

Technical Volume 3

“Emergency preparedness and response”



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IAEA

International Atomic Energy Agency



The Fukushima Daiichi Accident
Technical Volume 3

INTRODUCTION



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Technical Volume 3 - background

- Volume 3 describes the key events and response actions from the onset of the accident at the Fukushima Daiichi nuclear power plant (NPP), operated by the Tokyo Electric Power Company (TEPCO), on 11 March 2011.
- It also describes the national emergency preparedness and response (EPR) system in place in Japan and the international EPR framework prior to the accident.
- Key events relevant to the EPR area and response actions during the first year after the accident have been compiled in chronological order and are presented in the form of timelines

Table of contents

3.1. Initial response in Japan to the accident

3.2. Protecting emergency workers

3.3. Protecting the public

3.4. Transition from the emergency phase to the recovery phase and analyses of the response

3.5. Response within the international framework for EPR

Three Appendices

Two Annexes



The Fukushima Daiichi Accident
Technical Volume 3, Section 3.1

INITIAL RESPONSE IN JAPAN TO THE ACCIDENT

3.1. INITIAL RESPONSE IN JAPAN TO THE ACCIDENT

- It describes the initial actions of Japan in response to the accident, involving:
 - relevant EPR arrangements in Japan prior to the accident;
 - identification of the accident;
 - notification of off-site authorities and activation of the response;
 - mitigatory actions taken on-site; and initial off-site response.

3.1. INITIAL RESPONSE IN JAPAN TO THE ACCIDENT

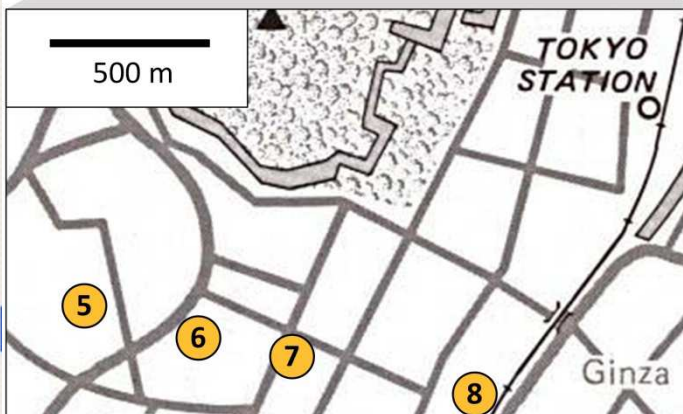
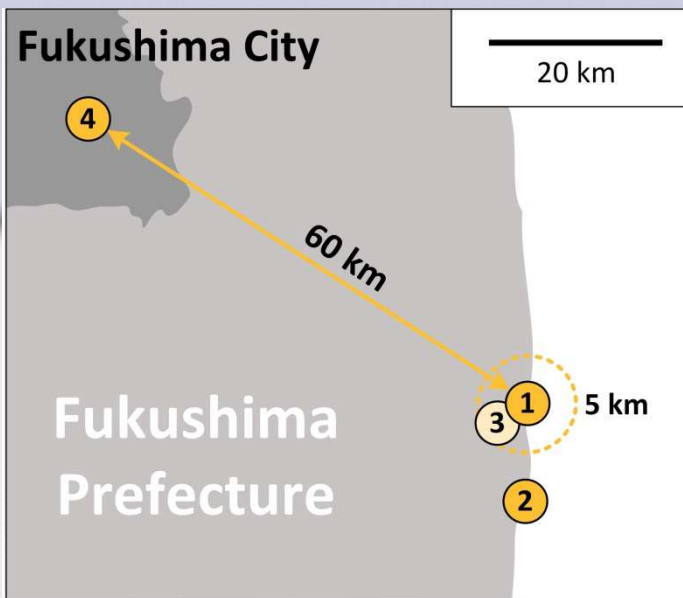
- At the time of the accident, separate arrangements were in place to respond to nuclear emergencies and natural disasters at the national and local levels.
- There were no coordinated arrangements for responding to a nuclear emergency and a natural disaster occurring simultaneously.
- This was also not addressed in relevant training and exercise programs.

3.1. INITIAL RESPONSE IN JAPAN TO THE ACCIDENT

- Arrangements to respond to nuclear emergencies envisaged that:
 - Following the detection of relevant adverse conditions at an NPP a notification would be sent from the plant to local and national governments.
 - The national government would then assess and determine whether the situation was to be categorized as a 'nuclear emergency'.
 - A declaration would be issued at the national level and decisions about necessary protective actions would be taken on the basis of dose projections.

3.1. INITIAL RESPONSE IN JAPAN TO THE ACCIDENT

- After the onset of the accident, NPP personnel promptly activated the on-site ERC and notified offsite officials.
- The national Government declared a nuclear emergency in the evening of 11 March 2011, more than two hours after having been notified by the Fukushima Daiichi NPP.
- Activation of the emergency Off-site Centre was difficult because of extensive damage caused by the earthquake and tsunami. Within a few days it became necessary to evacuate the Off-site Centre due to adverse radiological conditions.



- 1. FUKUSHIMA DAIICHI NUCLEAR POWER PLANT**
 - On-site – Emergency Response Centre at the NPP
- 2. FUKUSHIMA DAINI NUCLEAR POWER PLANT**
 - On-site – Emergency Response Centre at the NPP
- 3. OFF-SITE CENTRE**
 - Local NERHQ – Local Nuclear Emergency Response Headquarters
 - JCNER – Joint Council for Nuclear Emergency Response
 - Local Prefectural NERHQ – Local Prefectural Nuclear Emergency Response Headquarters
- 4. FUKUSHIMA PREFECTURAL GOVERNMENT OFFICE**
 - Fukushima Prefecture Headquarters for Disaster Control

KEY ENTITIES IN VARIOUS LOCATIONS IN JAPAN

Tokyo

- JNES – Japan Nuclear Energy Safety Organization
- MEXT – Ministry of Education, Culture, Sports, Science and Technology
- MHLW – Ministry of Health, Labour and Welfare
- MAFF – Ministry of Agriculture, Forestry and Fisheries
- MOE – Ministry of the Environment
- MOD (SDF) – Ministry of Defense (Self-Defense Forces)
- JMA – Japan Meteorological Agency

Ibaraki

- JAEA – Japan Atomic Energy Agency

Chiba

- NIRS – National Institute of Radiological Sciences

5. PRIME MINISTER'S OFFICE

- Prime Minister and general support staff
- NERHQ – Nuclear Emergency Response Headquarters

6. NUCLEAR SAFETY COMMISSION

7. EMERGENCY RESPONSE CENTRE OF MINISTRY OF ECONOMY, TRADE AND INDUSTRY/NUCLEAR AND INDUSTRIAL SAFETY AGENCY (METI/NISA)

- NERHQ Secretariat – Nuclear Emergency Response Headquarters Secretariat

8. TEPCO HEADQUARTERS

- TEPCO HQ-ERCs – Emergency Response Centres at TEPCO Headquarters

3.1. INITIAL RESPONSE IN JAPAN TO THE ACCIDENT

- The on-site response was marked by the extreme difficulties resulting from the effects of the earthquake and tsunami.
- Many mitigatory actions could not be carried out in a timely manner.
- Extensive damage of transport infrastructure due to the earthquake and tsunami, in addition to insufficient pre-planning, impaired effectiveness of off-site support.
- The national Government was directly involved in decisions concerning mitigatory actions on the site.

3.1. INITIAL RESPONSE IN JAPAN TO THE ACCIDENT – LESSONS AND OBSERVATIONS

- In preparing for the response to a possible nuclear emergency, it is necessary to consider emergencies that could involve severe damage to nuclear fuel in the reactor core or to spent fuel on the site, including those involving several units at a multi-unit plant possibly occurring at the same time as a natural disaster.
- The emergency management system for response to a nuclear emergency needs to include clearly defined roles and responsibilities for the operating organization and for local and national authorities. The system, including the interactions between the operating organization and the authorities, needs to be regularly tested in exercises.
- There is a need for arrangements to conduct mitigatory actions for the full range of postulated emergencies, including emergencies not considered in the design basis (e.g. severe fuel damage) and those involving several units at a multi-unit plant.
- Arrangements are needed to enable the on-site emergency response organization (ERO) to provide and receive assistance (including heavy equipment) for performing mitigatory actions in an emergency, particularly in the case of long lasting emergencies and emergencies involving several units at a multi-unit plant.



The Fukushima Daiichi Accident
Technical Volume 3, Section 3.2

PROTECTING EMERGENCY WORKERS

3.2. PROTECTING EMERGENCY WORKERS

- It describes:
 - protective measures taken for personnel in response to the earthquake and tsunami;
 - protection of emergency workers;
 - medical management of emergency workers;
 - voluntary involvement of members of the public in the emergency response.

3.2. PROTECTING EMERGENCY WORKERS

- The national legislation and guidance in Japan addressed the requirements and the measures to be taken for the protection of emergency workers, but only in general terms and not in sufficient detail.
- Implementation of the arrangements for ensuring the protection of workers against radiation exposure was severely affected by the extreme conditions at the site.

3.2. PROTECTING EMERGENCY WORKERS

- In order to maintain an acceptable level of protection for on-site emergency workers, a range of impromptu measures was implemented.
- Emergency workers came from various organizations and public services. Not all had been designated prior to the emergency as emergency workers
- During the response, the dose limit for emergency workers undertaking specific emergency work was temporarily increased to 250 mSv, to allow the necessary activities to continue.

3.2. PROTECTING EMERGENCY WORKERS

- People from the affected areas, as well as from all over Japan, and from a number of non-governmental organizations (helpers) volunteered to assist in such activities as the provision of food, water and necessities, and later in decontamination and monitoring activities.
- Medical management of emergency workers was also severely affected and major efforts were required to meet the needs of on-site emergency workers.

3.2. PROTECTING EMERGENCY WORKERS- LESSONS LEARNT

- Emergency workers need to be designated, assigned clearly specified duties, regardless of which organization they work for, given adequate training, and be properly protected during an emergency. Arrangements need to be in place to integrate into the response those emergency workers who had not been designated prior to the emergency.
- Arrangements need to be pre-planned for members of the public (referred to as helpers) who volunteer to assist in response actions to be integrated into the emergency response organization and to be afforded an adequate level of radiation protection.
- There is a need to involve non-governmental organizations in establishing adequate emergency arrangements at the preparedness stage to facilitate their effective support to the overall emergency response.
- Arrangements for the protection of emergency workers need to be elaborated in detail in the relevant emergency plans and procedures.
- There is a need for the training of emergency workers in the implementation of measures and actions for their protection in an emergency, with specific emphasis on severe environmental and radiological conditions.
- Arrangements for medical preparedness and response in relation to emergency workers need to be detailed and integrated in the overall emergency planning.



The Fukushima Daiichi Accident
Technical Volume 3, Section 3.3

PROTECTING THE PUBLIC

3.3. PROTECTING THE PUBLIC

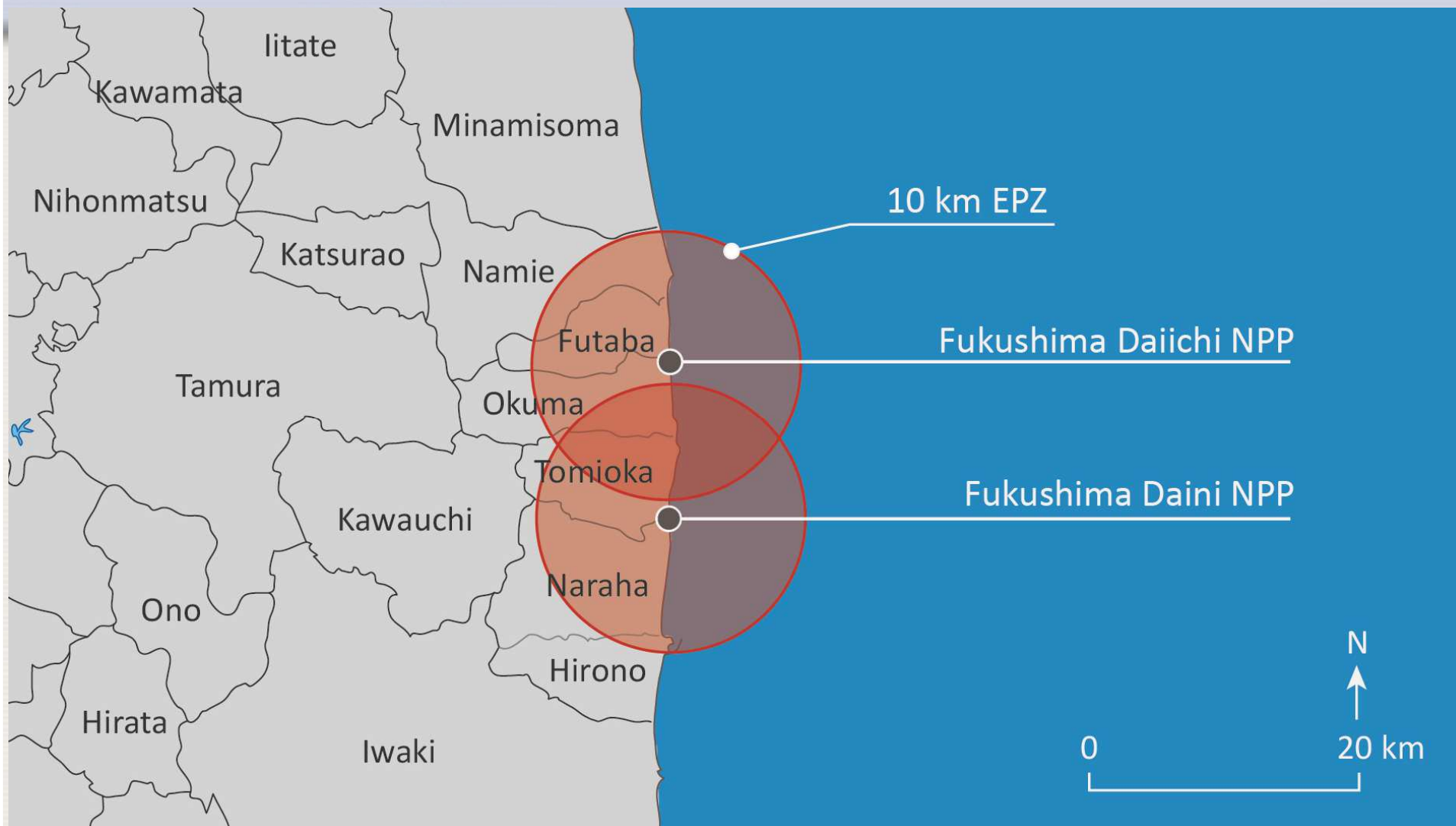
- It describes:
 - public protective actions and other response actions taken by Japan;
 - the use of a dose projection model, the System for Prediction of Environmental Emergency Dose Information (SPEEDI), as a basis for decisions on protective actions during the accident;
 - environmental monitoring;
 - provision of information to the public and international community;
 - issues related to international trade and waste management.

3.3. PROTECTING THE PUBLIC

- National emergency arrangements at the time of the accident envisaged that decisions on protective actions would be based on estimates of the projected dose to the public that would be calculated when a decision was necessary using the dose projection model SPEEDI.
- The arrangements did not envisage that decisions on urgent protective actions for the public would be based on predefined specific plant conditions. However, in response to the accident, the initial decisions on protective actions were made on the basis of plant conditions.

3.3. PROTECTING THE PUBLIC

- The arrangements prior to the accident included criteria for sheltering, evacuation and iodine thyroid blocking in terms of projected dose, but not in terms of measurable quantities.
- No predetermined criteria (i.e. generic, in terms of dose, or operational, in terms of measurable quantities) for relocation.
- Prior to the accident, 10 km emergency planning zones (EPZ) were in place around the Fukushima Daiichi and Fukushima Daini NPPs.

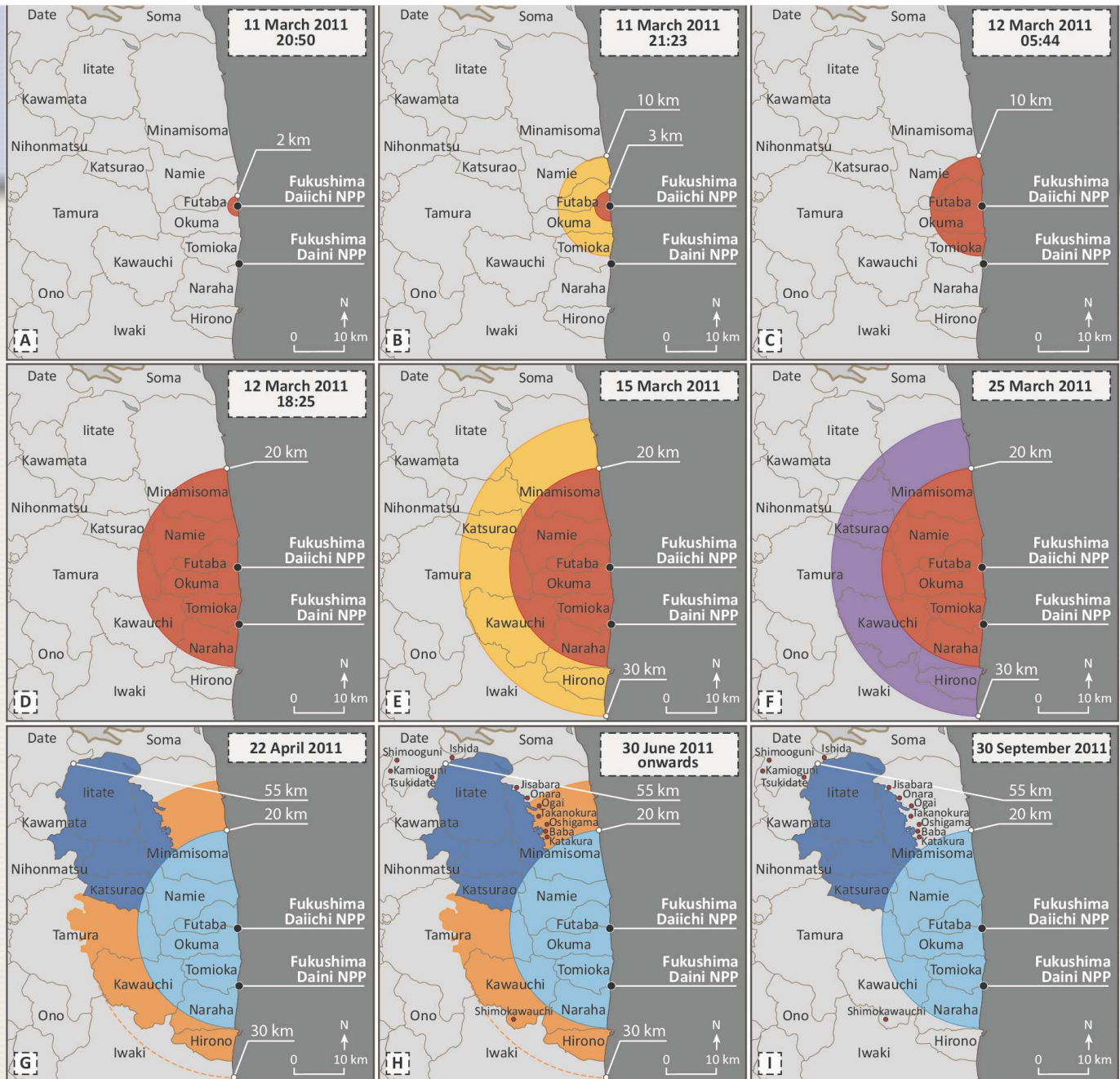


3.3. PROTECTING THE PUBLIC

- Public protective actions and other response actions implemented:
 - evacuation; sheltering; iodine thyroid blocking (through the administration of stable iodine); restrictions on the consumption of food and drinking water; relocation; and the provision of information.
- There were difficulties in evacuation due to earthquake and tsunami damage and associated transportation and communication problems.
- There were also significant difficulties encountered when evacuating patients from hospitals and nursing homes from within 20 km of the NPP.

3.3. PROTECTING THE PUBLIC

- Owing to a lack of detailed preplanned arrangements for evacuation to locations outside the 10 km emergency planning zone, and because of difficulties in coordination, many evacuees were relocated several times during the first 24 hours.
- Dose rate measurements from 15 March onward indicated that relocation for some areas beyond the 20 km evacuation zone was warranted.



3.3. PROTECTING THE PUBLIC

- Several channels were used to keep the public informed and to respond to people's concerns during the emergency, including television, radio, the Internet and telephone hotlines.
- Calculated doses or various measured quantities (e.g. dose rates or radionuclide concentrations) were used to explain the situation, without placing them into context and trying to explain the situation to the public.

3.3. PROTECTING THE PUBLIC

- Arrangements were made regarding protective actions in the agricultural area and restrictions on the consumption and distribution of food and consumption of drinking water.
- A certification system for food and other products intended for export was established.
- Various instructions and guidelines were developed to address issues related to waste.

3.3. PROTECTING THE PUBLIC - LESSONS AND OBSERVATIONS

- Arrangements need to be in place to allow decisions to be made on the implementation of predetermined urgent protective actions for the public based on predefined plant conditions.
- Arrangements need to be in place to enable urgent protective actions to be extended or modified in response to developing plant conditions or monitoring results. Arrangements are also needed to enable early protective actions to be initiated on the basis of monitoring results.
- Arrangements need to be in place to ensure that protective actions and other response actions in a nuclear emergency do more good than harm. A comprehensive approach to decision making needs to be in place to ensure that this balance is achieved.
- Arrangements need to be in place to assist decision makers, the public and others (e.g. medical staff) to gain an understanding of radiological health hazards in a nuclear emergency in order to make informed decisions on protective actions. Arrangements also need to be in place to address public concerns locally, nationally and internationally.

3.3. PROTECTING THE PUBLIC - LESSONS AND OBSERVATIONS

- **Medical staff** (health care professionals) **need to be trained** in basic medical response to a nuclear emergency and in adequate management of (possibly) contaminated patients to **avoid delays** in the treatment of **injured people**.
- **Arrangements** need to include provisions at the preparedness stage for **implementing restrictions** on the use and distribution of **non-food commodities** which have been, or could be, contaminated as a result of the emergency.
- **Radioactive waste** arising from the emergency needs to be **managed** in a manner that **does not compromise** the protection strategy.



The Fukushima Daiichi Accident
Technical Volume 3, Section 3.4

**TRANSITION FROM THE EMERGENCY PHASE TO THE
RECOVERY PHASE AND ANALYSES OF THE RESPONSE**

3.4. TRANSITION FROM THE EMERGENCY PHASE TO THE RECOVERY PHASE AND ANALYSES OF THE RESPONSE

- It describes:
 - transition from the emergency phase to the recovery phase;
 - national analysis of the accident and the emergency response.

3.4. TRANSITION FROM THE EMERGENCY PHASE TO THE RECOVERY PHASE AND ANALYSES OF THE RESPONSE

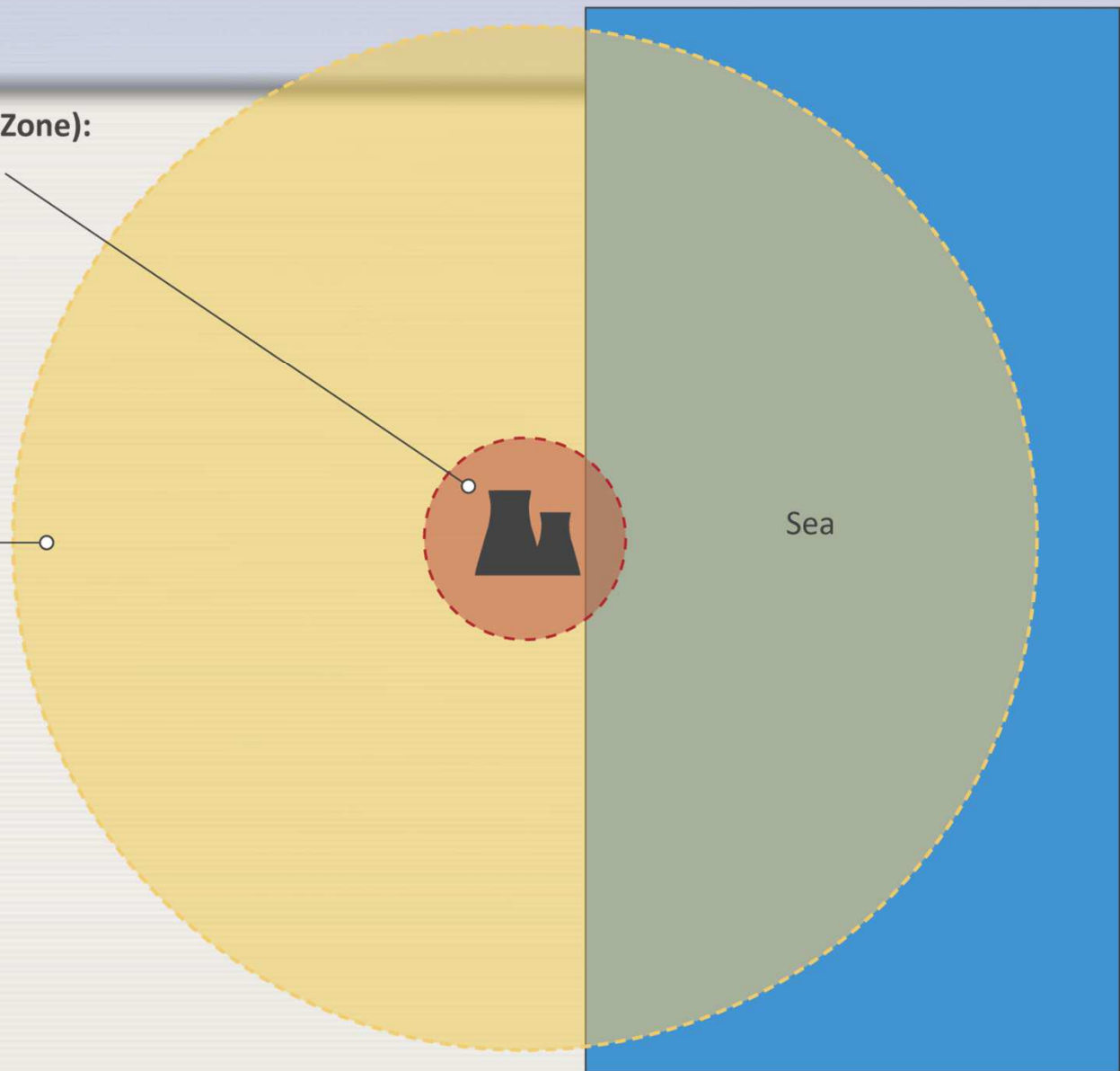
- Specific policies, guidelines, criteria and arrangements for the transition from the emergency phase to the recovery phase were not developed before the accident.
- In developing these arrangements, the Japanese authorities decided to apply the latest recommendations of ICRP.

3.4. TRANSITION FROM THE EMERGENCY PHASE TO THE RECOVERY PHASE AND ANALYSES OF THE RESPONSE

- After the accident, national EPR arrangements were, in many cases, revised to take account of the findings of these analyses and of relevant IAEA safety standards in the area of EPR.
- On the basis of these analysis and lessons identified, corrective actions were taken to strengthen EPR arrangements.

PAZ (Precautionary Action Zone):
Approx. 5 km radius

**UPZ (Urgent Protective
Action Planning Zone):**
Approx. 5–30 km radius



 Nuclear Power Plant



3.4. TRANSITION FROM THE EMERGENCY PHASE TO THE RECOVERY PHASE AND ANALYSES OF THE RESPONSE – LESSONS AND OBSERVATIONS

- **Arrangements** need to be developed at the preparedness stage for termination of protective actions and other response actions, and **transition to the recovery phase**.
- **Timely analysis of an emergency** and the response to it, drawing out lessons and identifying possible improvements, **enhances emergency arrangements**.



The Fukushima Daiichi Accident
Technical Volume 3, Section 3.5

**RESPONSE WITHIN THE INTERNATIONAL FRAMEWORK
FOR EMERGENCY PREPAREDNESS AND RESPONSE**

3.5. RESPONSE WITHIN THE INTERNATIONAL FRAMEWORK FOR EPR

- It describes:
 - response by the IAEA;
 - response by other international organizations within the Inter - Agency Committee on Radiological and Nuclear Emergencies (IACRNE);
 - actions of IAEA Member States with regard to protective actions recommended to their nationals in Japan;
 - provision of international assistance.

3.5. RESPONSE WITHIN THE INTERNATIONAL FRAMEWORK FOR EPR

- An extensive international EPR framework existed at the time of the accident, consisting of international legal instruments, IAEA safety standards and operational arrangements.
- The IAEA liaised with the official contact point in Japan, shared information, and kept States, relevant international organizations and the public informed.
- Communication with the official contact point in Japan in the early phase of the emergency response was difficult.



3.5. RESPONSE WITHIN THE INTERNATIONAL FRAMEWORK FOR EPR

- The Assistance Convention was not invoked and RANET was not utilized.
- Different States either took or recommended different protective actions for their nationals in Japan in response to the accident.
- These differences were generally not well explained to the public and occasionally caused confusion and concern.

3.5. RESPONSE WITHIN THE INTERNATIONAL FRAMEWORK FOR EPR - LESSONS AND OBSERVATIONS

- The implementation of international arrangements for **notification and assistance** needs to be strengthened.
- There is a need to **improve consultation and sharing of information** among States on protective actions and other response actions.
- There is a need for the IAEA Secretariat to provide States, international organizations and the public **with timely, clear, factually correct, objective and easily understandable information** during the nuclear emergency on its potential radiological **consequences** and the **prognosis** of possible emergency progression.
- There is a need for **continuous enhancements** and exercising of the inter-agency coordination mechanism in the EPR area, and for **further strengthening** the role of the IACRNE.

Appendices

- There are three Appendices that provide supplementary information:
 - Appendix I describes the key documents and elements of Japan's EPR system that existed prior to the accident.
 - Appendix II describes the radiation emergency medical system that was in place in Japan prior to the accident.
 - Appendix III describes the emergency drills and exercises that took place prior to the accident.

Annexes

- There are two Annexes that provide supplementary information.
 - Annex I contains a provisional English translation by the IAEA of the notification faxes sent by the Fukushima Daiichi NPP Site Superintendent to off-site officials on 11 March 2011.
 - Annex II reproduces a copy of a message issued by the International Commission on Radiological Protection (ICRP) on 21 March 2011 that includes quotes from its generally applicable recommendations.
- The annexes are included in the attached CD-ROM.

THANK YOU