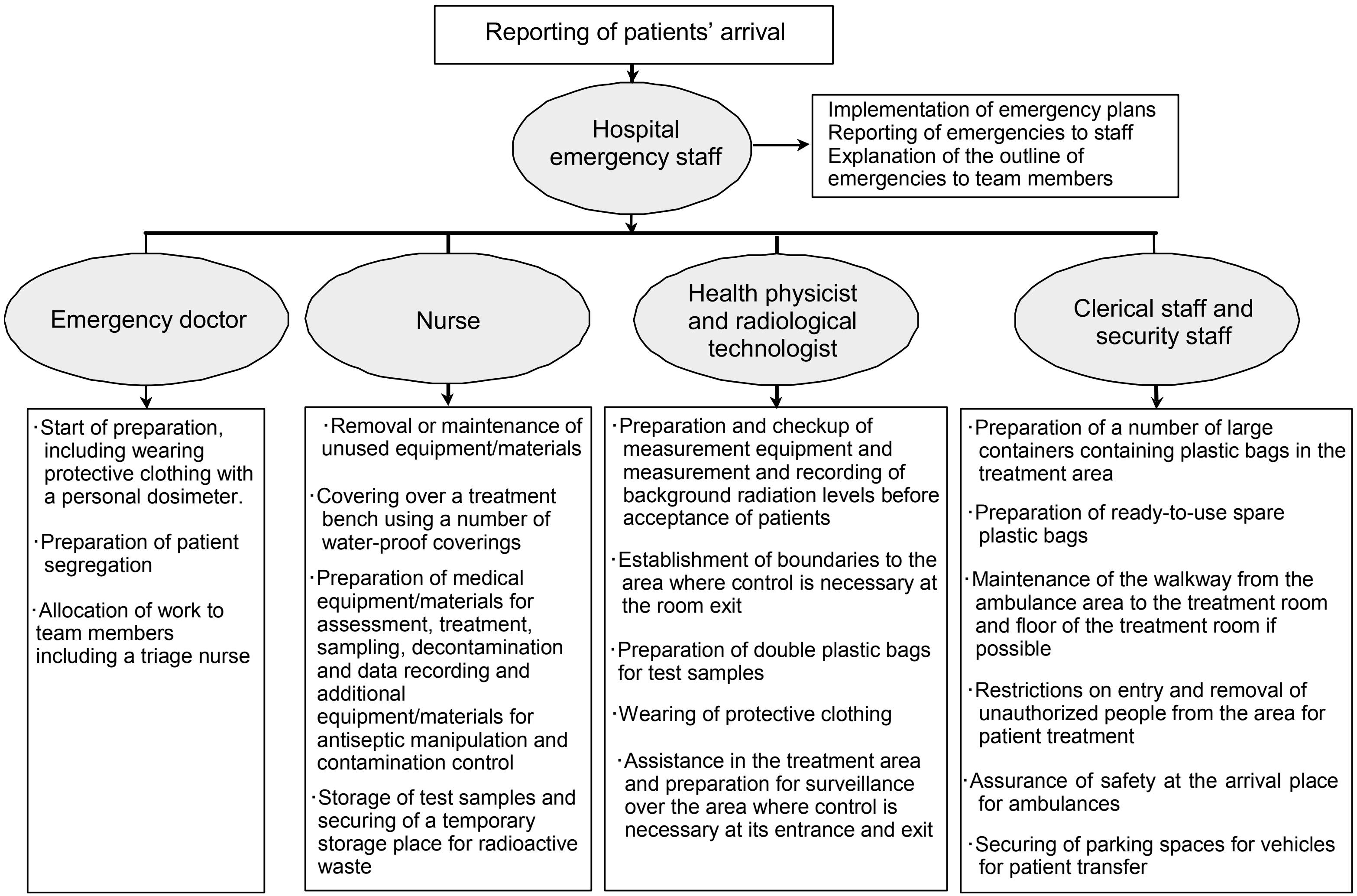
(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to IAEA/WHO Safety Reports Series No.2 Diagnosis and Treatment of Radiation Injuries)
(a): Patients exposed to very high-level radiation (>50 Gy) die before hematopenia occurs.
(b): Mortality and death time vary according to treatment.

(Note)
*1: Even if ARS is mild, it is necessary to carefully observe time courses and accordingly provide treatment including symptomatic treatment if radiation dose assessment is not conducted sufficiently. Patients should be hospitalized as necessary. If patients are discharged from the hospital, sufficient explanation needs to be provided to reduce their anxieties.

Table 2-4 Contamination Control Methods during Patient Transfer

Patient	Necessary of radiation protection	Method
Neither radiation exposure nor contamination is observed.	Absence	The absence of radiation injury and contamination needs to be ensured by checking the patient transfer sheet.
External radiation exposure only	Absence	
The absence of radioactive contamination can be ensured.	Presence	It is necessary to cover patients using a sheet or a blanket or to locally cover patients' body surface and wounds using a water-proof covering, which needs to be fixed with tape. A cap and shoe covers for surgical use are used as necessary
External contamination	Presence	
Internal contamination	Presence	Vomiting may cause contamination to spread to equipment and medical providers. It is necessary to take measures for the prevention of internal contamination spread.

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to IAEA EPR-MEDICAL 2005 "Generic Procedures for Medical Response during a Nuclear or Radiological Emergency" on Page 81)



(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to IAEA EPR-MEDICAL 2005 "Generic procedures for medical response during a nuclear or radiological emergency" on Page 47)

Figure 3-1 Allocation of Work for First Response in Hospital

4. Therapeutic Methods for Internal Radiation Exposure

Therapeutic methods for internal radiation exposure according to radionuclides that are identified by bioassay are shown below. For treatment, the latest information is to be referred to.

Table 4-1 Therapeutic Methods for Internal Contamination Mentioned in Generic Procedures for Medical Response during a Nuclear or Radiological Emergency (IAEA, 2005)

Radionuclide	Decontamination method	Precaution	Note
Americium (Am), californium (Cf), curium (Cm), neptunium (Np), plutonium (Pu), ruthenium (Ru), thorium (Th), ferrum (Fe), cobalt (Co) and zirconium (Zr)	**Drug:** Ca-DTPA (calcium diethylentriaminepentaacetic acid-trisodium) **Dosage/administration:** 1 g of Ca-DTPA using an optimal administration route **Administration route:** Intravenous administration (Either Ca-DTPA stock solution or Ca-DTPA solution diluted with 100-250 mL of either saline or 5% glucose solution is intravenously administered for 3-4 minutes.) or inhalation (20% Ca-DTPA solution aerosol (5 mL) or 25% Ca-DTPA solution aerosol (4 mL), prepared using an ampoule, is inhaled for 30 minutes.)	Blood pressure is monitored during intravenous administration. Ca-DTPA cannot be used in patients having either nephrotic syndrome or bone marrow suppression. Zn-DTPA is used in pregnant women if possible. The DTPA drugs cannot be used in patients contaminated with large amounts of uranium because uranium may remain in the kidneys and cause acute nephritis.	If is difficult to obtain Ca-DTPA, Zn-DTPA is used instead[*1]. However, Ca-DTPA is approximately 10 times more effective than Zn-DTPA for 24 hours after administration. If the DTPA drugs are administered within four hours of the administration of a soluble compound, radiation doses can be reduced by approximately 80%, but their efficacy is reduced to less than 25%.
Cesium (Cs)	**Drug:** Prussian blue (ferric ferrocyanide) **Dosage/administration:** The drug (1 mg/dose) is administered three times a day. In children a daily dose of 1-1.5 g is divided into 2-3 doses. The drug is administered for a few days. **Administration route:** Oral dose (The drug is orally administered either in the form of a capsule with a small amount of water or after being dissolved in lukewarm water.)	The drug is not contraindicated for use and is effective in anyone having normal digestive function. The stool color changes to blue, so this must be explained to patients.	The drug can reduce radiation doses to approximately 1/2-1/3. If it is indicated for clinical use, it can be administered to pregnant women. HEYL GmbH in Germany is selling it in the 0.5 g capsule formulation (Radiogardase®-Cs), often called Berlin blue or ferric ferrocyanide.
Cobalt (Co)	**Drug:** Co-EDTA (ethylenediaminetetraacetato cobaltate) **Dosage/administration:** The drug (0.6 g, two ampoules of 300 mg/20 mL) is administered. **Administration route:** Intravenous administration (Co-EDTA solution (40 mL) is intravenously administered slowly, followed immediately by the intravenous administration of hypertonic glucose solution.)	Blood pressure is monitored during intravenous administration.	Co-EDTA is manufactured by Serb Labs under the brand name of Kelocyanor®. If it is difficult to obtain it, Ca-DTPA can be used instead[*2].
	Drug: cobalt gluconate		Cobalt gluconate is

	Dosage/administration: The drug (0.9 mg, two ampoules of 0.45 mg/2 mL) is administered. **Administration route:** Sublingual administration (The drug is not diluted.)		manufactured by Labcatal Labs under the brand name of Cobalt Oligosol®.
Iron (Fe)	**Drug:** deferoxamine (Desferal®, Novartis Pharma) **Dosage/administration:** The drug (1 g, two 500 mg vials) is administered. **Administration route:** Intravenous administration (The drug is prepared using sterile water (5 mL/vial), diluted with at least 100 mL of saline and intravenously administered slowly (15 mg/kg/h).)	Its quick administration may cause prostration. The drug needs to be administered under a doctor's supervision.	Deferoxamine is often called DFOA or desferrioxamine.
	Drug: colloidal aluminum phosphate **Dosage/administration:** The drug (five 20 g sachets) is administered. **Administration route:** Oral administration (One sachet contains 2.5 g of aluminum phosphate.)	The drug is administered if patients took up the radionuclide.	
Radium (Ra)	**Drug:** ammonium chloride (Chlorammonic®, Chiesi) **Dosage/administration:** A daily dose of 6 g is divided into three doses (four tablets per dose). **Administration route:** Oral administration (One tablet contains 500 mg of ammonium chloride.)	The drug cannot be used in patients concomitantly having metabolic acidosis, uric acid calculus, kidney failure, hepatic failure, nephritis or uremia.	
	Drug: barium sulfate (Micropaque®, Guerbet) **Dosage/administration:** The drug (300 mg) is administered once. **Administration route:** Oral administration (One Micropaque® vial contains 100 g of barium sulfate.)	The drug may cause mild constipation.	
Ruthenium (Ru)	**Drug:** colloidal aluminum phosphate **Dosage/administration:** The drug (five 20 g sachets) is administered.	The drug is administered if patients took up the radionuclide.	

	Administration route: Oral administration (One sachet contains 2.5 g of aluminum phosphate.)		
Strontium (Sr)[*3]	**Drug:** ammonium chloride (Chlorammonic®, Chiesi) **Dosage/administration:** A daily dose of 6 g is divided into three doses (four tablets per dose). **Administration route:** Oral administration (One tablet contains 500 mg of ammonium chloride.)	The drug cannot be used in patients concomitantly having metabolic acidosis, uric acid calculus, kidney failure, hepatic failure, nephritis or uremia.	Instead of ammonium chloride, calcium gluconate can be used. The drug (1 g) is intravenously administered for 5-15 minutes. Its quick administration may decrease blood pressure.
	Drug: sodium alginate (Gaviscon®, SmithKline Beecham) **Dosage/administration:** A daily dose of 10 g is divided into 1-2 doses. **Administration route:** Oral administration (The solution (200 mL) containing 5 g/100 mL of sodium alginate is orally administered.)		If it is difficult to obtain the solution, the tablet is orally administered with half a cup of water without chewing. (One table contains 0.26 g of sodium alginate.)
Thorium (Th)[*4]	**Drug:** colloidal aluminum phosphate **Dosage/administration:** The drug (five 20 g sachets) is administered. **Administration route:** Oral administration (One sachet contains 2.5 g of aluminum phosphate.)	The drug is administered if patients took up the radionuclide.	
Tritium (^{3}H)	**Drug:** water **Dosage/administration:** Water (3-4 L/day) is orally administered. **Administration route:** Oral administration		Oral water loads reduce the biological half-life of tritiation to 1/2-1/3.
Uranium (U)	**Drug:** isotonic sodium bicarbonate solution (1.4% $NaHCO_3$) **Dosage/administration:** Isotonic sodium bicarbonate solution (250 mL) is administered. **Administration route:** Intravenous administration (The solution is intravenously administered slowly for a number of days according to the progression of contamination.)	Isotonic sodium bicarbonate solution is alkaline. Blood pH and electrolyte count need to be monitored. It may worsen or elicit hypopotassemia. Sodium ion is inhibited for use in patients showing sodium retention.	Instead of isotonic sodium bicarbonate solution, two sodium bicarbonate tablets are orally administered every four hours until urine pH reaches 8-9[*5]. If patients are contaminated through the skin, the skin is washed with 1.4% isotonic sodium bicarbonate solution.

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to IAEA EPR-MEDICAL 2005 "Generic Procedures for Medical Response during a Nuclear or Radiological Emergency" on Pages 70-72)

(Note)

*1: Ca-EDTA [Literature 1] and deferoxamine [Literature 1] are reportedly effective to some extent. It is also reported that their efficacy persists for some time [Literature 2].

*2: Recent reports recommend D-penicillamine[Literature 1] and DTPA[Literature 1].

*3: It is also reported that stable strontium is effective. (Stable strontium is sold overseas as a drug for osteoporosis under the name of strontium ranelate[Literature 1].)

*4: Deferoxamine[Literature 1] and DTPA[Literature 1] are reportedly effective to some extent.

*5: According to some experts, sodium bicarbonate is contraindicated for oral use in patients taking up high concentrations of uranium because it increases uranium concentrations in the kidneys of such patients.

Literature 1: NCRP Report No. 65, Management of Persons Accidentally Contaminated with Radionuclides (the fifth edition, 1993)

Literature 2: Grappin et al. TREATMENT OF ACTINIDE EXPOSURES: A REVIEW OF Ca-DTPA INJECTIONS INSIDE CEA-COGEMA PLANTS Radiation Protection Dosimetry (2007), pp. 1–5

5. Radiation Dose Assessment Method

Radiation dose assessment is categorized into physical assessment including the measurement of radiation energy or radioactivity and biological assessment including the estimation of radiation doses by chromosome analysis. Radiation measurement methods vary according to radiation types and radioactive substances.

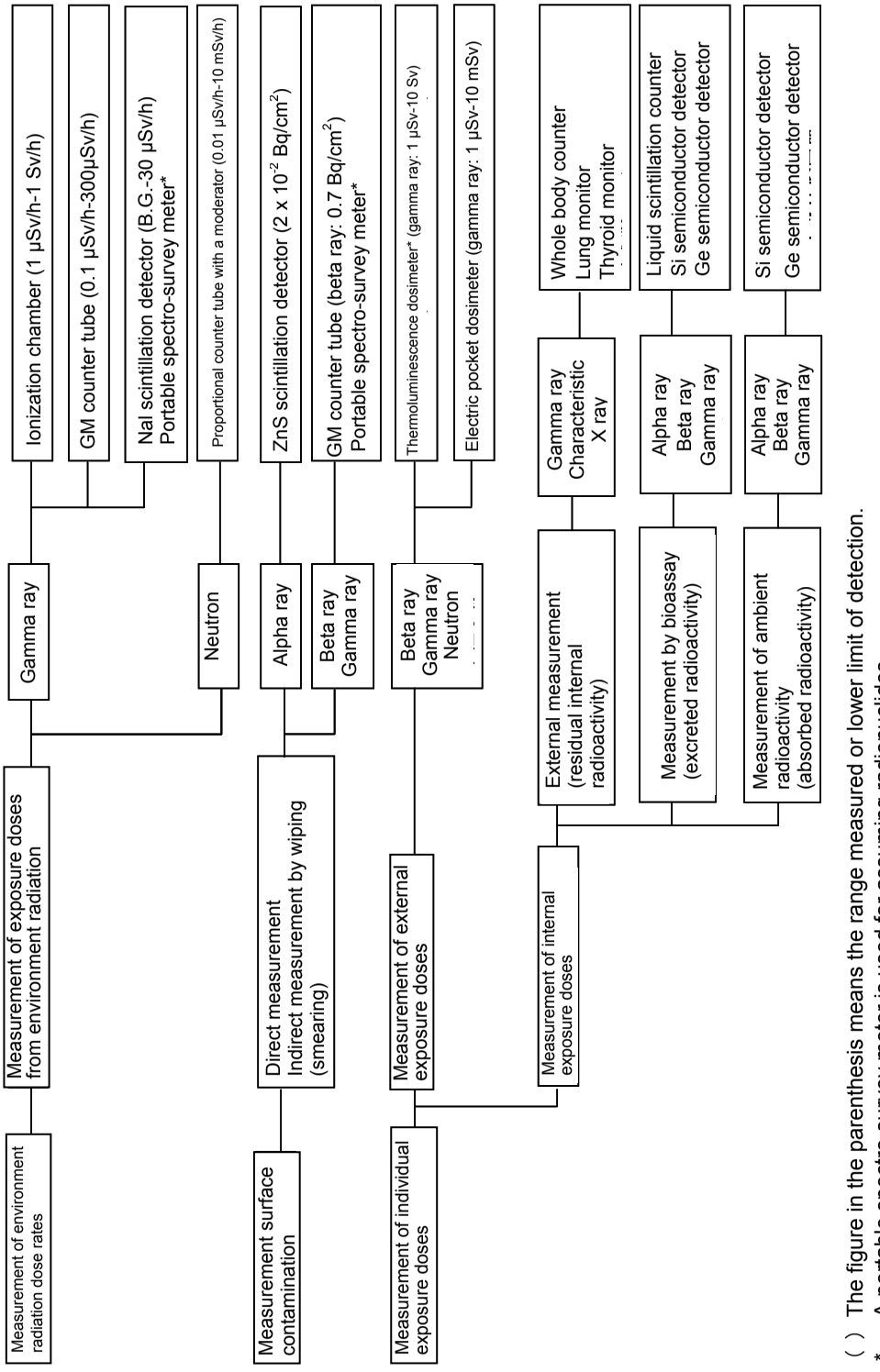


Figure 5-1 Radiation Measurement Methods Related to Radiation Dose Assessment (Environmental monitoring and individual monitoring)

Table 5-1 Identification of Radionuclides Causing Internal Contamination by Bioassay of Test Samples

Radionuclide	Test sample	Analytical method or equipment
H-3, C-14, Sr-89, 90,P-32	Urine	Liquid scintillation counter
Fe-59	Urine	Gamma ray spectrometry
Co-57, 58, 60	Urine, feces	Gamma ray spectrometry
Sr-85, 89, 90	Urine	Liquid scintillation counter
Ru-106	Urine	Gamma ray spectrometry
I-125, 129, 131	Urine	Gamma ray spectrometry, Liquid scintillation counter
Cs-134, 137	Urine	Gamma ray spectrometry
Ra-226, 228, Pb-210	Urine	Proportional counter tube
Uranium	Urine	Spectrophotometry, alpha ray spectrometry, ICP-MS*1
Thorium	Urine, feces	Spectrophotometry, alpha ray spectrometry, ICP-MS*1
Pu-238, 239, 240	Urine, feces	Alpha ray spectrometry
Np-237	Urine, feces	Gamma ray spectrometry
Am-241	Urine, feces	Alpha ray spectrometry
Cm-242, 244	Urine, feces	Alpha ray spectrometry
Cf-252	Urine, feces	Gamma ray spectrometry, Alpha ray spectrometry
Other radionuclides	Urine, feces	Gamma ray spectrometry

*1: Inductively coupled plasma mass spectrometer

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to IAEA EPR-MEDICAL 2005 "Generic Procedures for Medical Response during a Nuclear or Radiological Emergency" on page 127)

6. First Response at Nuclear Emergency Area

The International Atomic Energy Agency (IAEA) compiled a manual for first responders to a radiological emergency, which is used when the status of radiation exposure and radioactive contamination are unknown.
The National Council on Radiation Protection (NCRP) in the US also compiled an instruction manual.
The outline of the IAEA's manual is shown below.

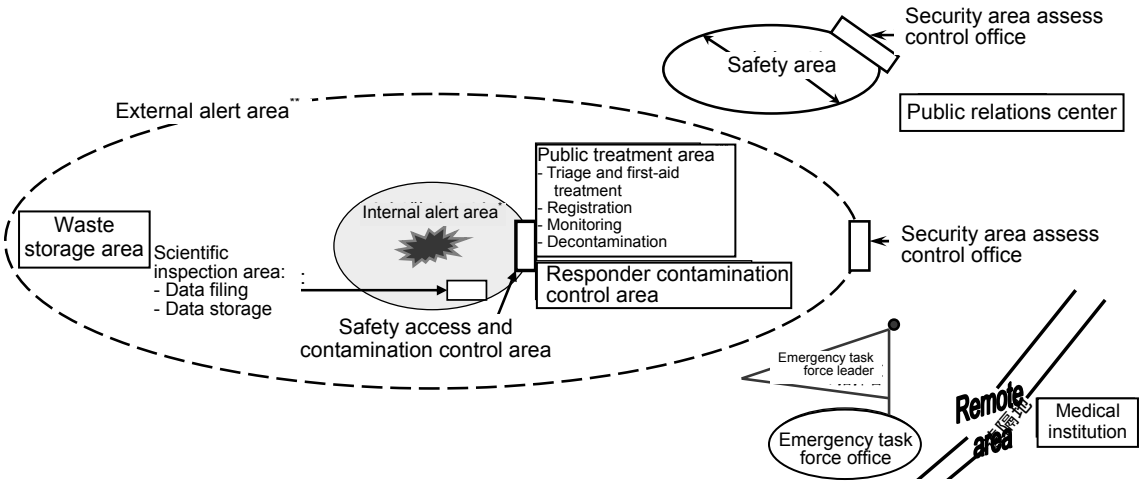


Figure 6-1 Facilities and their locations in nuclear emergency area

* Internal alert area (hot zone): safety boundary, the area where preventive measures are taken to protect first responders and residents from external radiation exposure and radioactive contamination
** External alert area: security boundary, the area where safety is ensures
*** Area with a radiation dose rate of ≤0.3 μSv/h

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to EPR FIRST RESPONDERS 2006 "Manual for First Responders to a Radiological Emergency"
The manual was created as guidance for first response within a few hours of the discovery of abandoned, lost or stolen radiation sources, misuse of radiation sources, public radiation exposure or contamination of unknown causes, serious excessive radiation exposure (medical radiation accidents), criminal threat/act and emergencies during transfer.)

Table 6-1 IAEA's Specifications for Internal Alert Area

	Situation	Internal alert area (safety boundary)
Initial decision - Outside of nuclear facility	Unshielded or damaged radiation source	Approximately 30 m in radius
	Massive radiation leakage	Approximately 100 m in radius
	Fire, explosion and gas leakage (inflammable or explosive) near radiation source	300 m in radius
	Suspicion of an exploded or unexploded bomb (possibility of a radioactive substance releasing device)	400 m or more in radius for protection from explosion
Initial decision - Inside of nuclear facility	Damage to radiation source, loss or shielding or radiation leakage	Affected area and adjoining area (including upper and lower floors)
	Fire at a radiation source, which may expand to the whole facility (through ventilation) and other accidents	Whole facility and the above-mentioned distances from facility
Expansion according to radiation monitoring	Radiation dose rate of 100 μSv/h	All areas where radiation dose rate is 100 μSv/h

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to EPR FIRST RESPONDERS 2006 "Manual for First Responders to a Radiological Emergency")

If environmental radiation dose rates can be measured, the IAEA's and NCRP's guidelines can be referred to for the determination of the areas.

(1) IAEA: EPR FIRST RESPONDERS 2006 "Manual for First Responders to a Radiological Emergency"

- ○ Lower limit of the environmental radiation dose rate when gamma ray dose rates are known

  Lifesaving: 100 mSv/h (The area where environmental radiation dose rate is lower than 100 mSv/h is accessible without the supervision of personnel for radiation assessment. If higher, it is allowed to stay for less than 30 minutes under the supervision of personnel for radiation assessment.)

(2) NCRP: NCRP Commentary No. 19, Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism (Guidelines for emergency responses for nuclear or radioactive attacks)

- ○ Lower limit of the radiation dose in the external alert area
  Radiation dose rate: 10 mR/h (air kerma rate: ≤0.1 mGy/h)
- ○ Lower limit of the radiation dose in the internal alert area
  Radiation dose rate: 10 R/h (air kerma rate: ≤0.1 Gy/h)

7. Major Nuclear Accidents in the World

Table 7-1 Nuclear Reactor Accidents

Nuclear plant/country	Year of accident	Accident	Damage
Windscale plant (No. 1 reactor) (GCR), UK	1957	Fuel meltdown occurred due to overheating of the graphite moderator during the release of Wigner energy. The graphite moderator was burned. A large amount of radiation leaked. The shipping of milk produced around the plant was stopped.	Fourteen workers (whole body) were exposed to radiation higher than ICRP's permissible dose.
SL-1 plant (BWR), US	1961	The rapid withdrawal of the central control rod increased nuclear reactions, resulting in the excessive nuclear energy release.	Three workers were killed
Three Mile Island plant (No. 2 reactor) (PWR), US	1979	The malfunction of the pilot-operated pressurizer relief valve caused the primary cooling water to pour out. The nuclear cooling system was urgently stopped by the operator. The nuclear reactor core was seriously damaged.	No large amounts of radioactive substances were released into the environment. The maximum radiation dose among residents around the plant was 1 mSv.
Saint Laurent plant (No. 2 reactor) (GCR), France	1980	The channel part was blocked out by foreign bodies in the primary system, resulting in fuel meltdown.	A small amount of radioactive substances was released into the environment.
Chernobyl plant (No. 4 reactor) (RBMK), former USSR	1986	A low-power turbine experiment was conducted. Steam voids were formed, leading to increased reactor power. The fuel rod and nuclear reactor was damaged, and the graphite moderator and building were burned.	A large amount of radioactive substances was released in the environment. Thirty-one people were killed, and more than 200 were diagnosed with acute radiation injury.
Sarrey plant (No. 2 reactor) (PWR), US	1986	The main water pipe was broken due to reduction of its thickness.	Eight workers had burn injuries due to the release of high-temperature steam, of whom four died later.
Narora plant (No. 2 reactor) (PHWR), India	2000	When 180 MWe power was produced, heavy water leaked from the flange joint on the flow-in side of the moderator pump. The water level in the calandria tube was lowered. To stop the reactor, the primary and secondary shutdown systems were manually started. Seven tons of heavy water leaked from the moderator system, but most of it was recovered.	Two workers inhaled tritium gas when shutting away the leakage area. (<20 mSv/year)
Le Blayais plant (PWR), France	2001	The contract worker was exposed to radiation when inspecting the welding part of the radiation source. The cause was that a worker did not change the films without putting the radiation source in a safe place, as instructed.	One contract worker was exposed to radiation. (16 mSv)
Madras plant (PHWR), India	2002	The worker taking radiographs in the adjuvant turbine system outside the reactor building was exposed to radiation. The cause was that the radiation source was not placed properly in the shielded and remote-controlled room.	One radiological technologist was exposed to radiation. (151 mSv)
Fessenheim plant (No. 1 reactor) (PWR), France	2004	The filter in the purification system was blocked due to the workers' valve operation error, leading to the leakage of the radioactive ion exchange resin. The reactor was stopped for filter washing.	Seven workers were exposed to radiation (≤0.5 mSv)
Mihama plant (No. 3 reactor) (PWR), Japan	2004	The A-system cooling pipe from the fourth steam exchanger to the steam generator located near the ceiling of the second floor of the turbine hall burst.	Five workers from a cooperative company were killed by the leakage of steam and high-temperature water, six have injuries.
Atucha plant (No. 1 reactor) (PHWR), Argentine	2005	The worker was exposed to tritium during the calibration of the newly replaced fuel exchanger.	One worker was exposed to radiation higher than the permissible dose. (41.85 mSv)

(Note) RBMK: reaktor bolshoy moshchnosti kanalniy (former USSR), PWR: pressurized water reactor, PHWR: pressurized heavy water reactor, BWR: boiling water reactor, GCR: Gas cooled reactor

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to the nuclear encyclopedia ATOMICA and assessment of instances of radiation exposure in accordance with the International Nuclear Event Scale (INES))

Table 7-2 Accidents at Reprocessing Plants

Reprocessing plant/country	Year of accident	Accident	Damage
Savannah River plant, US	1953	Explosion of the first cycle feed tank due to the acute thermal cracking of the TBP-uranyl nitrate complex	Equipment and part of the building were damaged. Two operators had injuries.
Kyshtm plant, former USSR	1957	Explosion of the high-level waste liquid tank, explosion of an organic mixture (acetate, etc.) due to the breakdown of the cooling system	A large amount of radioactive substances were released into the environment. Thirty-four thousand people were exposed to radiation, and approximately 10,000 evacuated.
Windscale plant (Sellafield), UK	1973	Fire of the solvent extraction system due to the insoluble residual organic solvent	Thirty-five people including operators were exposed to radioactive aerosol.
Savannah River plant, US	1975	Explosion during the denitrification process due to the acute thermal cracking of the TBP-uranyl nitrate complex	Equipment and part of the building were damaged. Two operators had injuries.
La Hague plant, France	1980	Fire of the electric system caused by a short-circuit	Emergency treatment was carried out. No contamination was left.
Eurochemic/bitumen encapsulation plant, Belgium	1981	Fire during bitumen encapsulation due to acute chemical reaction between bitumen and nitrate salt	Equipment was damaged. Workers had external radiation exposure, and two for filter changing had the whole body exposed to radiation (0.6 mSv). A small amount of radioactive substances was released into the environment (2.85 MBq total between beta and gamma rays).
Tomsk plant, former USSR	1993	Explosion of the tank containing stored radioactive liquid waste due to the acute thermal cracking of the TBP-uranyl nitrate complex	Equipment and the building were damaged, and radioactive substances were released into the environment (Pu: 37 GBq; 1.5 TBq total between beta and gamma rays).
Hanford plant (plutonium reprocessing), US	1997	Explosion of the reagent tank in the plutonium reprocessing plant due to the acute thermal cracking of hydroxylamine nitrate (HAN)	Equipment and part of the building were damaged.
Bitumen encapsulation plant, Japan	1997	Fire during the bitumen encapsulation process due to the acute chemical reaction between bitumen and nitrate salt	Equipment was damaged. Thirty-seven workers were exposed to radiation (internal exposure, 0.4-1.6 mSv at maximum).
THORP, UK	2005	Workers were contaminated with radiation when changing the thermocouples of head-end dissolver C. The workers moved around in the plant for monitoring, causing the spread of contamination	Three workers had their faces and hands contaminated.

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to the nuclear encyclopedia ATOMICA and assessment of instances of radiation exposure in accordance with the International Nuclear Event Scale (INES))

Table 7-3 Major Criticality Accidents

Facility/country	Date of accident	Type of facility	Damage
LASL, Los Alamos, US	June 6, 1945	Critical assembly	Three workers were exposed to radiation (0.069-0.61 Gy[*1]).
LASL, Los Alamos, US	August 21,1945	Critical assembly	Two workers were exposed to radiation, of whom one died later (0.5 Sv and 5.1 Sv).
LASL, Los Alamos, US	May 21, 1946	Critical assembly	Eight workers were exposed to radiation, of whom one died later (0.37-3.6 Sv and 2.1 Sv).
LASL, Los Alamos, US	December, 1949	Nuclear rector	One worker was exposed to radiation (0.025 Sv).
ZEEP, Chalk River, US	~ 1950	Critical assembly	Three workers were exposed to radiation (annually permissible dose or more).
ANL, ZPR-1, Argonne, US	June 2, 1952	Critical assembly	Four workers were exposed to radiation (0.084-1.26 Gy*).
ORNL, Y-12, Oak Ridge, US	June 16, 1958	Uranium enrichment plant	Eight workers were exposed to radiation (0.29-4.61 Sv).
Boris Kidric, Vinca, Yugoslavia	October 15, 1958	Critical assembly	Six workers were exposed to radiation, of whom one died later (2.05-4.33 Sv).
LASL, Los Alamos, US	December 30, 1958	Plutonium enrichment plant	Three workers were exposed to radiation, of whom one died later (0.53 Sv, 1.34 Sv and 12 Sv).
ICPP, Idaho Falls, US	October 16, 1959	Reprocessing plant	Nineteen workers were exposed to radiation (0.32 Sv and 0.5 Sv in two and small doses in the remaining 17).
NRTS SL-1, Idaho Falls, US	January 3, 1961	Nuclear rector	Three workers died from injuries.
ICPP, Idaho Falls, US	January 25, 1961	Reprocessing plant	The number of workers exposed to radiation remains unknown (≤0.60 μSv).
Hanford Recuplex, Richland, US	April 7, 1962	Plutonium enrichment plant	Three workers were exposed to radiation (0.19 Sv, 0.43 Sv and 1.10 Sv).
LRL, Livermore, US	March 26, 1963	Critical assembly	1.20 μSv at maximum
UNC, Wood River Junction, US	July 24, 1964	Uranium enrichment plant	Three workers were exposed to radiation, of whom one died later (approximately 100 Sv, 0.60 Sv and 1.00 Sv).
VENUS, Mol, Belgium	December 30, 1965	Critical assembly	One worker was exposed to radiation (3.00-4.00 Sv to the head, 5.00 Sv to the chest and ≤40.0 Sv to the left leg).
BNFL, Windscale, UK	August 24, 1970	Plutonium enrichment plant	Two workers were exposed to radiation (≤0.02 Sv).
RA-2, Buenos Aires, Argentine	September 23, 1983	Critical assembly	One worker died (3.70 Sv).
Sarov, FKBN-2M, Russia	June 17, 1997	Critical assembly	One worker died (4.85 Sv).
JCO, Tokaimura, Ibaraki, Japan	September 30, 1999	Processing plant	Three workers were exposed to radiation, of whom two died later (1.0-4.5, 6.0-10 and 16-20 gray equivalent).

*1: absorbed dose; 1 rep = 0.0093 Gy, and effective or equivalent dose; 1 rem = 0.01 Sv

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to the nuclear encyclopedia ATOMICA)

Table 7-4 Major Nuclear Accidents Causing Deaths from Exposure to Radioisotopic Radiation Source

Country	Year of accident	Facility (radiation source)	Number of deaths	
			Radiological worker	Ordinary people
Switzerland	1961	Tritium plant	1	
Mexico	1962	Radiation source for radiography		4
China	1963	Seed irradiation equipment		2
Former West Germany	1964	Tritium plant	1	
Italy	1975	Food irradiation	1	
Algeria	1978	Radiation source for radiography		1
US	1981	Radiation source for industrial radiography	1	
Norway	1982	Radiation source for sterilization	1	
Morocco	1984	Radiation source for radiography		8
Brazil	1987	Radiation source for medical use		4
China	1990	Radiation source for sterilization	2	
China	1992	Radiation source for irradiation		3
Thailand	2000	Radiation source for medical use		3
Egypt	2000	Radiation source for radiography		2
Panama	2001	Radiation source for medical use		8
Georgia	2001	Unknown radiation source (^{90}Sr)		1
China	2004	Radiation source for food irradiation (^{60}Co)	2	

(Reference) Recent high-level radiation exposure

Country	Year of accident	Facility (radiation source)	Casualty		Radiation dose
			Radiological worker	Ordinary people	
Chile	2005	Unknown radiation source (^{192}Ir)		1	≥2,000 Gy*
Belgium	2006	Radiation source of sterilization (^{60}Co)	1		4.8 Gy

*1: partial exposure of the kidneys

(Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to the survey by the National Institute of Radiological Sciences, ΑΤΟΜΟΣ (Volume 31, No. 4 (1989)), Journal of Japanese Society of Radiation Chemistry (Volume 42, No. 9 (1999)), Recent Lost Source Events reported to INES and assessment of instances of radiation exposure in accordance with the International Nuclear Event Scale (INES))

8. International Network for Support to Nuclear or Radiological Emergencies

8.1 Response Assistance Network (RANET)

International measures against nuclear or radiological emergencies were approved at the IAEA's conference in 2004. In 2005, the Incident and Emergency Center (IEC), which plays a key role in emergency response, was established. The former emergency response network was newly named the Response Assistance Network (RANET).

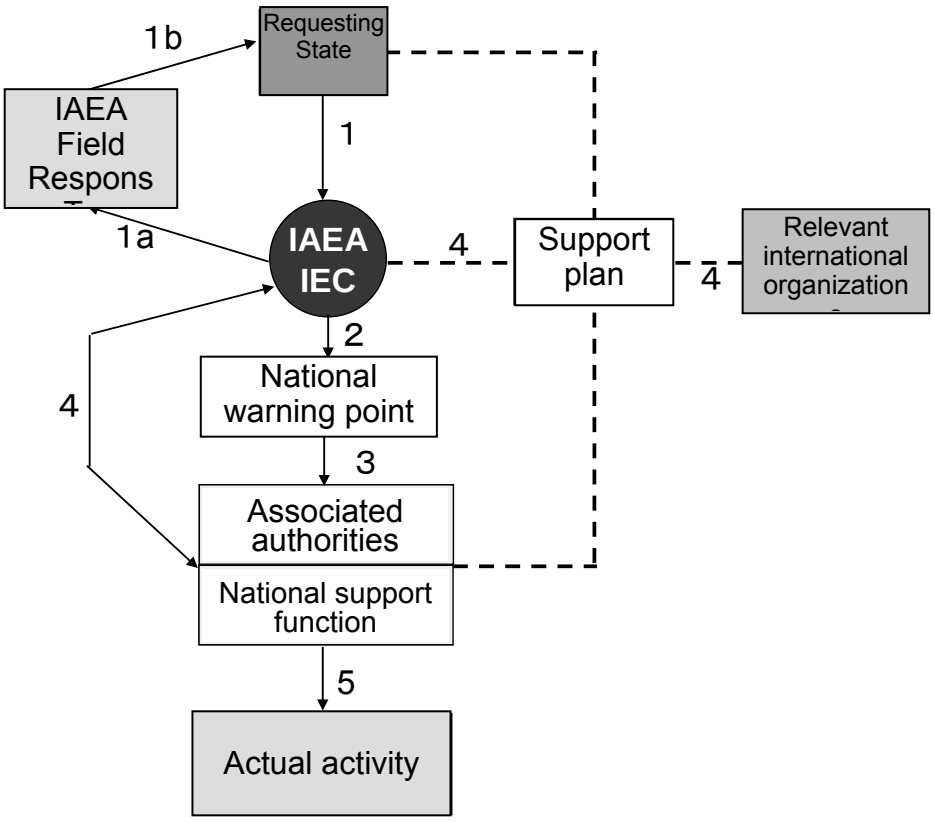


Figure 8-1 Concept of RANET

1) A national government asks for support from IEC.
   1a and 1b) IEC sends IAEA's response team and determines the status of the nuclear or radiological emergency and necessity of support.
2) If IEC determines that alerts are necessary from the activity of RANET's information providers,
3) IEC contacts associated institutions in other countries.
4) Associated institutions in requesting states discuss with IEC about support. IEC draws up support plans, in consultation with the associated institutions and international institutions.
5) Support is provided in accordance with the support plans.
   (Created by the Nuclear Facility Disaster Prevention Expert Committee in reference to EPR-RANET 2006, IAEA Response Assistance Network, Incident and Emergency Centre on Page 12)

8-2 Radiation Emergency Preparedness and Network (REMPAN)

Following the nuclear reactor accident in Chernobyl in 1986, the framework of an international system against nuclear and radiological emergencies has been established in accordance with two international agreements[*1]. In 1987, WHO established the Radiation Emergency Preparedness and Network (REMPAN) under the two international agreements, with the aim to organize educational seminars and give advice and coordinate assistance regarding emergency treatment and public hygiene to people over-exposed to radiation, including the promotion of long-term follow-up, epidemiological research and diagnosis of people exposed to radiation and research of radiation dose assessment. To achieve this aim, institutions in 22 countries specializing in medical diagnosis/treatment for radiation injury, radiation dose assessment, medical care, long-term follow-up and internal radiation exposure are participating in the network. Also, collaboration centers[*2] and liaison institutions[*3], appointed by WHO, are participating in the network, and WHO's headquarters controls them in accordance with the Radiation & Environmental Health (WHO/RAD) Programme. Ulm University in Germany has created a database on past radiation exposure accidents in cooperation with Russia and Ukraine.

*1 The aim of the "Convention on Early Notification of a Nuclear Accident" is to enhance international cooperation by providing the signatories with emergency information on nuclear accidents to prevent or minimize cross-boundary radiological effects.
The aim of the "Convention on Assistance in the Case of a Nuclear Accident" is to facilitate prompt assistance and support to minimize the effects of nuclear or radiological emergencies and to protect health and environments from the effects of radioactive substances.

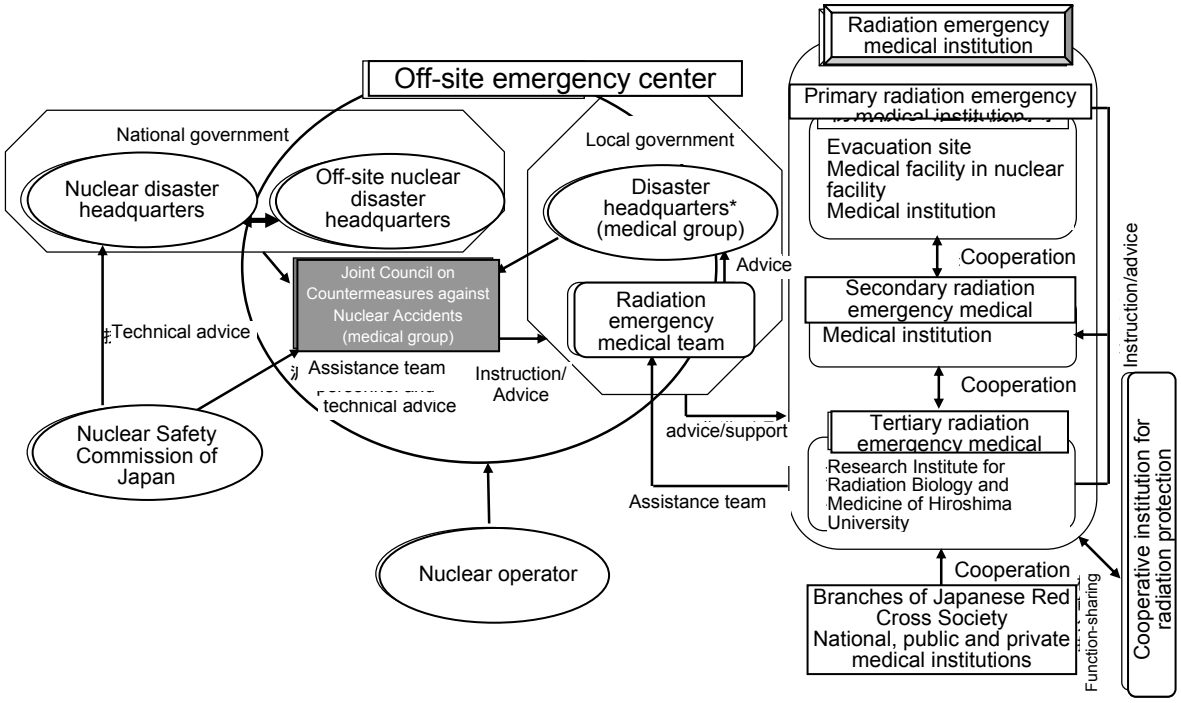
*2 Collaboration centers: They are designated by the WHO Secretary-General. They cooperate with WHO in the fields of nursing care, occupational health, infectious diseases, nutrition, mental health, chronic diseases, health technologies and radiation. There are 900 centers in 99 countries, and 15 centers in 10 countries are participating in REMPAN. In Japan, the Radiation Effects Research Foundation and the Atomic Bomb Disease Institute of Nagasaki University Graduate School of Biomedical Sciences are designated.

*3 Liaison institutions: They are institutions unofficially accredited by WHO's coordinator in charge of REMPAN. There are 24 institutions in 16 countries. In Japan, the National Institute of Radiological Sciences and the Research Institute for Radiation Biology and Medicine of Hiroshima University are accredited.

9. Radiation Emergency Medical System and Seminars for Emergency Excercise

9.1 Radiation emergency medical system for emergency excercise

A The radiation emergency medical system for nuclear emergencies is shown below. Emergency excercise should be conducted in line with the system.



*Local governments establish on-site disaster headquarters as necessary.

Figure 9-1 Radiation Emergency Medical System for Nuclear Emergencies

Instruction/

9.2 List of seminars for disaster prevention in FY2009

Table 9-1 List of Seminars for Disaster Prevention in FY2009

<table>
<tr><th>Category</th><th>Basic seminar (beginner's level)</th><th>Practical seminar (intermediate level)[*1]</th><th>Special seminar (advanced level)[*2]</th></tr>
<tr><td>Attendee</td><td>Seminar/course name</td><td>Seminar/course name</td><td>Seminar/course name</td></tr>
<tr><td>◎Nuclear disaster prevention specialists</td><td>Basic seminar for nuclear disaster prevention specialists[*3]</td><td>Practical seminar for nuclear disaster prevention specialists[*3]</td><td></td></tr>
<tr><td rowspan="3">◎Responders in disaster headquarters and off-site center
・Government officials
・Local-government officials
・Officials in municipalities</td><td rowspan="6">Common basic seminar[*4, *6]</td><td rowspan="3">Practical seminar for public servants[*4, *6]</td><td>Seminar on emergency response[*3, *5]</td></tr>
<tr><td>Off-site center activity training[*3, *7]</td></tr>
<tr><td>Seminar on emergency public information[*3]</td></tr>
<tr><td>◎Fire-service officials</td><td>Practical seminar for fire servants[*4, *6]</td><td rowspan="2">Seminar on nuclear fuel transportation[*3, *7]</td></tr>
<tr><td>◎Police-service officials</td><td>Practical seminar for police service officials[*4, *6]</td></tr>
<tr><td>◎Officials in the Ministry of Defense</td><td>Practical seminar for officials in the Ministry of Defense[*4, *6]</td><td></td></tr>
<tr><td>◎Officials in the Japan Coast Guard</td><td>Practical seminar for officials in the Japan Coast Guard[*4, *6]</td><td></td></tr>
<tr><td>◎Lifeguards</td><td>Practical seminar for lifeguards[*4, *6]</td><td></td></tr>
<tr><td rowspan="2">◎Officials involved in emergency environmental radiation monitoring</td><td rowspan="2">Basic seminar on emergency monitoring[*4, *6]</td><td>Practical seminar for officials involved in emergency environmental radiation monitoring[*4, *6]</td><td rowspan="2">Special seminar on emergency monitoring[*4, *6]</td></tr>
<tr><td>Practical seminar for the SPEEDI network system[*4, *6]</td></tr>
<tr><td>◎Fire-brigade officials</td><td>Basic seminar for fire brigade officials[*4, *6]</td><td>Practical seminar for fire brigade officials[*4, *6]</td><td></td></tr>
<tr><td rowspan="2">◎Medical providers
・Doctors, nurses and radiological technologists
・Emergency service officials
・Public health center officials</td><td colspan="2">Basic course I for radiation emergency medical care[*4, *8]
・Decontamination course
・Transfer course</td><td>Seminar on Radiation emergency medical care[*4, *9]
Seminar on Radiation emergency medical care[*4, *10]</td></tr>
<tr><td colspan="2">Basic course II for radiation emergency medicine[*4, *8]
・Whole body counter (WBC) course</td><td>Seminar on radioactivity measurement for radiation emergency medical care[*4, *10]</td></tr>
</table>

*1: It is preferable to attend basic seminars beforehand.
*2: Practical seminars including training
*3: Seminars organized by the Nuclear and Industrial Safety Agency of the Ministry of Economy, Trade and Industry
*4: Seminars organized by the Ministry of Education, Culture, Sports, Science and Technology
*5: Seminars organized by the Nuclear Emergency Assistance and Training Center of the Japan Atomic Energy Agency
*6: Seminars organized by the Nuclear Safety Technology Center
*7: Seminars organized by the Japan Nuclear Energy Safety Organization
*8: Seminars organized by the Nuclear Safety Research Association
*9: Seminars organized by the National Institute of Radiological Sciences and Hiroshima University
*10: Seminars organized by the National Institute of Radiological Sciences

Remarks: List of associated institutions

・Radiation Emergency Medical Research Center, National Institute of Radiological Sciences
4-9-1 Anakawa, Inage-ku, Chiba-city, Chiba 263-8555 Tel: (043) 206-3115 (direct)
The center plays a key role in the radiation emergency medical system and is regarded as a tertiary radiation medical institution on a nationwide basis and in the eastern block of Japan. It maintains a radiation emergency medical system in cooperation with local governments, radiation medical institutions and fire service institutions and organizes seminars for training specialists.
It is providing medical providers and disaster prevention service officials with 24-hour service in the case of over-exposure and contamination accidents: “Radiation emergency medical service dial” ((043) 206-3189).

・Radiation Emergency Medical Promotion Center, Hiroshima University
1-2-3 Kasumi, Minami-ku, Hiroshima-city 734-8553 Tel: (082) 257-5398 (direct)
As a tertiary radiation medical institution in the western block of Japan, the center maintains a system for treatment for over-exposed patients in cooperation with experts in Hiroshima University Hospital, the Research Institute for Radiation Biology, Medical Treatment and Radiation Effects Research Foundation. In Hiroshima University Hospital, it has a 24-hour service in the case of over-exposure and contamination accidents: “High-grade emergency medical center” ((082) 257-5586).

・Nuclear Emergency Assistance and Training Center, Japan Atomic Energy Agency
11601-13 Nishijusanbugyo, Hitachinaka-city, Ibaraki-ken 311-1206
Tel: (029) 265-5111
The center provides disaster prevention officials in the national and local governments, police services, fire services and nuclear facilities with technical support. In addition, the center has a branch in the Fukui Prefecture. At normal times, it trains responders in nuclear emergencies, gathers information, establishes databases and participates in emergency excercises.

・Safety Standard Division, Japan Nuclear Energy Safety Organization
4F Tokyu Reit Toranomon Building, 3-17-1 Toranomon, Minato-ku, Tokyo 105-0001
Tel: (03) 4511-1600
Specializing in nuclear disaster prevention, the division assists the national and local governments in organizing emergency excercises and maintains the emergency facilities in the off-site center. In case of emergency, they assist the national government by using an emergency assistance system.

・Japanese Association for Medical Management of Radiation Accident, Nuclear Safety Research Association
5-18-7 Shimbashi, Minato-ku, Tokyo, 105-0004
Tel: (03) 5470-1982
The association conducts various studies from scientific and objective viewpoints, with the aim to contribute to the peaceful use of nuclear power. In cooperation with academic experts and researchers in various associated fields, it conducts studies on the safety of nuclear power and various studies with financial support from the national and local governments and private companies ,providing a place for joint studies by scientific and industrial societies.

・Nuclear Safety Technology Center
4F Tokyo Toyamakaikan Building, 5-1-3-101, Hakusan, Bunkyo-ku, Tokyo 112-8604
Tel: (03) 3814-7600
The center organizes seminars in accordance with the Radiation Hazards Prevention Law, does a wide range of work for nuclear disaster prevention including seminars on disaster prevention, and conducts studies for ensuring the safety of nuclear power.

10. Main Relevant Laws and Regulations

(1) Basic Law Concerning Countermeasures Against Disasters

Article 2 (Definitions)

The terminology used in this Law is defined below respectively.

1. Disaster
   "Disaster" refers to damage resulting from storms, heavy rain, heavy snowfall, floods, high tides, earthquakes, tsunamis, volcanic eruptions, other abnormal natural phenomena, major fires or explosions, and other damages resulting from causes specified in government ordinances.
2. Disaster prevention
   "Disaster prevention" refers to activities to prevent the occurrence of disasters, limit the damage if a disaster occurs, and recover from damage of a disaster.
3. Designated administrative organs
   For the purpose of this law, "administrative organ" refers to the following organs designated by the prime minister.
   a) The Cabinet Office, Imperial Household Agency and Organs prescribed in Article 49, paragraphs 1 and 2 of the Law for Establishment of the Cabinet Office (Law No.89 of 1999) and in Article 3, paragraph 2 of the Law on National Government Organization (Law No. 120 of 1948).
   b) Organs prescribed in Articles 37 and 54 of the Law for Establishment of the Cabinet Office, Article 16, paragraph 1 of the Imperial Household Agency Law (Law No. 70 of 1947), and Article 8 of the National Government Organization Law.
   c) Organs prescribed in Articles 39 and 55 of the Law for Establishment of the Cabinet Office, Article 16, paragraph 2 of the Imperial Household Agency Law, and Article 8-2 of the National Government Organization Law.
   d) Organs prescribed in Articles 40 and 56 of the Law for Establishment of the Cabinet Office, and Article 8-3 of the National Government Organization Law.
4. Designated local administrative organs
   Local branch offices of designated administrative organs (the local branch offices prescribed in Articles 43 and 57 of the Law for Establishment of the Cabinet Office [including cases of mutatis mutandis application in Article 18, paragraph 1 of the Imperial Household Agency Law], Article 17, paragraph 1 of the Imperial Household Agency Law, and Article 9 of the National Government Organization Law), and other local administrative organs of the State designated by the prime minister.
5. Designated public institutions
   Incorporated administrative agencies (prescribed in Article 2, paragraph 1 of the Law on General Rules for Incorporated Administrative Agency [Law No. 103 of 1999]), the Bank of Japan, Japanese Red Cross Society, Japan Broadcasting Corporation, and other public institutions and corporations providing public utilities such as electricity, gas, transportation, or telecommunication that are designated by the prime minister.
6. Designated local public institutions
   Local incorporated administrative agencies (prescribed in Article 2, paragraph 1 of Law on Local Incorporated Administrative Agency [Law No. 118 of 2003], port authorities prescribed in Article 4, paragraph 1 of the

Ports and Harbors Law [Law No. 218 of 1950], land improvement districts prescribed in Article 5, paragraph 1 of the Land Improvement Law [Law No. 195 of 1949]), managers of other public facilities and corporations providing public utilities such as electricity, gas, transportation, or telecommunication in a prefectural area that are designated by the governor of the relevant prefecture.

7. Disaster prevention plans
   Basic Plans for Emergency Preparedness, Disaster Prevention Work Plan of Designated Administrative Agency, and Regional Emergency Prevention Plan.
8. Basic Plans for Emergency Preparedness
   A basic plan formulated by the Central Disaster Prevention Council concerning disaster prevention.
9. Disaster Prevention Work Plan of Designated Administrative Agency
   A disaster prevention plan formulated by the head of a designated administrative organ (or the relevant designated administrative organ when it corresponds to any of the commission prescribed in Article 49, paragraph 1 or 2 of the Law for Establishment of the Cabinet Office, commission prescribed in Article 3, paragraph 2 of the National Government Organization Law, and institutions prescribed in the same Article, same paragraph, Item 3-b or 3-d of the same Law that adopts a council system; hereinafter the same shall apply except for paragraph 8 of Article 12, Item 3 of paragraph 6 of Article 28-3, and paragraph 2 of Article 28-6) or a designated public institution (or the head of the designated local administrative organ or designated local public institution to which the head of a designated administrative organ or a designated public institution entrusted affairs or services) under the Basic Plans for Emergency Preparedness concerning affairs or services under its jurisdiction.
10. Regional Emergency Prevention Plan
    Disaster prevention plans concerning specified areas comprises:
    a) Prefectural disaster prevention plan: A plan formulated by the Prefectural Disaster Prevention Council of each prefecture concerning its areas.
    b) Municipal disaster prevention plan: A plan formulated by the Municipal Disaster Prevention Council or the head of each municipality concerning its areas.
    c) Inter-prefectural local disaster prevention plan: A plan formulated by the sub-council of Prefectural Disaster Prevention Council concerning all or part of area across two or more prefectures.
    d) Inter-municipal local disaster prevention plan: A plan formulated by the sub-council of Municipal Disaster Prevention Council concerning all or part of area across two or more municipalities.

Article 3 (Responsibility of the State)

The State shall be responsible for taking all possible measures for disaster prevention by mobilizing all of its organizations and functions in view of its mission to protect national land, and lives, health, and property of citizens from disasters.

2. In order to fulfill the responsibility stated in the preceding paragraph, the State shall draw up a basic plan for disaster prevention, emergency measures, and recovery from a disaster, and implement the plan in accordance with legislation, promote and coordinate affairs or services for disaster prevention handled by local governments, designated public institutions, designated local public institutions, etc., and rationalize the bearing of expenses in connection with disasters.

3. In performing the duties under jurisdiction, the designated administrative organs and the designated local administrative organs shall cooperate with each other so that the responsibility of the State set forth in paragraph 1 may be fully achieved.
4. The head of each designated administrative organ and each designated local administrative organ shall recommend, instruct, or advise the relevant prefecture or municipality, or take other appropriate actions for them concerning the duties under its jurisdiction so as to facilitate the preparation and implementation of local disaster prevention plans by prefectures and municipalities under this Law.

Article 4 (Responsibility of Prefectures)

In order to protect their areas and lives, health, and property of their residents from disasters, prefectures shall be responsible for formulating disaster prevention plans concerning their areas with the cooperation of relevant organs and other local public institutions and for implementing them in accordance with legislation, and help municipalities and designated local public institutions in their areas performing duties or services concerning disaster prevention, as well as general coordination of their performance.

2. In performing their duties under jurisdiction, prefectural organs shall cooperate with each other so that the responsibility of prefectures set forth in the preceding paragraph may be fully achieved.

Article 5 (Responsibility of Municipalities)

In order to protect, as a fundamental local government, their areas and lives, health, and property of their residents from disasters, municipalities shall be responsible for formulating disaster prevention plans concerning their areas with the cooperation of relevant organs and other local public governments, and implementing them in accordance with legislation.

2. In order to fulfill the responsibility stated in the preceding paragraph, the head of each municipality shall strive to establish fire-fighting agencies, flood-control brigades, etc., and to strengthen disaster prevention organizations in the municipality including public organizations and voluntary disaster prevention organizations ("voluntary disaster prevention organization" in paragraph 2 of Article 8) based on the spirit of mutual cooperation among community residents so that all functions of the municipality may be fully demonstrated.
3. Fire-fighting agencies, flood-control brigades, and other municipal agencies, in performing affairs under jurisdiction, shall cooperate with each other so that the responsibility of municipalities set forth in paragraph 1 may be fully performed.

Article 5-2 (Mutual Cooperation between Local Governments)

in order to fulfill the responsibilities set forth in paragraph 1 of Article 4 and paragraph 1 of the preceding Article, if necessary, local governments shall cooperate with each other.

(2) Special Law on Nuclear Disaster Countermeasures

Article 26 (Emergency Response Actions and Responsibility)

Emergency Response Actions shall be carried out to deal with the following

matters.

(1) Matters concerning the communication of information on nuclear disasters including nuclear emergency declarations, or evacuation recommendations or instructions.
(2) Matters concerning the measurement of radiation dose and collection of information concerning nuclear disasters.
(3) Matters concerning rescue, relief, and other protection measures for sufferers.
(4) Matters concerning the preparation, inspection, and emergency recovery of facilities and equipment.
(5) Matters concerning the maintenance of social order in areas affected by a nuclear disaster including crime prevention and traffic control.
(6) Matters concerning the securing of emergency transportation.
(7) Matters concerning the implementation of emergency actions including the securing of foods, drugs, and other goods, measurement of radiation exposure, and removal of contamination with radioactive material.
(8) Other matters concerning actions for preventing nuclear disasters from getting more serious (including such probability arising from nuclear disasters).

2. During a period from the declaration of the state of nuclear emergency to the declaration ending the state of nuclear emergency, the head of each designated administrative organ, the head of each designated local administrative organ, the head of each local government, other executive organs, designated public institutions, designated local public institutions, nuclear operators, and other persons responsible for the performance of emergency response actions, shall implement emergency response actions in accordance with legislation, disaster prevention plans, or Disaster Prevention Work Plans of Nuclear Operators.
3. In accordance with legislation, disaster prevention plans, or Disaster Prevention Work Plans of Nuclear Operators, each nuclear operator shall take measures as required, such as to dispatch nuclear disaster prevention personnel and lend materials and equipment for nuclear disaster prevention so as to ensure smooth operation of emergency response actions carried out by the head of each designated administrative organ, the head of each designated local administrative organ, the head of each local government, and other executive organs.

(3) Law on the Regulation of Nuclear Source Material, Nuclear Fuel Material, and Reactors

Article 64 (Emergency Measures)

With respect to nuclear fuel material or material contaminated with nuclear fuel material or nuclear reactors held by any nuclear operator, etc. (including persons entrusted thereby to provide transportation or storage service; hereinafter the same shall apply in this Article), if a disaster resulting from such nuclear fuel material or material contaminated with nuclear fuel material or nuclear reactor is likely to occur or has occurred, the relevant nuclear operator, etc. shall immediately take emergency actions as prescribed by ordinance of the competent ministry (i.e., order issued by the minister stated in the corresponding item in the list of nuclear operators, etc. in paragraph 3).

2. The person who discovered the anormalies described in the preceding paragraph shall immediately notify a police or coast guard officer to that effect.
3. With regard to paragraph 1, when acknowledging an urgent necessity in order to prevent a disaster resulting from nuclear fuel material or material contaminated with nuclear fuel material or nuclear reactor, the Minister of Education, Culture, Sports, Science and Technology, Minister of Economy, Trade and Industry, or Minister of Land, Infrastructure and Transport are empowered to order the persons set forth in the same paragraph to take measures necessary for preventing a disaster resulting from nuclear fuel material or material contaminated with nuclear fuel material or nuclear reactor according to the following classification of nuclear operators, etc., such as suspension of the operations of refinement facilities, processing facilities, nuclear reactor establishments, facilities storing spent fuels, reprocessing facilities, waste burial facilities, waste management facilities, or waste recycling facilities, or change of the place for storing nuclear fuel material or material contaminated with nuclear fuel material
   (1) Nuclear-material refinery operators , nuclear fuel manufacturers, spent fuel storage service providers, reprocessing businesses, disposal facility operators (including former refiners operators, former manufacturers, former spent-fuel storage service providers, former reprocessing facility operators, former disposal facility operators, etc.) and their contractors entrusted to provide transportation service. Minister of Economy, Trade and Industry (Minister of Economy, Trade and Industry or Minister of Land, Infrastructure and Transport according to the classification set forth in paragraph 1 of Article 59 in the case of transportation set forth in the same paragraph, or Minister of Land, Infrastructure and Transport in the case of transportation by ship or plane).
   (2) Handlers of radioactive materials (including former handlers, etc.; hereinafter, the same shall apply in this item) or their contractors entrusted to provide transportation service. Minister of Education, Culture, Sports, Science and Technology (Minister of Education, Culture, Sports, Science and Technology or Minister of Land, Infrastructure and Transport according to the classification defined in paragraph 1 of Article 59 in the case of transportation set forth in the same paragraph, or Minister of Land, Infrastructure and Transport in the case of transportation by ship or plane).
   (3) Reactor owners (including former reactor owners; hereinafter, the same shall apply in this item) and their contractors entrusted to provide transportation service. Minister set forth in the corresponding item among those listed in paragraph 1 of Article 23 according to reactor types (Minister set forth in the corresponding item among those listed in paragraph 1 of Article 23 or Minister of Land, Infrastructure and Transport according to the classification defined in paragraph 1 of Article 59 in the case of transportation set forth in the same paragraph, or Minister of Land, Infrastructure and Transport in the case of transportation by ship or plane).
   (4) Foreign nuclear ship operators and their contractors entrusted to provide transportation service. Minister of Land, Infrastructure and Transport.
   (5) Storage service providers Minister set forth in the corresponding item among those listed in paragraph 1 of Article 60.

(4) Law on Prevention from Radiation Hazards due to Radio-Isotopes, etc.

Article 24 (Measures for Persons Actually or Possibly Exposed to Radiation Hazards)

Licensed and registered users (including users of certified equipment with labeling), registered distributors, registered leasers and licensed disposal facility operators shall, pursuant to the Ordinance of the Ministry of Education, Culture, Sports, Science and Technology, take measures for the health of those who have suffered or might have suffered radiation injury, such as limited access to handling facilities, waste refill facilities, storage facilities, waste storage facilities, or waste facilities.

Article 33 (Emergency Measures)

If an earthquake, a fire, or other disasters are likely to cause or have actually caused a radiation hazard in connection with radioactive isotopes, material contaminated with radioactive isotopes, or radiation generator that is held by any licensed and registered user, etc., such user shall immediately take emergency measures in accordance with the Ordinance of the Ministry of Education, Culture, Sports, Science and Technology (Ordinance of the Ministry of Education, Culture, Sports, Science and Technology or Ordinance of the Ministry of Land, Infrastructure and Transport in the case of transportation of radioactive isotope or material contaminated with radioactive materials outside of the plant or factory [including transportation by ship or plane]; this shall also apply in paragraph 3).

2. The person who discovered the state defined in the preceding paragraph shall immediately notify a police or coast guard officer to that effect.
3. If an incident defined in paragraph 1 has occurred, the licensed and registered user, etc., shall without delay notify the Minister of Education, Culture, Sports, Science and Technology (Minister of Education, Culture, Sports, Science and Technology or Minister of Land, Infrastructure and Transport in the case of transportation of radioactive isotope or material contaminated with radioactive isotopes outside of the plant or factory [including transportation by ship or plane]; this shall also apply in the following paragraph) in accordance with the Ordinance of the Ministry of Education, Culture, Sports, Science and Technology.
4. With regard to paragraph 1, if urgently required in order to prevent radiation hazards, the Minister of Education, Culture, Sports, Science and Technology is empowered to order the person set forth in the same paragraph to take necessary measures for preventing radiation hazards such as changing the location of radioactive isotopes or material contaminated with radioactive isotopes or removal of contamination by radioactive isotopes.

(5) Enforcement Regulations for the Law concerning the Prevention from Radiation Injury due to Radio-Isotopes, etc.

Article 23 (Measures for those who have suffered or might have suffered radiation injury)

Measures to be taken by licensed and registered users, users of certified equipment with labeling, registered distributors, reported leasers and licensed disposal facility operators under Article 24 shall be as set forth in the following items.

(1) If a radiation worker has suffered or might have suffered a radiation injury, measures, such as reducing the time spent in the controlled area, prohibition of access, reassignment to a job with lower possibility of

exposure to radiation, shall be taken according to the extent of actual or possible radiation injury, and health guidance shall be provided as required.

(2) If a person other than radiation workers has suffered or might have suffered a radiation injury, appropriate measures shall be taken without delay, such as diagnosis by a doctor or health guidance as required.

(6) Medical Practitioners' Law

Article 19 (Obligation to Provide Medical Examination)

Doctors engaged in medical examination shall not refuse a request for diagnosis and treatment without reason that can be justified.

2 (Omitted)

Article 22 (Obligation to Issue Prescription)

A doctor who acknowledges the need to prepare and administer medicine to his/her patient shall issue a prescription to the patient or the person who actually takes care of the patient, except when the patient or the person who actually takes care of the patient expresses their will not to request the issuance of prescription or when any of the following items is applicable.

(1) Issuance of a prescription may prevent the achievement of suggestive effect when such effect is expected.
(2) Issuance of a prescription may make the patient uncertain about treatment or convalescence of the disease, and may make the treatment of the disease difficult.
(3) Medicine is administered according to changes in the condition of the disease at short time intervals.
(4) No method of examination or treatment is decided.
(5) Medicine is administered as an emergency measure required for treatment.
(6) No one other than the patient who needs to rest in bed can receive the medicine.
(7) A stimulant is administered to the patient.
(8) Medicine is administered in a ship where no pharmacist is onboard.

(7) Medical Service Law

Article 1-2 (Principle of Medical Service)

In providing medical care, efforts should be made to ensure the respect for life and the dignity of individuals and to establish a trustful relationship between doctors, dentists, pharmacists, nurses, or other persons engaged in medical care and persons receiving medical care, and consideration shall be given for persons receiving medical care, and good and appropriate care shall be provided that includes not only treatment but also disease prevention measures and rehabilitation.

2. Based on each resident's efforts to maintain and promote his/her health, medical care shall be efficiently provided, with good respect for the intention of persons receiving the medical care, in hospitals, clinics, care and health services facilities for the aged, pharmacies that prepare medicines, and other facilities providing medical care (collectively, "medical care facilities") according to the functions of medical care facilities ("medical care functions"), keeping an effective linkage with welfare and other related services.

Article 1-3 (Responsibility of the State and Local Governments)

The State and local governments shall strive to ensure a system that efficiently provides good and appropriate medical care to residents in accordance with the principle stated in the preceding article.

Article 1-4 (Responsibility of Doctors, etc.)

Doctors, dentists, pharmacists, nurses, or other persons engaged in medical care shall strive to provide good and appropriate medical care to persons receiving the medical care under the principle stated in Article 1-2.

2. In providing medical care, doctors, dentists, pharmacists, nurses, or other persons engaged in medical care shall give an appropriate presentation to obtain the consents from the persons receiving the medical care.
3. Doctors and dentists engaging in medical examination in medical care facilities shall, as needed, in order to contribute to function-sharing and cooperation between medical care facilities, introduce persons receiving the medical care to other medical care facilities, and provide doctors, dentists, or pharmacists engaging in medical examination or preparation in other medical care facilities with information concerning medical examination or preparation concerning the persons receiving the medical care to the extent required for such examination, and strive to take other necessary measures.
4. The manager of a hospital or clinic shall, when a patient leaving his/her hospital needs to continue to receive medical care, take consideration so that such patient may continue to receive medical care under an appropriate environment in cooperation with persons providing healthcare or welfare service.
5. In order to contribute to the dissemination of medical techniques and the efficient provision of medical care, the owners and managers of medical care facilities shall take consideration so as to make the buildings or equipment of the relevant medical care facilities available for examination, research, or training for doctors, dentists, pharmacists, nurses, and other persons engaging in medical care who are not working in the relevant medical care facilities.

Article 1-5 (Definitions of Hospital and Clinic)

For the purpose of this Law, a "hospital" means a place where doctors or dentists provide medical or dental care for the public or a specified number of people with a facility where 20 or more patients can be hospitalized. Hospitals shall be organized and operated for the principal purpose of providing facility where the patients may receive scientific and appropriate medical examination.

2. For the purpose of this Law, a "clinic" means a place where doctors or dentists provide medical or dental care for the public or a specified number of people without a facility for hospitalizing patients or with a facility where 19 or fewer patients can be hospitalized.

Article 7.

When attempting to establish a hospital, or when a person other than those registered under Article 16-4, paragraph 1 of the Medical Practitioners' Law (Law No. 201 of 1948; registration under Article 7-2, paragraph 2 of the same Law is required for those who have received the order of the Minister of Health, Labour and Welfare under Article 7-2, paragraph 1 of the same

Law ["doctor who has completed clinical training etc."] and other than those registered under Article 16-4, paragraph 1 of the Dental Practitioners' Law [Law No. 202 of 1948; registration under Article 7-2, paragraph 2 of the same Law is required for those who have received the order of the Minister of Health, Labour and Welfare under Article 7-2, paragraph 1 of the same Law ["dentist who has completed clinical training etc."]), or when a person who is not a midwife attempts to establish a maternity clinic, a license of the governor of the prefecture where such facility is established shall be obtained (in the case of a clinic or maternity clinic, the mayor of a municipality or the mayor of a special ward when the clinic is established in the municipality with a health center or in the special ward; the same shall also apply in Articles 8 and 9, Article 12, Article 15, Article 18, Article 24, and Articles 27-30).

2 – 5 (Omitted)

(8) Labor Safety and Sanitation Law

Article 13. (Occupational Health Physician, etc.)

The employer shall, at each workplace of the scale defined by government ordinance and as provided for by the Ordinance of the Ministry of Health, Labour and Welfare, appoint an occupational health physician from among medical doctors, and have such physician provide healthcare to workers and carry out other matters set forth by the Ordinance of the Ministry of Health, Labour and Welfare (hereinafter referred to as "healthcare, etc., for workers").

2. The occupational health physician shall be a person who meets the requirements set forth by the Ordinance of the Ministry of Health, Labour and Welfare concerning the knowledge of medicine required to carry out healthcare, etc., for workers.
3. The occupational health physician may make the necessary recommendations for workers regarding healthcare, etc., to the employer where it is deemed necessary to maintain the health of the workers.
4. Where the employer receives recommendations set forth in the preceding paragraph, he shall respect them.

(9) Labor Safety and Sanitation Law Enforcement Order

Article 5 (Workplace Required to Appoint an Occupational Health Physician)

A workplace of the scale defined by government ordinance stated in Article 13, paragraph 1 of the Labor Safety and Sanitation Law shall have 50 workers or more regularly employed to perform work.

(10) Ordinance on Labor Safety and Sanitation

Article 13 (Appointment of an Occupational Health Physician)

The appointment of an occupational health physician pursuant to the provision of paragraph (1) of Article 13 of the Law shall be performed as prescribed below:

(1) A physician shall be appointed within 14 days from the date when a reason necessitating appointment of a physician has arisen.
(2) For a workplace where 1,000 workers or more are regularly employed or 500 workers or more are regularly engaged in the work listed as follows, a person exclusively assigned to the said workplace shall be appointed.

(a) Work handling a large quantity of high-temperature substances or the work in extremely hot places.
(b) Work handling a large quantity of low-temperature substances or the work in extremely cold places.
(c) Work in which workers are exposed to radium rays, X-rays and other harmful radiation.
(d) Work in a place where extreme amount of airborne dust, powdered soil or stone, animal hair, etc., is flying.
(e) Work under extraordinary atmospheric pressure.
(f) Work exposing workers to extreme vibrations due to the use of a rock drill, riveting machine, etc.
(g) Heavy work, such as handling of heavy material.
(h) Work in a place where extreme noise is generated, such as boiler manufacturing.
(i) Work in a pit.
(j) Work including late-night work.
(k) Work handling mercury, arsenic, yellow phosphorus, hydrofluoric acid, hydrochloric acid, nitric acid, sulfuric acid, prussic acid, caustic alkali, carbolic acid or other substances as harmful as these substances.
(l) Work in a place exuding gas, vapor, dust of lead, mercury, chromium, arsenic, yellow phosphorus, hydrogen fluoride, chlorine, hydrochloric acid, nitric acid, sulfurous acid, sulfuric acid, carbon monoxide, carbon disulfide, prussic acid, benzene, aniline or other substances as harmful as these substances.
(m) Work liable to extreme contamination by pathogens.
(n) Other work designated by the Minister of Health, Labour and Welfare.

(3) For a workplace where more than 3,000 workers are regularly employed, two or more occupational health physicians shall be appointed.

2. The provisions of paragraph (2) of Article 2 shall apply mutatis mutandis to occupational physicians, except for school physicians who have been appointed or entrusted pursuant to the provision of Article 16 of the School Health Law (Law No.33 of 1958) to perform the duties of an occupational physician for the relevant school.
3. The provisions of Article 8 shall apply mutatis mutandis to occupational physicians. In this case, the term “paragraph (1) of the preceding Article” in the same Article shall be deemed to read as “paragraph (1) of Article 13.”

Article 14 (Duties, etc., of an Occupational Physician or Occupational Dentist)

The matters prescribed by the Ordinance of the Ministry of Health, Labour and Welfare set forth in paragraph (1) of Article 13 of the Law shall be the following matters requiring specialized knowledge of medicine:

(1) Matters relating to the implementation of medical examinations and face-to-face guidance, etc. (meaning face-to-face guidance prescribed in paragraph (1) of Article 66-8 of the Law ["face-to-face guidance”] and to necessary measures prescribed in Article 66-9 of the Law) and measures to be taken based on their results to maintain workers' health.
(2) Matters relating to the maintenance and control of the working environment.
(3) Matters relating to the control of work.
(4) Matters relating to the healthcare of workers other than those stated in the preceding three items.
(5) Matters relating to health education, health counseling and other

measures for maintaining and promoting worker health.

(6) Matters relating to health education.

(7) Matters relating to the investigation of the causes of health impairment in workers and measures for preventing recurrence.

2. A person who meets the requirements of the Ordinance of the Ministry of Health, Labour and Welfare set forth in paragraph (2) of Article 13 of the Law shall be as follows:

(1) A person who has completed a training course provided by the Minister of Health, Labour and Welfare for learning medial knowledge necessary for carrying out healthcare, etc., for workers, prescribed in paragraph (1) of Article 13 of the Law ("healthcare, etc., for workers").

(2) A person who has completed and graduated from regular medical courses established for the purpose of developing occupational physicians in universities of industrial health or other universities designated by the Minister of Health, Labour and Welfare, and has completed the practical training provided by the Minister of Health, Labour and Welfare.

(3) A person who has passed the industrial health consultant's examination in the category of health and hygiene.

(4) A person who works or formerly worked as a professor, associate professor, or lecturer (limited to full-time employees) covering the subjects related to industrial health at a university accredited under the School Education Law.

(5) Other persons than those stated in each item above who are designated by the Minister of Health, Labour and Welfare.

3. The occupational health physician may make recommendations to the general safety and sanitation manager, and give guidance or advice to the health officer about the matters specified in each item of paragraph 1.

4. The employer shall not dismiss or otherwise disadvantage an occupational health physician for reason of recommendations made by the same occupational health physician pursuant to the provision of paragraph (3) of Article 13 of the Law or recommendations, guidance or advice given pursuant to the provision of the preceding paragraph.

5. The employer shall, as regards workplaces where 50 workers or more are regularly employed to perform the work set forth in paragraph 3 of Article 22 of the Order, obtain the opinion of the occupational dentist on the condition of worker teeth or their supporting tissues out of the matters listed in each item of paragraph (1).

6. The occupational dentist who has conducted a medical examination set forth in paragraph 3 of Article 66 of the Law for workers who work in a workplace set forth in the preceding paragraph may recommend measures necessary for preventing worker health impairment (limited to health impairment related to teeth and their supporting tissues) to the employer or the general safety and sanitation manager of the relevant workplace.

(11) Ordinance on the Prevention of Ionizing Radiation Hazards

Article 31 (Contamination Test on Leaving Persons)

The employer shall provide a space for contamination test at the exit of the room for handling radioactive materials and conduct a contamination test to check the contamination in the body and equipment of workers who were handling radioactive materials in the room and are leaving there.

2. If contamination exceeding one-tenth (1/10) of the limit specified in Schedule 3 is detected with the body or equipment of a worker through the

test under the preceding paragraph, the employer shall not permit the relevant worker to leave the room for handling radioactive materials unless it takes the following measures at the space of contamination test prepared under the preceding paragraph.

(1) To make the worker wash his/her body or take similar measures when his/her body is contaminated so as to reduce the level of contamination to one-tenth or less of the limit specified in Schedule 3.

(2) To make the worker take off or remove the equipment when it is contaminated.

3. The relevant worker shall wash his/her body or take similar measures, or take off or remove the equipment in accordance with instructions of the employer given under the preceding paragraph.

Schedule 3

Category	Limit (Bq/cm^2)
Radioactive isotope that emits alpha rays	4
Radioactive isotope that does not emit alpha rays	40

Bq/cm^2, unit of limit, indicates becquerel per square centimeter.

Article 44 (Medical Examination etc.)

The employer shall have workers corresponding to any of the following items promptly receive medical examination or treatment by a doctor.

(1) A person who was in the area set forth in the corresponding item among those listed in paragraph 1 of Article 42 when the accident set forth in the same item occurred.

(2) A person who received an effective dose or equivalent dose exceeding the limit specified in paragraph 1 of Article 4 or Article 5.

(3) A person who accidentally inhaled or orally took in a radioactive material.

(4) A person who is unable to reduce the contamination level to one tenth of the limit specified in Schedule 3 by washing the body or taking other measures.

(5) A person with a wound contaminated by a radioactive material.

2. When the employer has an employee who falls within any item of the preceding paragraph, he shall promptly notify the Chief of the competent Labour Standards Inspection Office to that effect.

(12) Regulations for Buildings and Facilities for Pharmacies, etc.

Article 1 (Buildings and Facilities of Pharmacies)

The buildings and facilities of each pharmacy shall meet the following requirements.

(1) To be well ventilated and clean.

(2) To be distinctly segregated from the living quarters and unsanitary areas.

(3) To be ensured that the area is at least 19.8 square meters and to allow the appropriate operations of the pharmacy.

(4) To be provided with lighting of at least 60 luxes in the areas where the drugs are routinely displayed or delivered, and lighting of at least 120 luxes on the dispensing workbenches.

(5) To be provided with a dispensing room that meets the following requirements.

a. Being ensured that the area of the dispensing room is at least 6.6 square meters.

b. Being ensured that the ceilings and floor of the dispensing room are

made of wood, concrete or equivalent materials.

(6) To be provided with the facilities for storing in a cooled and/or dark condition.

(7) To be provided with storage facilities that can be locked with locks.

(8) To be provided with the following facilities and equipment required for dispensing.

a. Liquid measuring equipment (those of which capacity are 20 cc and 200 cc)
b. Thermometers (100° C)
c. Water baths
d. Dispensing workbenches
e. Ointment slabs
f. Mortars (for powder drugs) and pestles
g. Balances (those of which sensibility reciprocal are 10 mg and 100 mg)
h. Beakers
i. Sieving equipment
j. Spatulas (those which are made of metal, horn or equivalent mater
k. Measuring pipettes and pipette stands
1. Measuring flasks and measuring cylinders
m Spoons (those which are made of metal, horn or equivalent materials)
n. Funnels and funnel stands
o. Publications necessary for dispensing.

(9) (Omitted)

2 – 5 (Omitted)

(13) Ordinance on the Number of Pharmacists Engaged in Pharmacy and First-Class Retail Business

Article 1 (Number of Pharmacists Engaged in Pharmacy)

The number of pharmacists engaged in the practical services related to pharmaceutical affairs in a pharmacy, which is to be defined by the Ordinance of the Ministry of Health, Labour and Welfare under Item 2 of Article 5 of the Pharmaceutical Affairs Law, shall be one when the average number of daily prescriptions filled by the pharmacy is not more than 40 and one shall be added for every increase of 40 or 40 plus a fraction thereof.

2. The average number of daily prescriptions filled by the pharmacy stated in the preceding paragraph shall be calculated by dividing the total number of prescriptions filled in the previous year (i.e., the sum of the numbers determined by multiplying two-thirds (2/3) by the number of prescriptions filled in the previous year by the ophthalmology, otolaryngology, and dental departments, respectively and the number of prescriptions filled by other departments) by the number of business days in the previous year. However, if the number of business days in the previous year is none or less than 3 months, the foregoing number may be estimated.

11. Basic Plans for Emergency Preparedness (Part 10: Nuclear Disaster Countermeasures)

Chapter 1 Disaster Prevention

Section 2 Quick and Smooth Emergency Disaster Prevention Measures and Preparedness to Disaster Restoration

5 Rescue / First aid, medical care, and fire fighting activities

(1) Rescue / First-aid activities

○ Local governments shall strive to fully prepare vehicles such as rescue vehicles, ambulances, lighting vehicles, helicopters, and first-aid materials and equipment necessary for emergency measures. For implementing such maintenance, the State shall provide information, etc., concerning the materials and equipment to be fully prepared.

○ In close cooperation with persons involved in radiation emergency medical activities, local governments shall fully prepare consistent plans with various concerned organs in order to ensure effective radiation emergency medical care.

○ Ministries and agencies involved in rescue and first-aid activities [National Police Agency, Japan Ministry of Defense, Japan Coast Guard, and Fire Defense Agency] shall grasp the information on the status of materials and equipment in their organs, exchange information as needed, and strive for the preparation of appropriate materials and equipment for rescue and first-aid activities.

○ In order to perform efficient rescue and first-aid activities while securing the safety of personnel, the ministries and agencies involved in rescue and first-aid activities [National Police Agency, Japan Ministry of Defense, Japan Coast Guard, and Fire Defense Agency] shall strengthen their mutual cooperation systems and rescue / first-aid functions, as well as provide training and drills to personnel.

○ Nuclear operators shall fully prepare, maintain, and manage facilities, etc., for providing first-aid treatment and decontamination of radiation-exposed patients in order to establish a system of medical care for radiation exposure, and ensure systematic establishment concerning a chain of command, reporting and communication, and information transmission in nuclear facilities, and maintain a close relationship with relevant organizations, such as medical institutions, ministries and agencies involved in rescue and first-aid activities [National Police Agency, Japan Ministry of Defense, Japan Coast Guard, and Fire Defense Agency], and local governments, for reporting and communication, and carrying and accepting radiation-exposed patients.

(2) Medical activities

○The State [Ministry of Education, Culture, Sports, Science and Technology and Ministry of Health, Labour and Welfare], Japanese Red Cross Society, local governments, and nuclear operators shall strive to fully prepare radiation measurement materials and equipment, decontamination materials and equipment, stable iodine, medical supplies for emergency relief, medical materials and equipment, etc. Note that the State shall provide information, etc., concerning materials and equipment to be fully prepared when local governments are fully preparing medical materials and equipment, etc.

○In order to improve and reinforce radiation emergency medical activities, the State [Ministry of Education, Culture, Sports, Science and Technology and Ministry of Health, Labour and Welfare] and local governments shall establish medical institutions for responding to radiation injuries and establish and maintain a system to dispatch a team of medical staffs in case of radiation injuries. Special medical institutions, such as state-run or public hospitals that provide radiation emergency medical service, shall fully prepare materials and equipment for providing medical care concerning radiation injuries and establish organizational systems.

○The National Institute of Radiological Sciences shall build a network of cooperation with external special medical institutions for radiation emergency medicine and strive to improve the emergency medical care system for radiation over-exposure in ordinary times through information exchange via such network, research cooperation, and personnel exchanges.

○Local governments shall strive to establish a primary exposure medical care system for outpatients and a secondary exposure medical care system for inpatients and a network of such systems by actively involving medical personnel .

○The State [Ministry of Education, Culture, Sports, Science and Technology and Ministry of Health, Labour and Welfare] shall strive to build a tertiary exposure medical care system in areas corresponding to special hospitalized treatment.

○Local tertiary radiation emergency medical institution [National Institute of Radiological Sciences and Hiroshima University] shall establish a network for transporting and accepting radiation-exposed patients, which is associated with medical networks for initial and secondary medical care systems that local governments are striving to build. They shall also implement training programs for doctors, nurses, etc., to improve the capabilities of relevant medical institutions concerning the medical care of radiation hazards.

(3) Fire-fighting activities

○Nuclear operators shall strive to establish an its own fire-fighting system in ordinary times in order to respond properly to fire accidents, etc., at nuclear facilities.

○Local governments shall, in cooperation with nuclear operators, etc., in ordinary times, strive to secure water for fire-fighting and establish a fire-fighting system in order to respond prpperly to fire accidents, etc., at nuclear facilities and in surrounding areas.

Chapter 2 Emergency Disaster Response Measures

Section 6 Rescue / First-aid, Medical Care, and Fire-fighting Activities

1 Rescue / first-aid activities

(1) Rescue / First-aid activities by the State, local governments, and nuclear operators

○Nuclear operators shall perform rescue / first-aid activities at the disaster site and provide cooperation as required, such as lending materials and equipment for disaster prevention, for rescue / first-aid activities performed by the State and local governments.

○Nuclear operators, in transporting radiation-exposed patients to a medical institution, shall check the state of contamination and take measures to prevent spread of contamination to the extent possible in consideration of the status of the injury / disease, and have health physicist (a person with knowledge of radioactive materials and radiation and ability to execute dose assessment and take measures to prevent spread of contamination) accompany the patients. However, if health physicist is unable to accompany the patients for unavoidable reasons, the nuclear operator shall have the patients accompanied by a person who can take measures to prevent the spread of contamination by explaining him/her the circumstances of the accident and the status of exposure / contamination suffered by the patients.

○Local governments shall strive to quickly grasp information on the status of damage, as well as perform rescue / first-aid activities, and request support as needed from the local response headquarters, other local governments, nuclear operators, etc.

○Local governments, in response to requests from the medical institution that treated the radiation-exposed patients, shall promptly confirm no contamination by radioactive materials and publicly announce the result of such confirmation, and, in cooperation with the relevant medical institution and nuclear operator, shall collect and handle information to provide such information accurately to local residents, the press, etc.

○The Self-Defense Forces shall perform rescue / first-aid activities as needed in response to dispatch requests from the person set forth by statutes, such as the Chief of Nuclear Disaster Headquarters or prefectural governor.

○The National Police Agency shall, as needed, take measures for broad-based support such as the dispatch of the inter-prefectural emergency rescue unit.

○The Fire and Disaster Management Agency shall, as needed, take measures for broad-based support such as the dispatch of the emergency fire-fighting support team.

○The Japan Coast Guard shall perform rescue and first-aid activities on the sea, and, if possible, further support activities of local governments if necessary or in response to requests of the local response headquarters, etc.

○The Joint Council on Countermeasures against Nuclear Accidents shall perform general coordination to ensure smooth and efficient rescue / first-aid activities by relevant organs if necessary or in response to requests from local governments or designated administrative organs, etc.

(2) Procurement of materials and equipment, etc.

○Materials and equipment necessary for rescue / first-aid activities shall be carried in principle by the organs engaging in the relevant activities.

○The State and local governments shall secure materials and equipment for rescue / first-aid activities and perform efficient rescue / first-aid activities by obtaining cooperation, if necessary, from other local governments, nuclear operators, or other private sectors.

2 Medical activities

(1) Dispatch of emergency medical team for radiation exposure

○The State [Ministry of Education, Culture, Sports, Science and Technology and Ministry of Health, Labour and Welfare] shall, as needed, dispatch to the site an emergency medical team for radiation exposure, which consists of medical personnel from the National Institute of Radiological Sciences, the national hospitals, national medical school hospitals, etc.

(2) Provision of radiation emergency medicine

○ Prefectures shall form medical and relief teams consisting of medical personnel, etc., located in areas of emergency measures to perform emergency medical activities for radiation over-exposure.

○The emergency medical team for radiation exposure consisting of medical personnel from the National Institute of Radiological Sciences, national hospitals, and national medical school hospitals, etc., shall, under the prefectural disaster response headquarters, direct personnel of the initial and secondary exposure medical institutions concerning medical examination of

radiation-exposed patients (including possibly exposed persons) and also perform medical activities in cooperation with them.

○Upon request from a local government through the nuclear disaster response headquarters or similar organization, the national hospitals and national medical school hospitals shall, as needed, dispatch necessary personnel, such as doctors, nurses, radiological technologists, and pharmacists, to local medical institutions to provide drugs, medical devices, etc.

○ The National Institute of Radiological Sciences, national hospitals, and national medical school hospitals that can respond to medical care for radiation exposure (hereinafter, "radiation hazard special hospital, etc.") shall provide advanced services for decontamination and treatment that cannot be provided by the initial and secondary exposure medical institutions.

○National hospitals and national medical school hospitals that can respond to medical care for radiation over-exposure shall cooperate with the National Institute of Radiological Sciences, etc., when they conduct a follow-up survey, etc., concerning patients at a considerable level of exposure who were examined in hospitals, etc., specialized for radiation injuries.

○Hospitals, etc., specialized in radiation injuries shall mutually maintain close relations with each other in performing decontamination, treatment, follow-up surveys, etc.

○For the transport of over-exposed patients to the hospitals, etc., specialized in radiation injuries, the Fire and Disaster Management Agency shall preferentially secure means of transport upon request from a prefectural disaster response headquarters, local response headquarters, etc.

○The Self-Defense Forces shall support the transport of radiation-exposed patients to the hospitals, etc., specialized in radiation injuries if necessary or upon dispatch request from the person set forth by statutes, such as the Chief of Nuclear Disaster Response Headquarters or prefectural governor.

3 Fire-fighting activities

○If a fire accident occurs in a nuclear facility, the nuclear operator shall promptly grasp the state of fire occurrence and notify the fire station, and voluntarily perform initial fire-fighting activities, ensure safety, and promptly develop fire-fighting activity in close cooperation with the fire station.

○Taking into consideration the information from the nuclear disaster prevention manager, etc. ,and opinions of specialists concerning reactor engineering, radiation protection, etc., fire-fighting agencies shall promptly implement fire-fighting activities in cooperation with nuclear operators, etc., securing the safety of fire-fighting personnel who make decision on the method of fire-fighting activity and perform fire fighting.

○ Municipalities other than those located in the disaster site shall strive to provide quick and smooth support by fire-fighting agencies upon request from the local government in the disaster site or by mutual support agreement.

○ The Fire and Disaster Management Agency shall, as needed, perform general coordination for measures and fire-fighting activities taken by fire-fighting agencies of local governments other than in the disaster site for support.

○ The Joint Council on Countermeasures against Nuclear Accidents shall perform general coordination, such as requesting support of other organs, as needed, or upon request from the Fire and Disaster Management Agency.

Glossaries

Stable iodine drugs

Potassium iodide preparations to be used for reducing the exposure of the thyroid to radioiodine.

Abnormal circumstance

Situation where, due to abnormal circumstances at a nuclear facility, radioactive substances or radiation is or may be released from a nuclear facility at the abnormal level specified by Article 10 of the Special Law on Nuclear Disaster Countermeasures.

Off-site center (emergency response facility)

Regional center where the nuclear disaster headquarters of the national government and the disaster headquarters of a local government and a municipal council jointly establish a committee for the prevention and control of nuclear disasters, share information and cooperatively conduct emergency responses to nuclear emergencies.

External radiation exposure

Exposure to radiation released from outside the body – exposure to neutron rays or gamma rays released directly from a nuclear facility or to gamma rays from a radioactive plume (a portion of air containing gaseous or radioactive particulate).

Nuclear emergency

Situation where, due to abnormal circumstances at a nuclear facility, radioactive substances or radiation is or may be released from a nuclear facility at the abnormal level specified by Article 15 of the Special Law on Nuclear Disaster Countermeasures.

Nuclear facility

In this report, this refers to reactor facilities (excluding ship-propulsion reactors), reprocessing facilities, fabrication facilities, enrichment facilities, waste treatment facilities and waste management facilities (only facilities specified by the Special Law on Nuclear Disaster Countermeasures)..

Personal radiation dose assessment

This refers to the measurement and assessment of the radiation dose that

individuals have been exposed to or might have been exposed to. It is categorized into external radiation dose assessment and internal radiation dose assessment.

For external radiation dose assessment, there are two methods.

1) Physical method: A survey meter and a personal dosimeter are used.
2) Biological method: Time-course decreases in lymphocyte counts in the blood and incidences of chromosomal abnormalities are investigated.

For internal radiation dose assessment, there are also two methods.

1) A survey meter and a whole body counter are used.
2) Radionuclides or radioactive substances in the body are identified. Radiation doses are calculated using a certain model equation from the results of the measurement of the amount of identified radioactive substances using smear samples taken from the nasal cavity and oral angle, and the results of analyses of the identified radioactive substances in the urine and feces.

Survey meter

This is a portable radiation measurement device for either alpha rays, beta rays, gamma rays or neutron rays. A survey meter is categorized according to detector type into an ionization chamber type, a GM counter tube type, a proportional counter tube type, a scintillation counter type and a semiconductor element detector type. There is also a spectro-survey meter which is easy-to-carry and useful for obtaining information on energy of radiation.

JCO accident

This is the criticality accident that happened on September 30, 1999 in the Tokaimura uranium processing plant operated by JCO Co., Ltd. Its cause was the injection of a uranyl nitrate solution containing uranium at more than its critical mass into a precipitation drum that was originally designed for a different purpose. Three workers suffered serious radiation exposure, of whom two died. It was Japan’s first large nuclear accident for which residents around the plant were asked to evacuate or stay inside.

Decontamination

If radioactive substances are attached to clothes, body surface or wounds, they are removed by undressing, wiping and washing in order to reduce radiation exposure.

First response

Such activities as checking on damage, area assignment, rescue and prevention of damage expansion undertaken immediately after disasters by persons who arrive at the sites first.

Screening

To provide appropriate treatment, the level of radiation exposure of residents transferred to an evacuation site is determined by investigating the presence or absence of radioactive contamination and measuring radiation doses.

Smear

This is a test for investigating for surface contamination by radioactive substances. The condition where dust containing radioactive substances is attached to the surface of equipment, floor or experiment bench is referred to as “surface contamination”, which is categorized into adhesive surface contamination and loose surface contamination. In the case of the former, it is difficult to wipe dust off, but in the case of the latter, dust can be wiped off easily. A smear test is a method for investigating loose surface contamination by measuring the amount of radioactive substances collected by wiping surface dust off using filter paper.

Radiation dose

This refers to the level of radiation exposure in humans. For physical radiation doses, absorbed radiation doses (unit: Gy) are used to represent the energy from radiation per unit mass. Also, effective radiation doses (unit: Sv) are used to represent the biological effects of radiation exposure. It is assessed in consideration of the type of radiation, differences in energy and differences in radiation sensitivity between tissues and organs.

Internal radiation exposure

This refers to the condition where organs and tissues (thyroid, lungs, bone marrow, stomach, intestines, etc.) are exposed to radiation released from radioactive substances in the body, which are taken in by digestion or inhalation. It is caused mainly by alpha rays and beta rays that show potent ionizing effects.

Vital signs

Vital signs are basic signs suggesting life in humans, such as body temperature, pulse rate, blood pressure and respiration (occasionally including consciousness). These are the most basic indices for systematic conditions. For emergency medicine, it is necessary to check these quickly and accurately.

Radiation exposure

This refers to humans being exposed to energy called radiation. Radiation exposure is categorized into internal and external radiation exposure. Radiation exposure causes various disorders to occur. Radiation doses definitely causing acute radiation syndrome and cataracts are known, so the effects of such radiation doses are referred to as “deterministic effects”, while radiation doses causing cancer remain unknown, so the effects of such radiation doses are referred to as “stochastic effects”.

Medical cooperation

Cooperation between medical institutions for smooth and effective medical care: i.e., sharing of medical information and securing of beds for hospitalization.

Plutonium

Its atomic symbol is Pu, and its atomic number 94. It is not present on the earth in the natural state. It is produced by letting uranium absorb neutrons in a reactor. Plutonium releases alpha rays, so if humans take in fine plutonium particles, they deposit mainly in the lungs, bone surface and liver, and may cause cancer. It is important to take heed in handling.

Radioiodine

Radioiodine isotopes are iodine-131 and iodine-133. Radioiodine produced during nuclear power generation is enclosed in a fuel rod as a fission product. If fuel is damaged or melted, large amounts of gaseous iodine may be released, so it is regarded as a nuclide causing environmental contamination. Radioiodine accumulates selectively in the thyroid and may cause thyroid cancer and thyroid diseases. The risk of these diseases is high especially in children, so it is important to assess both whole body radiation doses and thyroid radiation doses.

Radiation control

To reduce radiation exposure to the public and nuclear operators in accordance with related standards and regulations, it is important to control access to and from radiation control areas and work in radiation control areas, and enhance radiation protection by measuring ambient doses.

Radiation protection

To prevent radiation injury, it is important to contain radioactive substances tightly sealed, prevent contamination from spreading and carry out decontamination, in addition to the management of the three main factors for external radiation protection: shielding, distance and time,

Whole body counter

This is a device for measuring and assessing the level and type of radiation released from humans. A radiation detector built in radiation shields is very sensitive but is not affected by environmental radiations including cosmic rays. This is also called a “human counter” or a “whole body measuring device”.

Health physics

This is related to radiology, chemistry, physics and engineering and aimed at systematic research and application of radiation protection.

Risk communication

Sharing of information on risks and opinion exchanges for better communication and mutual understanding

Criticality

Fissile materials including uranium cause fission reaction, generate huge energy and produce two or three new neutrons if neutrons collide with them. If the specified amount of fissile materials are present under certain conditions, new neutrons collide with fissile materials and cause fission reactions to continue. This continuous fission reaction is referred to as “criticality”.