NRA
Nuclear Regulation Authority

New Framework for Emergency Preparedness and Response in Japan

Masashi HIRANO
Director-General for Regulatory Standard & Research
Nuclear Regulation Authority (NRA)

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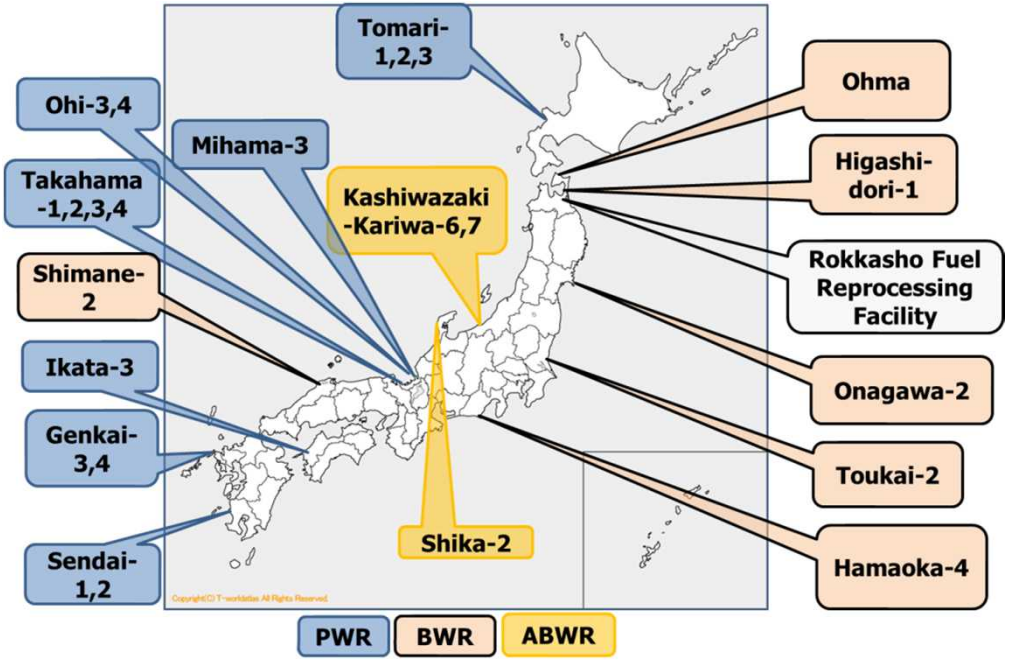
Contents

Introduction: Overview of Current Status

- The NRA was established in **Sep. 2012** and developed the **new regulatory requirements** to NPPs which came into force **in July 2013**.
  - All the 48 units have been shut down since Sep. 2013.
  - A total of 24 units (15 PWRs, 9 BWRs) have applied for conformance review. To date, the NRA has granted the permissions for 4 units.
- In **Oct. 2012**, the NRA issued the new **Guide for Emergency Preparedness and Response (EPR Guide)** and set forth the new EPR framework. Currently, the NRA is amending the Guide for further improvement.
- The former **JNES was merged with NRA** in **Mar. 2014**.
- The **IAEA IRRS mission** to be taken place in **Jan. 2016**.



Four Points in New EPR Framework

Point No. 1: Departure from a System Depending on Computer-Based Prognosis

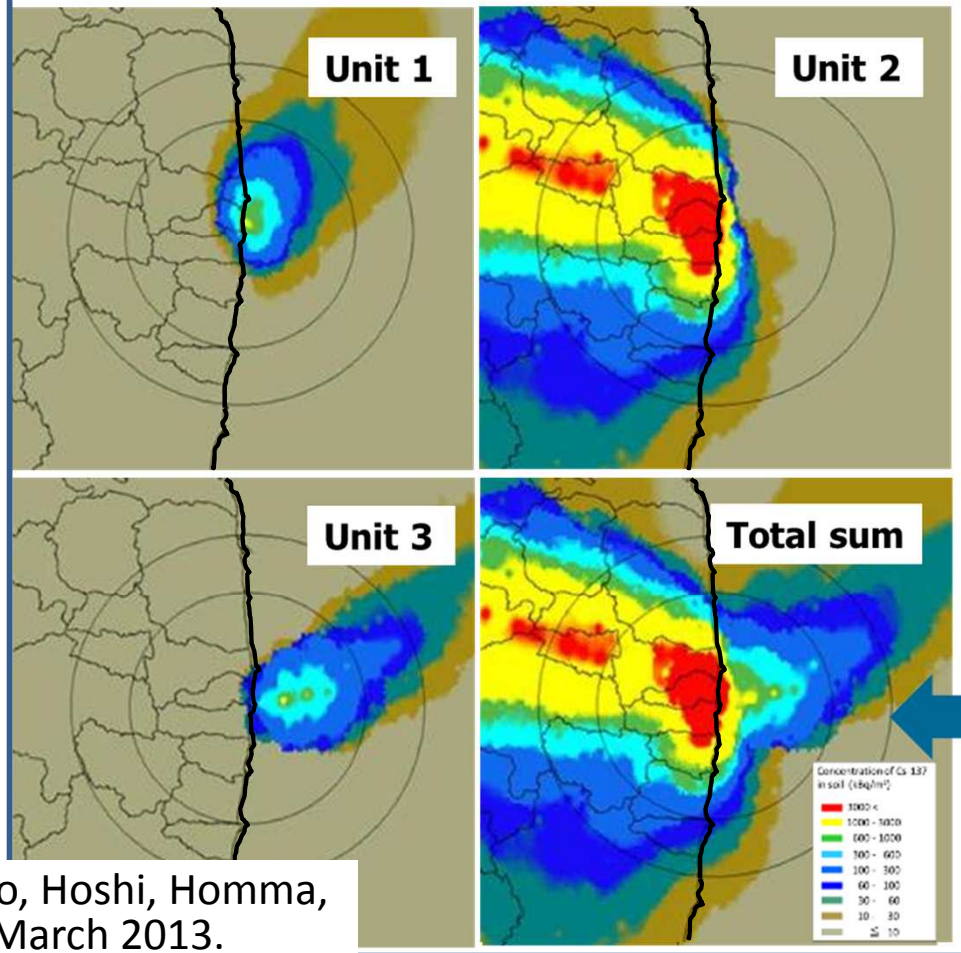
- Prior to the Fukushima Daiichi accident, decision making for initiating the off-site protective actions was **heavily dependent on the computer-based prognosis system**:
  - **ERSS/MAAP** for severe accident (SA) progression / **source term** analysis based on the plant data from **SPDS**
  - **SPEEDI** for atmospheric dispersion simulation
- In general, prediction of SA progression / source terms is quite difficult. **The NRA believes, therefore, the decision making should not be done based on such prognosis**.
- In the **new EPR Guide**, previous policy to use **such prognosis was abolished** and **a new framework** was introduced to use **EALs** and **OILs**, and the **measured monitoring data** that is basically consistent with the draft IAEA GSR Part 7.

SPEEDI: System for Prediction of Environmental Emergency Dose Information
ERSS: Emergency Response Support System
SPDS: Safety Parameter Display System

Source term evaluation is difficult! (1/2)

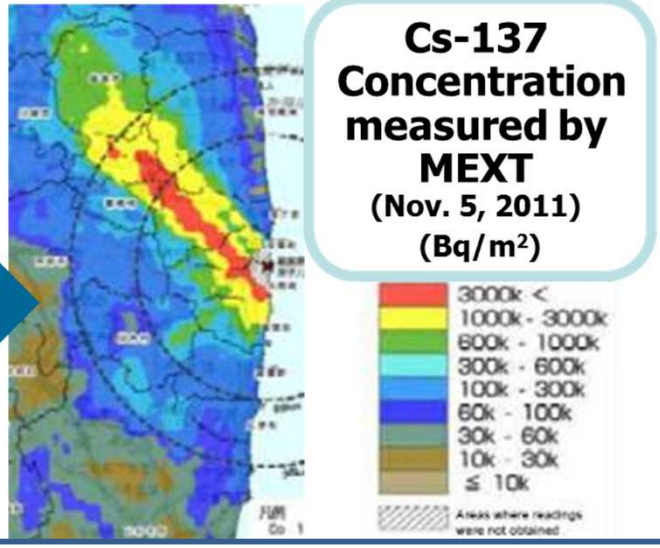
- The former JNES started a **SA progression analysis with MELCOR** just after the accident and has improved it step by step.
- **Four years after the accident, we still need a lot of assumptions.**

- By using the **source terms with MELCOR** (slide 6), an **environmental consequence analysis** was done in JAEA with **OSCAAR** developed there.



Major findings:

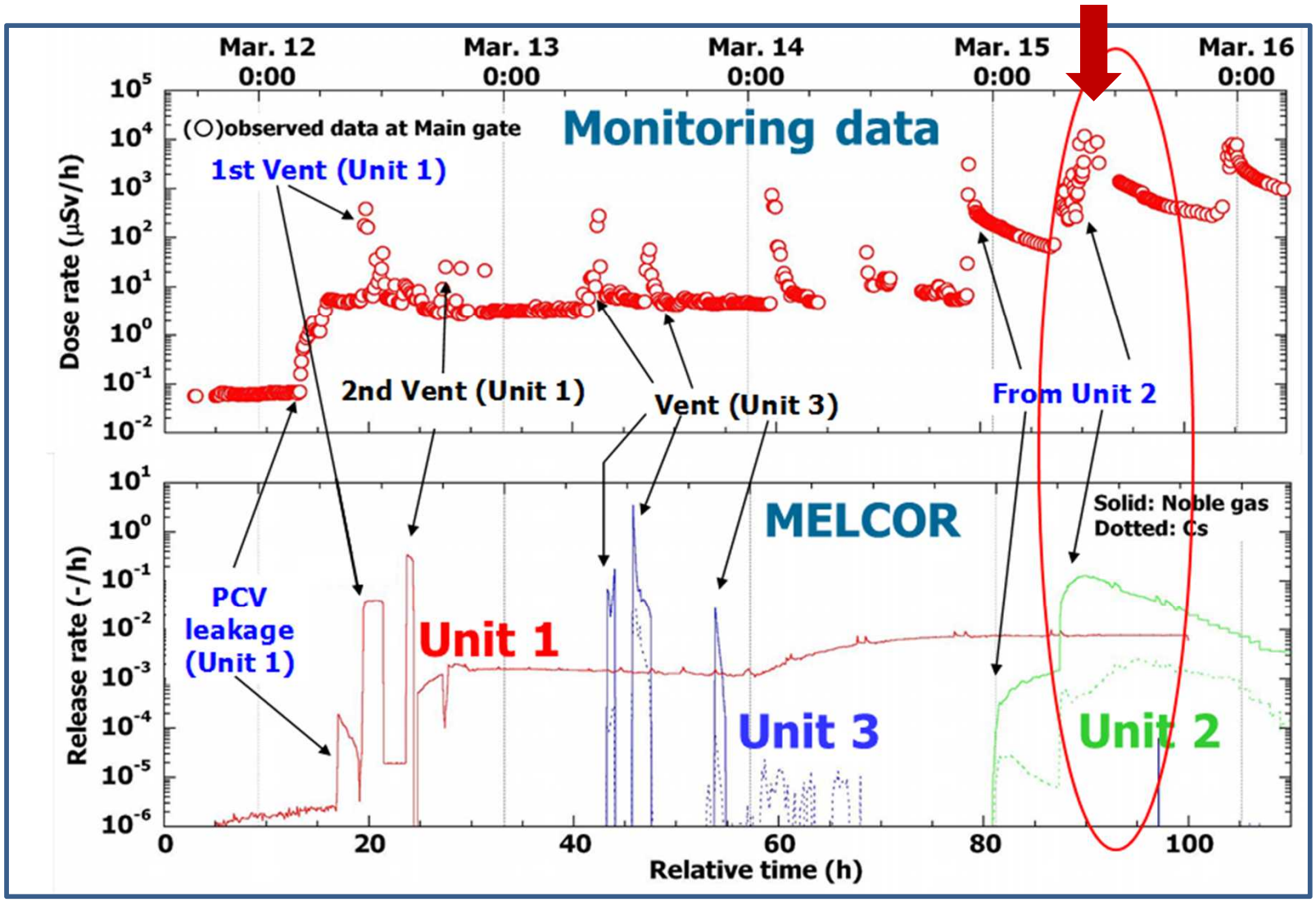
- The **release from Unit 2** on **March 15** had dominant contribution to the inland contamination.
- The release from **Units 1 and 3** mostly spread **to the ocean**.
- Sum of the release well reproduced the characteristics of the measured contamination.



Source: Hirano, Hoshi, Homma, U.S.NRC RIC, March 2013.

Source term evaluation is difficult! (2/2)

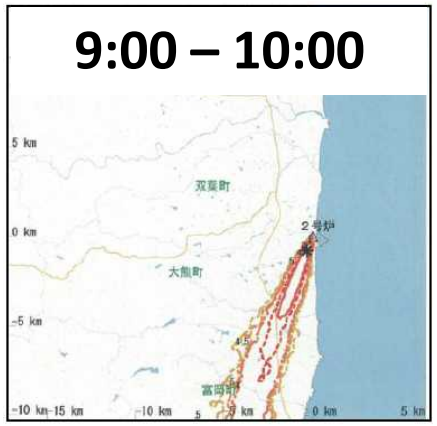
- Comparison between **the monitoring data** at the main gate and the **source terms obtained by MELCOR**.

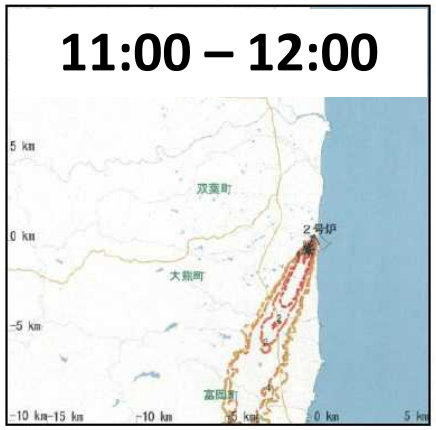


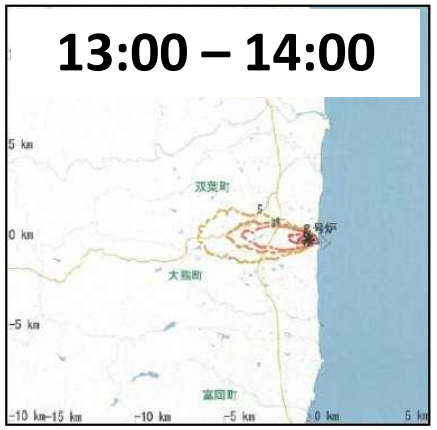
Source: Hirano, Hoshi, Homma, U.S.NRC RIC, March 2013.

Wind was whirling clockwise on March 15, 2011.

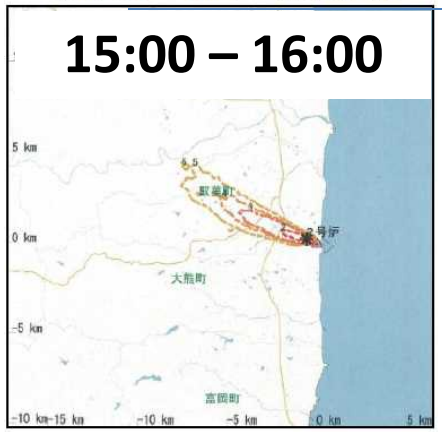
- During the accident, **ERSS/MAAP couldn't supply source terms to SPEEDI** since the plant data were unavailable due to SBO, etc.
- The **SPEEDI** simulation had been done every hour assuming a **unit release of 1 Bq/hour**, which was equivalent to the **meteorological data**.







SPEEDI calculations
Mar. 15, 2011

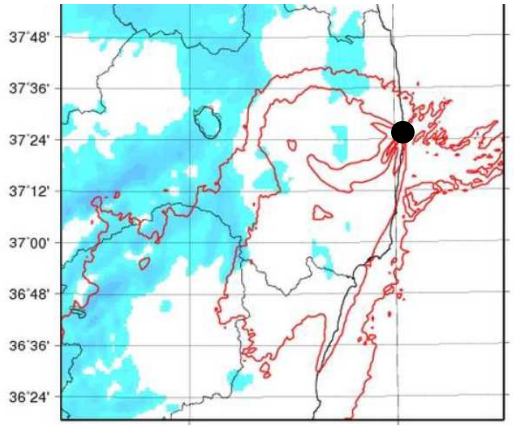


Source: Final Report, Investigation Committee on the Accident at Fukushima NPS of TEPCO, July 23, 2012

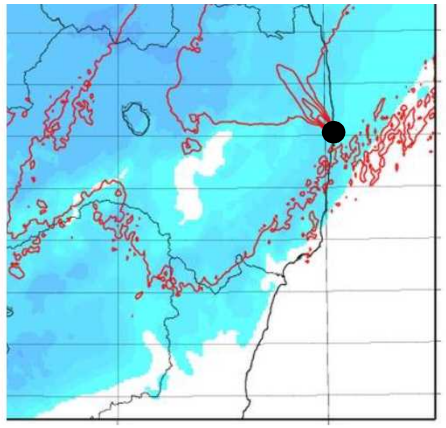
Source: M. Chino, JAEA, May 2013

Precipitation (Rainfall)

6:00 – 15:00



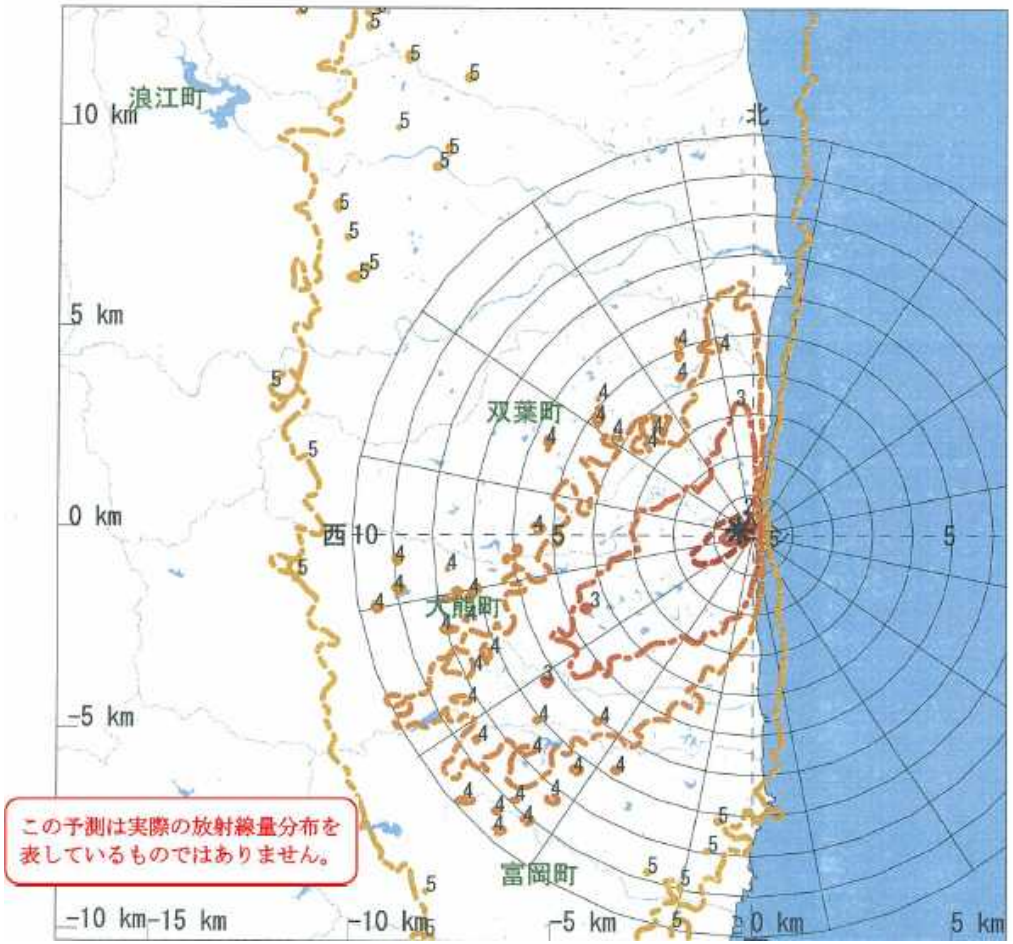
15:00 – 21:00



http://www.aec.go.jp/jicst/NC/iinkai/teirei/siryo2013/siryo18/siryo1.pdf

SPEEDI Prognosis Done during the Accident

- On **March 12**, 2011, a SPEEDI calculation was done by using **source terms of a SBO scenario which had been calculated prior to the accident.** The results were largely different from the actual situation:



Summary of Point No. 1:

- It is difficult to predict the changes **in wind direction** and **precipitation**,
- It is extremely difficult to predict the **release timing**.

Cumulative effective dose due to external exposure:
13:00 – 19:00 on March 12

Source: http://www.nsr.go.jp/archive/nisa/earthquake/speedi/erc/05-03120607.pdf

Four Points in New EPR Framework

Point No. 2: Giving Priority to "Sheltering"

- In the accident, the evacuation area was widened step by step.
- While the government issued the stay-indoors order to the residents between 20-30 km on March 15, some people voluntarily started evacuation:
  - … ***those who began evacuating early in the evening of March 15*** *were likely to have followed the evacuation routes* ***in the same direction as the dispersion of radioactive materials****.*

Source: the Diet report

Urgent Protective Actions Taken during the Fukushima Daiichi Accident

March 11, 2011
19:03 Declaration of General Emergency
20:50 **Evacuation** within **2** km (Fukushima prefecture)
21:23 **Evacuation** within **3** km (about 5,862 people)
⇒ **Completed at 1:45 on March 12**

March 12, 2011
5:44 **Evacuation** within **10** km (about 51,207 people)
18:25 **Evacuation** within **20** km (about 177,500 people)
⇒ **Completed at 14:00 on March 15**

March 15, 2011
11 : 00 **Sheltering** between **20-30** km
.....

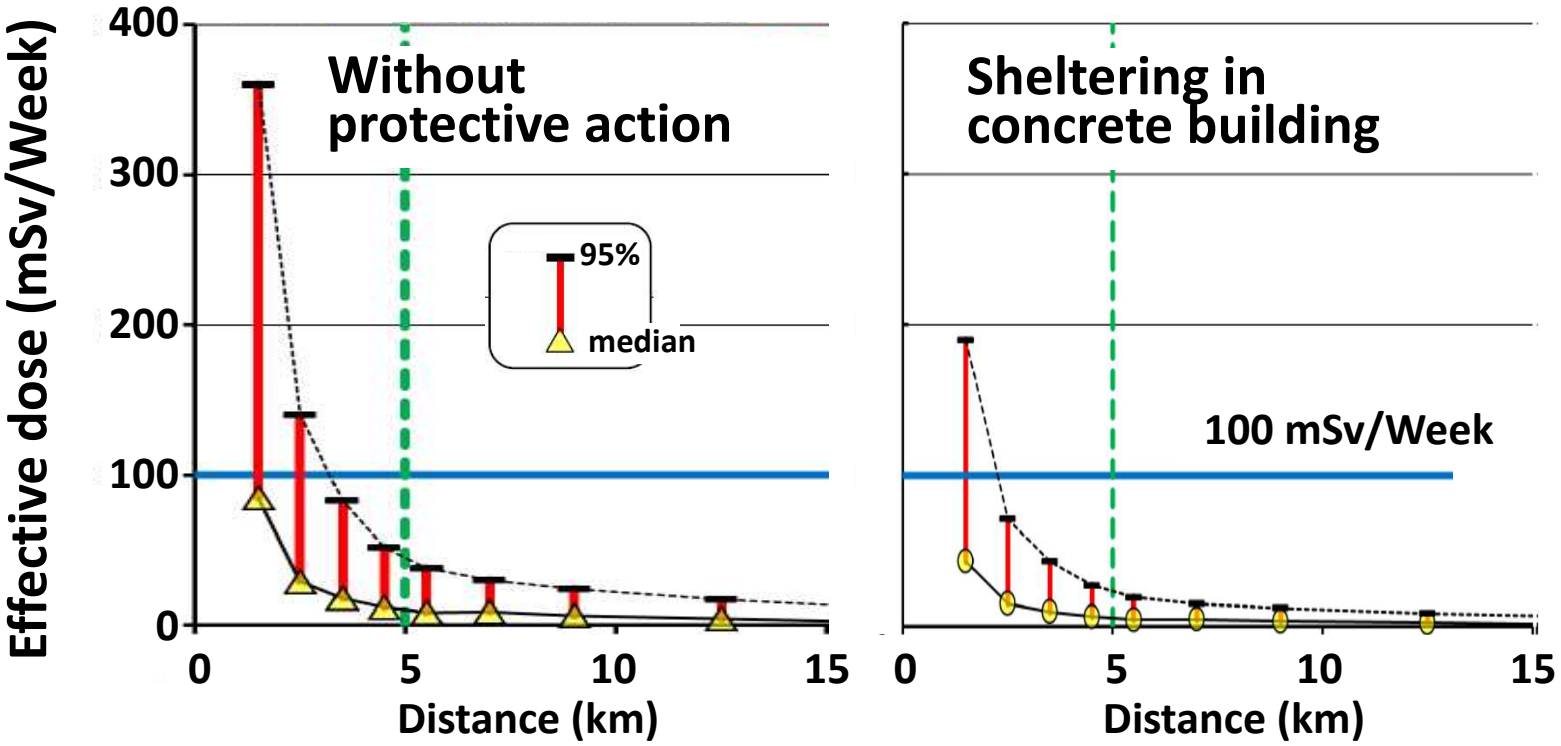
Source:http://www.nsr.go.jp/archive/nsc/senmon/shidai/bousin/bousin2011_02/ssiryo1.pdf

- In general, when the **evacuation area is expanded**, the more people are involved and **the more difficult it becomes to evacuate a large number of people simultaneously** especially if urban areas are involved.

Study on Effect of "Sheltering"

- Generic study was done by NRA/JAEA with **Level 3 PRA** assuming simplified source terms. (See Appendix C)

Source: https://www.nsr.go.jp/data/000047953.pdf



Major assumptions

Shielding:

- **40% reduction** of cloud shine
- **80% reduction** of ground shine

Airtightness:

- **95% reduction** of inhalation

Source:https://www.nsr.go.jp/data/000047953.pdf

- The new framework, therefore, took a basic policy to **giving priority to "sheltering"** within UPZ in order to **avoid the risks** associated with:
  - Exposure due to **release** of radioactive materials **during evacuation**,
  - Difficulty in **evacuating many people simultaneously** that may cause **traffic jam/turmoil** and require **longer time**

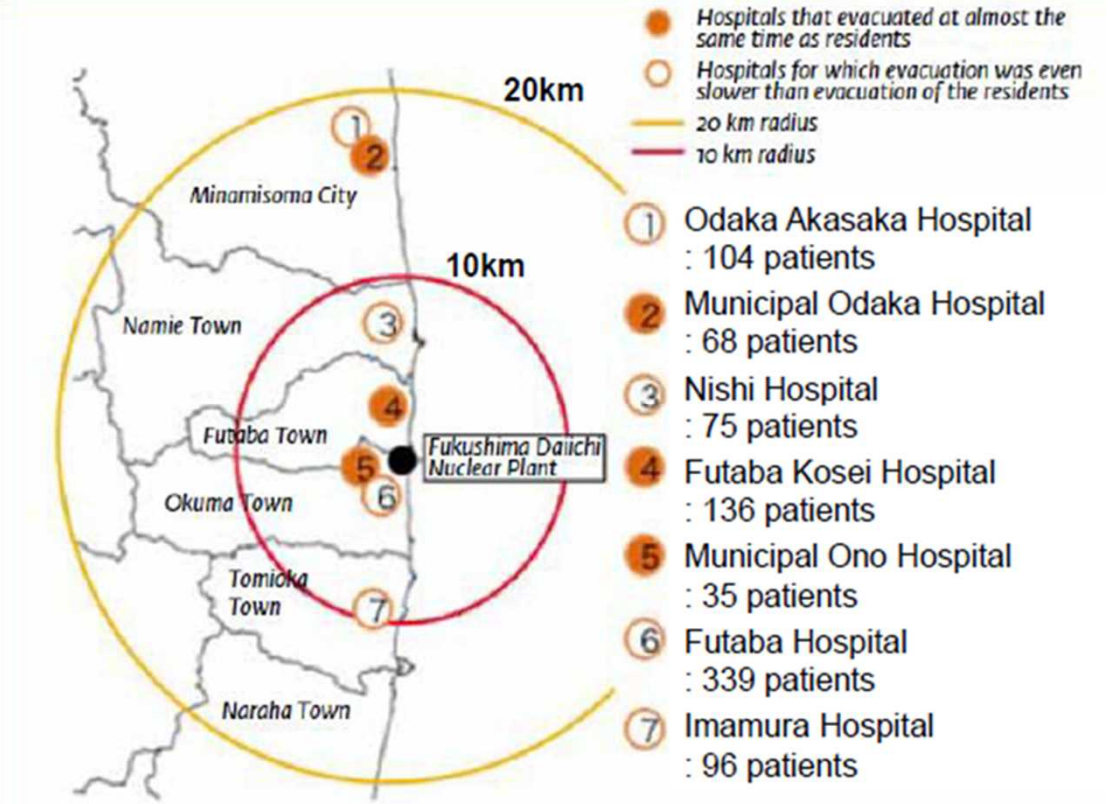
Point No. 3: Care for Those Who Need Support

- It is difficult to **evacuate the people who need support** especially those who are hospitalized and need medical care.
- Many cases were reported that heavy burdens were imposed on the people both physically and mentally such as **multiple relocations over long distances and long periods of time**.
- Learning from such lessons, the new framework took the following policy:
  - **The people who need support** start evacuation earlier, at the timing of **Site Area Emergency** while the other people start it at the timing of General Emergency, and
  - **Patients in hospitals and nursing homes** or in a similar situation **stay in place** or temporarily relocate to the **nearby temporal shelters** and start evacuation after accommodation, transportation routes and vehicles, etc. are fully ready.

Sixty lives that could not be saved.

- *There are seven hospitals inside the 20km radius zone . At the time of the accident, a total of approximately **850 patients were hospitalized** …. Among these patients, approximately **400 were seriously ill**....*
- ***At least 60 people died in the seven hospitals and in long-term care health facilities** by the end of March 2011.*

Figure 4.2.3-1: Overview of the hospitals within the 20km zone from Fukushima Daiichi NPP when the disaster occurred



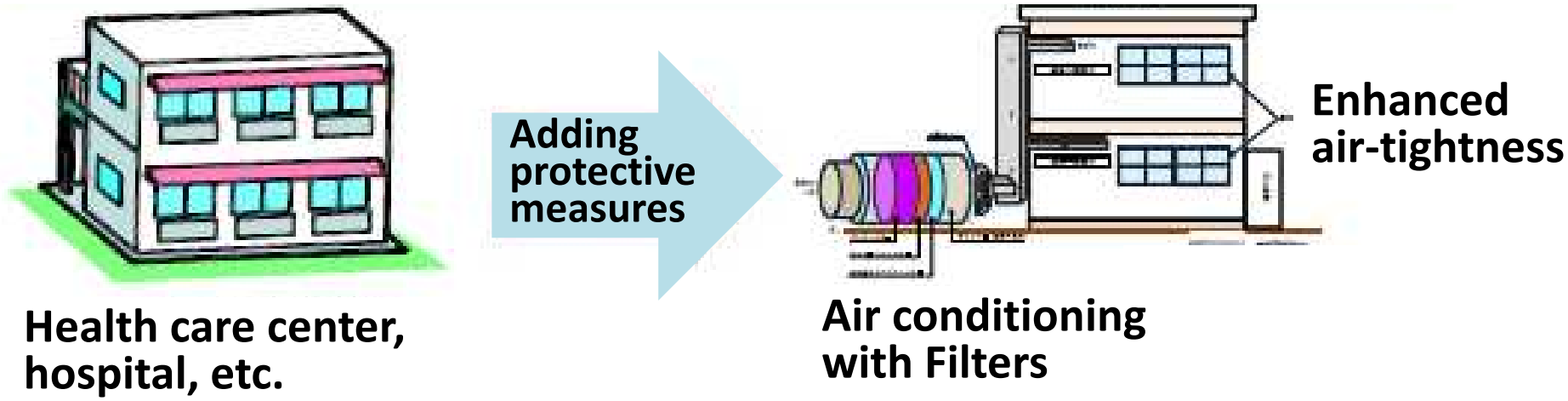
- *… experienced the severest evacuation situation, since it was **relatively slow to secure evacuation shelters with medical equipment** and **transportation measures** for evacuation; in addition it had **a large number of hospitalized patients**.*

Source: Report from the Fukushima Nuclear Accident Independent Investigation Commission, Chapter 4

Temporal Shelters

- The government has supplied subsidies to local governments for implementing **temporal shelters** by adding protective measures:
  - **Enhancement of airtightness** of the buildings,
  - Installation of **air conditioning system with filters**, etc.

  to the existing facilities, especially in peninsula areas, such as:
  - **Long-term care health facilities**, and
  - **Community halls**, **hospitals**, **school gymnasiums**, etc.



Four Points in New EPR Framework

Point No. 4: Wider Coverage of Area

- Before the accident, the area within **8 to 10 km** radius from a NPP was defined as **EPZ** (Emergency Planning Zone).
- In the accident, however, the radioactive materials deposited on the ground and brought about high radiation dose even **outside the 30 km** radius.
- The NRA, therefore, defined the area within approximately **30 km** radius as **UPZ** (Urgent Protective action planning Zone) and set forth a policy to take necessary protective measures even **outside UPZ**.
  - When a large release take places, **sheltering** is requested to the people even **outside UPZ**, if necessary, taking into account the plant status and results from **environmental monitoring**.
    - Ground survey by **monitoring cars**,
    - Areal survey by **helicopters**, etc.

A Total of 23 of the 24 Monitoring Posts Rendered Inoperative

- *As a result of the earthquake and tsunami damage, **23 of the 24 monitoring posts** the Fukushima government had installed in the prefecture **were rendered inoperative**...*
  - *… four **monitoring posts were swept away** by the tsunami.*
  - *The monitoring post at Namikura station had its **line for transferring data rendered inoperative due to the tsunami**.*
  - *Eighteen additional monitoring posts were unable to transfer data … because the **backup power supply** to the base station for the transfer data line **was cut off**.*

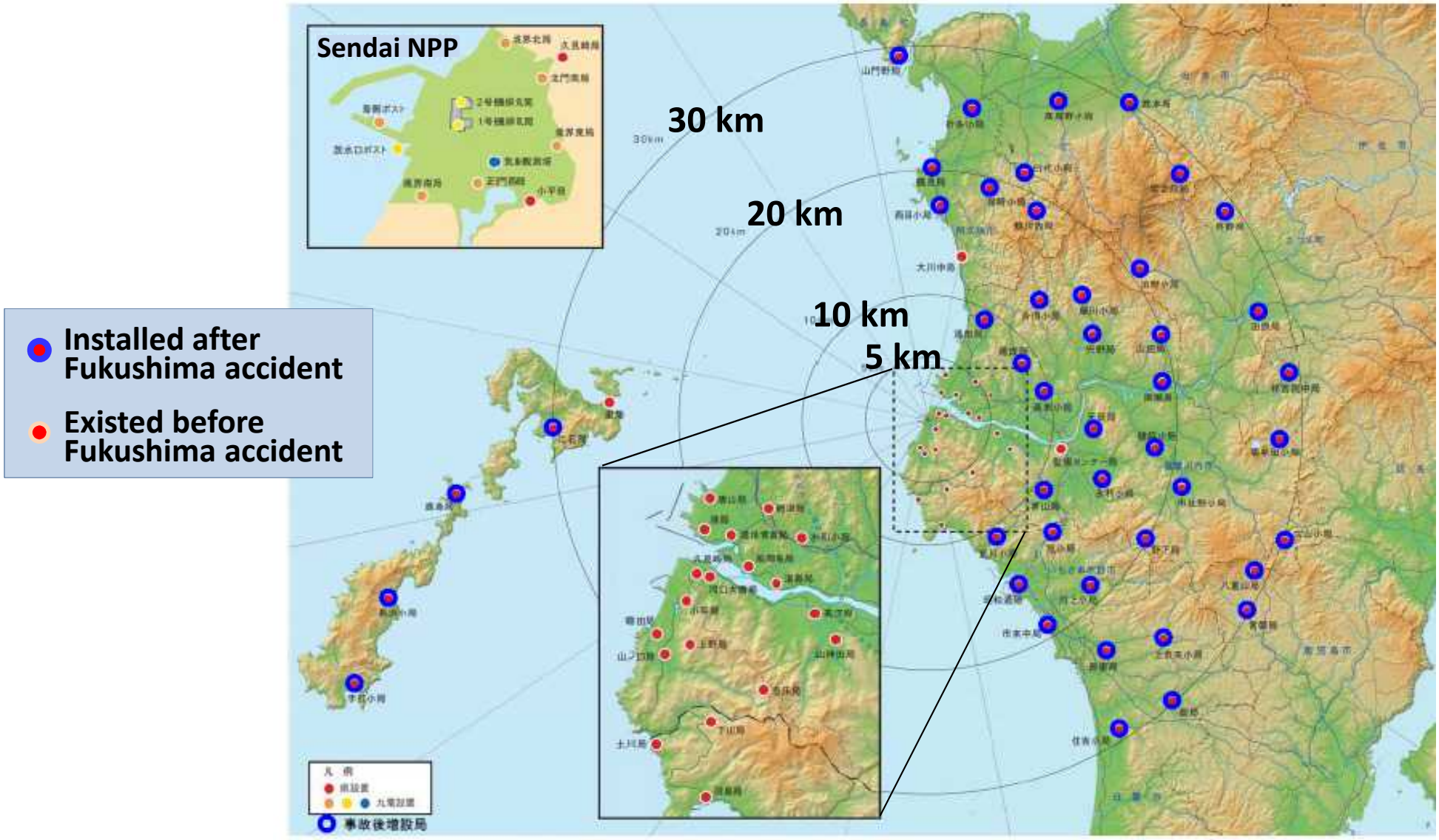
Source: The Government Interim Report*

- Based on these lessons, the environmental monitoring capability has been enhanced by the local governments with support from the government.

*Interim Report, Investigation Committee on the Accident at Fukushima NPS of TEPCO, December 26, 2011

Emergency Radiation Monitoring in Kagoshima Prefecture (1/4)

- Surrounding the Sendai NPP, there are **67** monitoring stations:
  - **22** before the Fukushima accident, **45 added after that**



Emergency Radiation Monitoring in Kagoshima Prefecture (2/4)

- Emergency **power supply** and **transmission channels** reinforced
- Additional **14 backup portable monitoring posts** and **30 dose measurement devices with GPS tracking**
- **Monitoring cars** equipped with instrumentation of radiation dose and concentration

Monitoring post with emergency power generator

Monitoring post with PV generator

Portable monitoring post with PV generator and cellular phone communication function

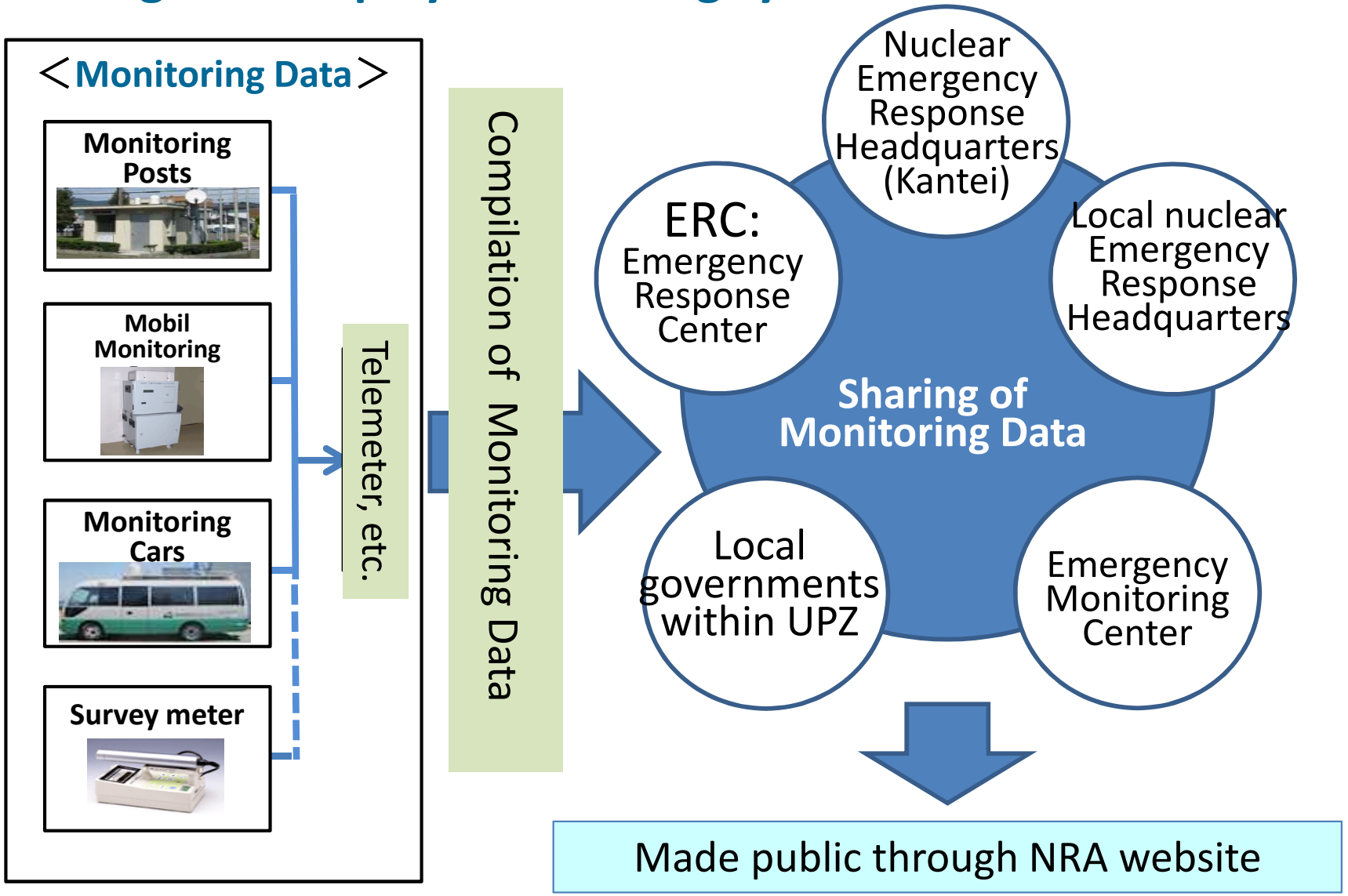
GPS tracking unit for measuring dose rate

Monitoring car

Portable dust iodine sampler

Emergency Radiation Monitoring in Kagoshima Prefecture (3/4)

- Enhanced radiation monitoring and development/installation of **monitoring data display and sharing system.**

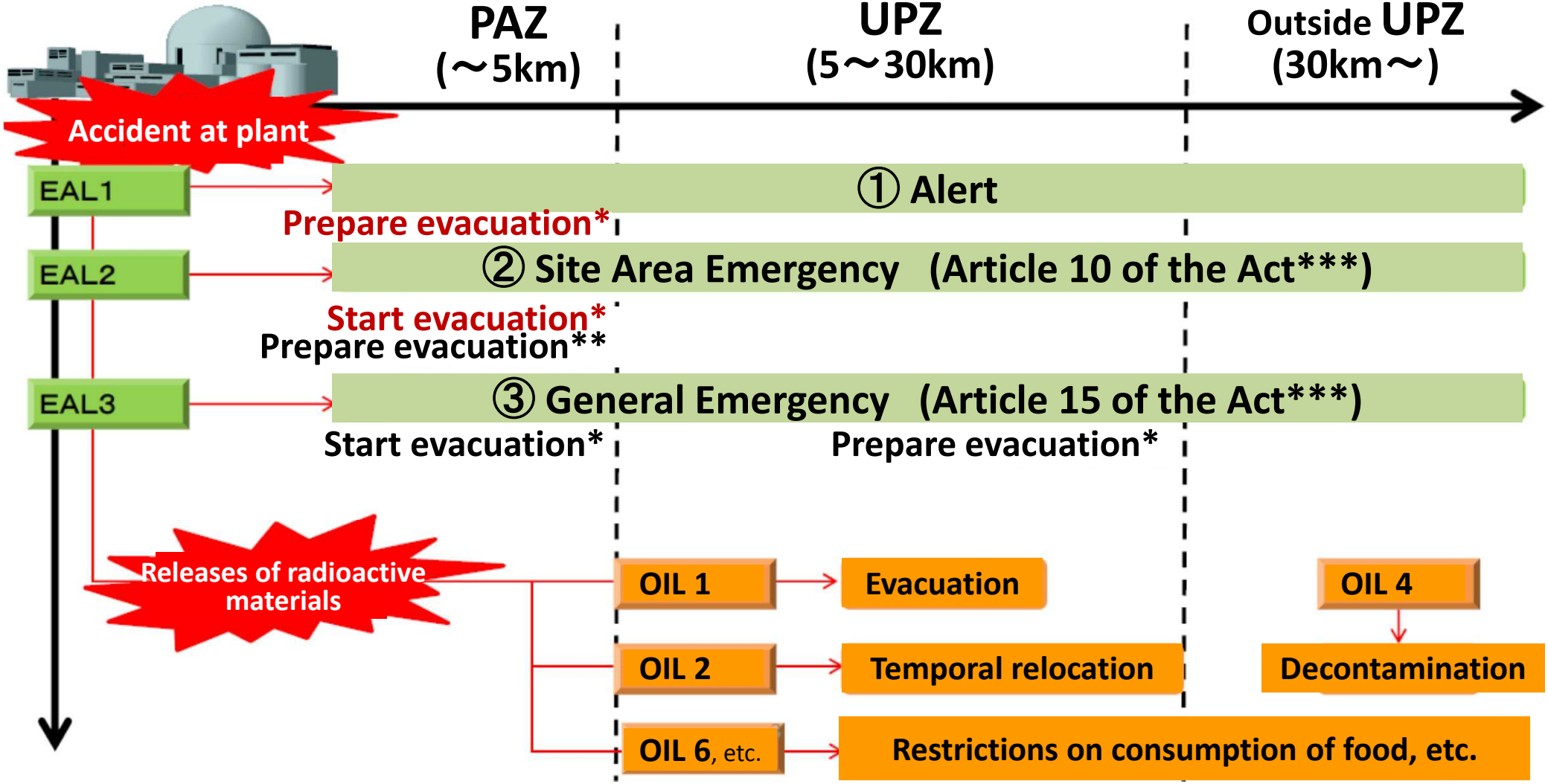


Emergency Radiation Monitoring in Kagoshima Prefecture (4/4)

■ Sample screen of prototype application software

Summary of New EPR Framework Based on EALs and OILs

PAZ: Precautionary Action Zone
UPZ: Urgent Protective Action Planning Zone



* : those who need support
**: the other people

*** Act on Special Measures Concerning Nuclear Emergency Preparedness

Summary

- Based on the lessons learned from the Fukushima Daiichi accident, in October 2012, the NRA established the new Guide for Nuclear Emergency Preparedness and Response and has continuously amended it to date.
- The new EPR framework is characterized by the 4 elements:
  - **Departure from a System Depending on Computer-Based Prognosis** : New framework based on EALs and OILs
  - **Giving Priority to "Sheltering":** Avoid the risks associated with "exposure of people during evacuation" and "difficulty in evacuation of many people at the same time"
  - **Care for Those Who Need Support:** Add air conditioning systems with filters to existing hospitals, etc.
  - **Wider Coverage of Area: UPZ** of approximately **30 km** radius and policy to take protective measures even beyond it
- The NRA continuously improve the new framework.

Some Examples of EALs: Emergency Action Levels

Emergency Category	EALs (Some Examples)
Alert	• If an earthquake with a magnitude of at least 6-lower on the Japanese seismic intensity scale has occurred in the prefecture the nuclear facilities are sited • If a major tsunami warning has been issued in the prefecture nuclear facilities are sited • In the event of a crucial failure of the reactor facilities • Loss of external electric power supply continues for 3 hours or longer
Site Area Emergency	• Leakage of reactor coolant that requires activation of ECCS • Failure of ECCS in the high pressure coolant injection system in the event of the loss of feedwater function(BWR) • Loss of all feedwater functions to steam generators(PWR) • Loss of all AC power supply continues for 30 minutes or longer
General Emergency	• Failure to shut down the reactor, when required • If the containment pressure reaches the maximum design pressure • Loss of all functions for cooling the reactor • SFP water level lowers to 2m above from top of spent fuel assemblies • Loss of all AC power supply continues for 1 hour or longer

Appendix B

OILs and Protective Measures

	Classification	Outline of Classification	Initial Figure	Outline of Protection Measures
Emergency protection measures	OIL1	Criteria for advising local residents to evacuate within a few hours or sheltering, in order to prevent radiation effects from surface soil, inhalation of re-suspended radioactive material, or inadvertent oral ingestion	500μSv/h (air radiation dose rate when measured 1m above the ground)	Identification of zones and evacuation within a few hours (including ordering those who cannot easily move to shelter indoors temporarily)
	OIL4	Criteria for conducting decontamination to prevent inadvertent oral ingestion and external exposure via skin contamination	βrays:40,000 cpm (detector counting rate a few cm from the skin) βrays:13,000 cpm (detector counting rate a few cm from the skin)	Screening of evacuees based on the evacuation standards and prompt decontamination of those exceeding the criteria
Initial protection measures	OIL2	Criteria for restricting ingestion of local produce and advising local residents, to temporarily relocate within a week or so, in order to prevent radiation effects from surface soil, inhalation of radioactive material, or inadvertent oral ingestion	20μSv/h (air radiation dose rate when measured 1m above the ground)	Identification of zones within a day or so and restriction of ingestion of local produce, as well as temporary relocation within a week or so
Restrictions on ingestion of food and drink	Screening criteria for food and drink (Response to OIL3)	Criteria for identifying areas where measurement of radionuclide concentrations in food and drink should be carried out in preparation for possible food and drink restrictions at OIL6	0.5μSv/h (air radiation dose rate when measured 1m above the ground)	Identification of zones where radionuclide concentrations in food and drink should be measured within a few days
	OIL6	Criteria when restricting food and drink intake in order to prevent radiation exposure via oral ingestion	Nuclide / Drinking water, milk, dairy products / Vegetables, cereals, meat, eggs, fish, other Radioactive iodine: 300Bq/kg / 2,000Bq/kg Radioactive cesium: 200Bq/kg / 500Bq/kg Alpha-emitting nuclides of plutonium and transuranic elements: 1Bq/kg / 10Bq/kg Uranium: 20Bq/kg / 100Bq/kg	Analysis of radionuclide concentrations in food and drink within a week, and prompt restrictions on food and drink intake if results are in excess of the criteria

Source: CNS National Report of Japan for 6th Review Meeting, August 2013

Generic Study Done by NRA/JAEA: Level 3 PRA with Simplified Source Terms

https://www.nsr.go.jp/data/000047953.pdf

Major assumptions Applied

- Site/Plant: A model site with a PWR (800MWe)
- Source terms:
  - Release timing: **12 hours after shutdown**
  - Release duration: **5 hours with a constant release rate**
    - **The amount of Cs 137 released is 100TBq.** All the other nuclides are released so that the release fractions are equal to those in NUREG-1465*. Additionally, the **whole initial inventories of noble gasses** are released.
- Modeling of sheltering:
  - Sheltering order is issued **7 hours after shutdown**. It takes **2 hours** to move and start sheltering (**staying indoors for 2days**).
- Meteorological data: Sampling from the hourly data for one year at the model site
- Dose evaluation: External doses due to **cloud shine** and **ground shine**, and internal dose due to **inhalation**

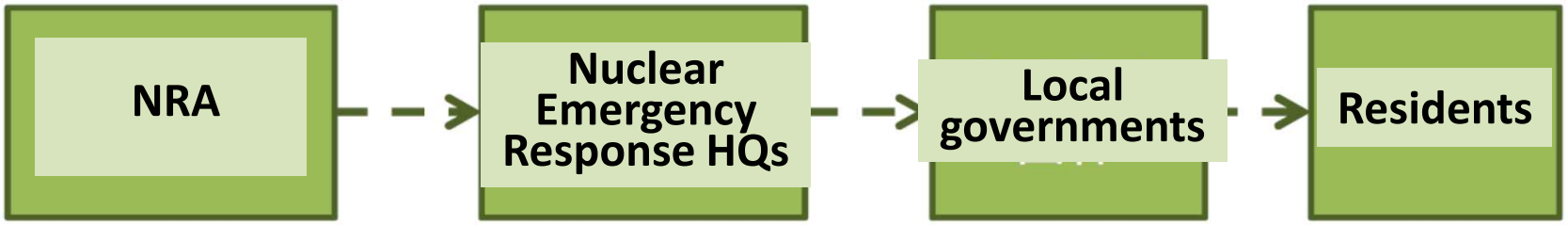
*http://pbadupws.nrc.gov/docs/ML0410/ML041040063.pdf

Prophylaxis with Stable Iodine

(1) Advance distribution of stable iodine tablets

- Hold meetings with residents
- Distribute the tablets to the residents after they are informed by medical doctor(s)
- Participate in the meeting and receive the tablets

(2) Prophylaxis with stable iodine tablets



- Judge the needs for intake
- Issue request for intake based on the judgment by NRA
- Intake

- Distribution of tablets in areas **outside PAZ**
  - Local governments procure the tablets **and stockpile them at appropriate places** such as **schools, town halls**, etc. where the residents gather in case of evacuation.
  - **Advance distribution** may be done in the same manner as within PAZ