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Emergency Responses to Accidents during Nuclear Material Transport in Japan

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Abstract

It is crucial that emergency responses be readied in advance to protect the public against accidents which may occur in the transport of nuclear material, despite the fact that no such accidents or incidents resulting in radiological consequences have yet to occur in Japan. In addition to the standard emergency framework, the Japanese government enacted the “Act on Special Measures Concerning Nuclear Emergency Preparedness” in 1999 to counter nuclear emergencies. Accordingly, radiological consequences were assessed based on hypothetical conditions beyond the accident conditions, which led to the government issuing a guideline specifically for emergencies during transport. Based on the guideline, carriers prepare their own response plans for emergencies during transport and submitted them to regulators for approval when so required. The Fukushima accident once again emphasized the importance of emergency responses and preparedness. The Nuclear Fuel Transport Co. ,Ltd. conducted risk assessments of transport to identify potential risks and enhanced training drills and exercises for responding to emergencies in order to continuously improve our emergency response capability.

Introduction

No accidents or incidents during the transport of nuclear material have yet to result in radiological consequences in Japan, but we have experienced some severe accidents and emergencies at nuclear facilities and Japan’s emergency response regime is being continuously improved. The “Act on Special Measures Concerning Nuclear Emergency Preparedness” was enacted in 1999 to facilitate a smooth and prompt response to a nuclear emergency after the unexpected criticality accident at JCO’s nuclear fuel fabrication facility [1]. The law applies principally to nuclear facilities, including nuclear power plants and other facilities that may potentially be at high risk, but it also covers the transport of nuclear material. Following the law’s enactment, the national guide “Emergency Preparedness for Nuclear Facilities” was also revised, and the radiological consequences were evaluated based on hypothetical conditions beyond the accident conditions defined in IAEA transport regulation SSR-6 [2], which prescribes safe distances for protecting the public. Furthermore, the “Guideline for Establishing Manuals for Safe Nuclear Material Transport” was issued for carriers of nuclear material. It provides specific responses and preparedness for emergencies arising during transport. All carriers establish their own transport plans, which include emergency responses as well as the necessary equipment for emergencies, based on the guideline.

1. Regulatory Framework in Japan

(1) Procedures for Transport Approval

Japan has a robust regulatory oversight and approval system for transport of radioactive material [3]. Regulatory requirements for transport of radioactive material, including nuclear materials, have basically adopted the IAEA transport regulations SSR-6, but some additional requirements have been instituted. The following procedures are required to ensure the safe transport of highly hazardous radioactive material, such as fissile material or spent fuel.

- Approval of package design: Regulators certify that package designs satisfy regulatory requirements. Certificates are valid for a period not to exceed three years.
- Approval of packaging: Regulators may also approve specific packagings by serial number. The approval is based on a review of the manufacturing of these packagings. The approval confirms that each packaging is manufactured and maintained according to the approved design,
- Confirmation of consignment: Regulators confirm that packaging is manufactured according to the package design approved, that the radioactive contents are within the limits for the approved design, and that the package complies with operational provisions such as surface dose rate and contamination levels. Such confirmation is carried out prior to shipment of a specific consignment.
- Confirmation of shipment method: Regulators confirm the shipment method together with the conveyance. This inspection includes verifying emergency response plans, loading methods, conveyance stowage, package tie downs, dose rates, and contamination levels on the package surface and other areas of the conveyance.

Furthermore, before shipment actually takes place, transport plans are submitted to the relevant law enforcement authorities as required. Nuclear material has been safely transported under the rigid regulatory procedures in Japan.

(2) Emergency Response

The IAEA regulation adopts the graded approach and it requires appropriate packaging shall be used depend on the potential hazard of the contents. Type B packaging, which is to contain high activity, should be capable of withstanding very severe conditions (the accident conditions), including 9 meter drops and thermal tests.

Therefore, it seems unlikely that there will be radioactive release from type B packages or a significant increase in the surrounding radiation level even if the packages are involved in an accident during transport. However, it is important for safe transport to plan countermeasures to transport accidents, provide the necessary equipment and instruments for such safe transport, and conduct appropriate educations and exercises in advance.

Accident Level

Japan has prepared two response regime levels. The emergency response regime prescribed by regulators to counter any incidents or accidents is shown in Fig.1. It shows that if a carrier encounters an incident or accident, the carrier is to notify the regulator immediately about the situation. However, any radiological consequences to the public are considered to be very limited in a usual incident or accident, and local accident response organization (fire brigade, police) should be able to handle the situation with assistance from experts and the carrier.

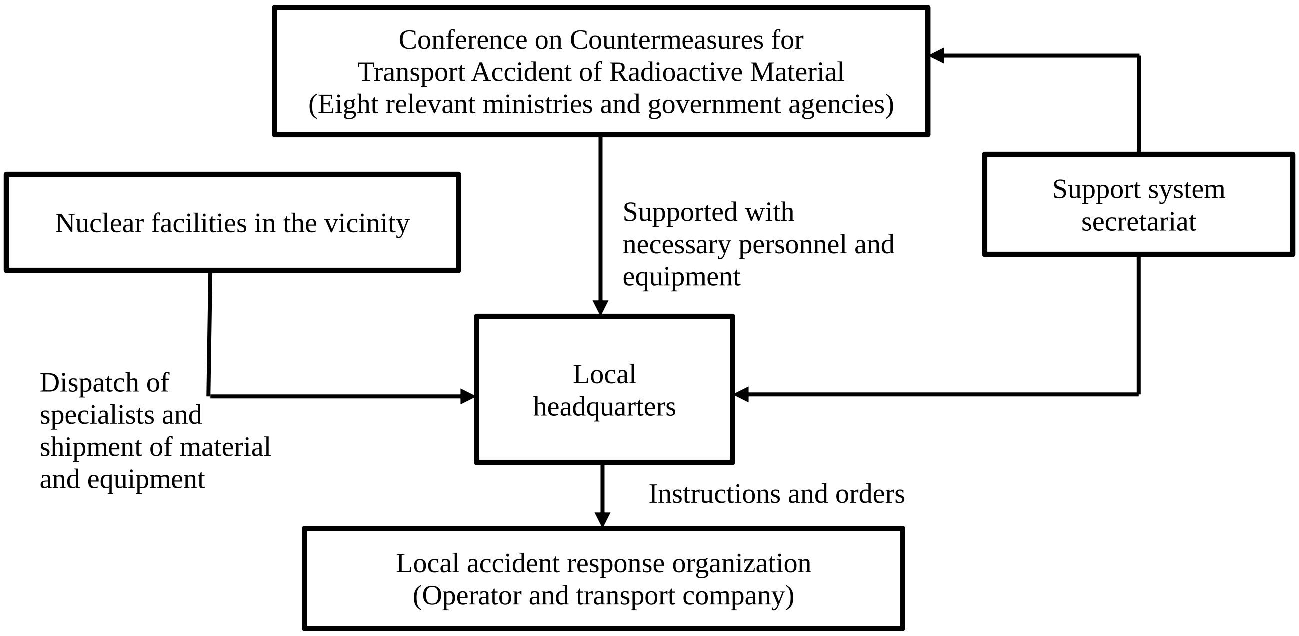

Fig.1 Emergency preparedness system for unusual events during transport [3]

Disaster Level

In addition to the above, Japan enacted the “Act on Special Measures Concerning Nuclear Emergency Preparedness” in 1999 to address nuclear disasters. It was established to facilitate a smooth and prompt response to nuclear disasters based on the lessons learned from the JCO accident [1], which brought to light problems in terms of the responsibility for emergency responses and protection of the public. The law is mainly for nuclear facilities, such as nuclear power plants and the other facilities with high potential risk, but it also covers the transport of nuclear material because transport may be in close proximity to the public despite the very limited radioactivity and heat loads in packages. The special law takes effect if any of the following are detected after a fire, explosion or similar events during an accident.

- Article 10 (Notification of preparation against a nuclear disaster)
  - Over 0.1 mSv/h at 1 m from a package
  - Release of radioactive material from a package
- Article 15 (Declaration of a nuclear disaster)
  - Over 10 mSv/h at 1 m from a package
  - Release rate of radioactive material from a package is over A_2/week

These events are determined based on not only the results of direct measurement, but also the reasonable possibility of such an occurrence as direct measurements may be difficult at the site. After a nuclear disaster is declared based on Article 15, the prime minister is responsible for the response of the disaster and can order necessary measures to protect the public. This law was implemented during the Fukushima Daiichi accident in 2011, and it helped stabilize the situation and protect the public.

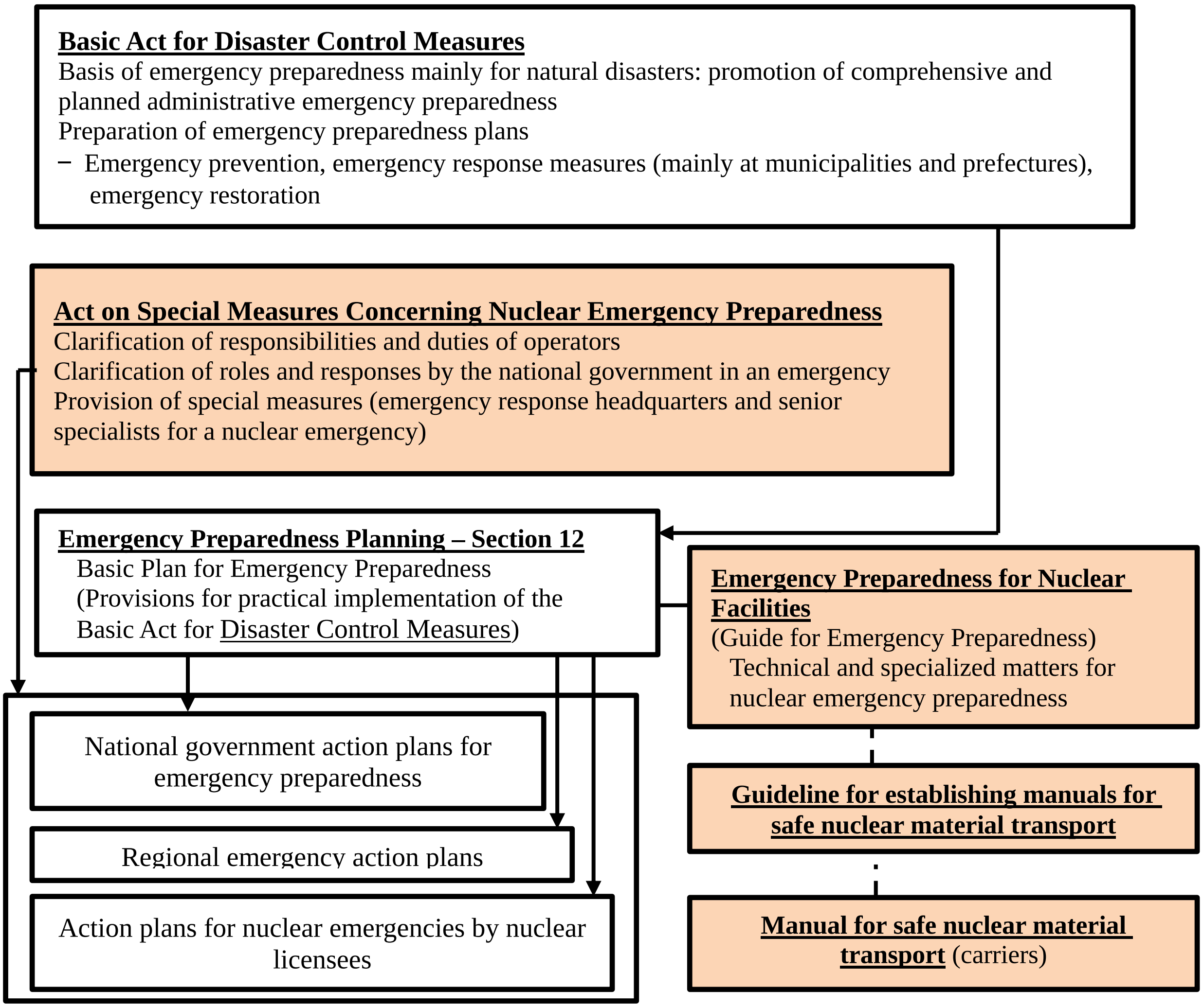

Fig.2 Emergency preparedness system for a nuclear emergency
(colored boxes are directly related to transport)

The law is a part of national framework for emergency preparedness shown in Fig. 2. In accordance with the law, the “Emergency Preparedness for Nuclear Facilities (Guide for Emergency Preparedness)” was revised. It provides specific measures for countering various emergencies including natural disasters and covers the nuclear disasters.

With regard to transport of nuclear material, some hypothetical conditions beyond the accident conditions specified under the IAEA regulations were assumed based on the practices in transporting nuclear material in Japan. The assessment results indicated that large type-B package used for spent nuclear fuel could have the most severe radiological consequences under the hypothetical conditions. However, the package structure provides for a significant margin of safety and could satisfy the accident condition criteria. Furthermore, the accident condition criteria are assumed conservatively as hypothetical conditions of a nuclear disaster during transport and such radiological consequences were assessed. The following results were obtained for type B packages containing spent fuel.

- Degradation of shielding performance: around 5 mSv over 10 hours at a distance of 15m from the damaged package.
- Degradation of containment performance: less than 5 mSv at a distance of 15m from the damaged package

The safe distance was evaluated independently by the Nuclear Emergency Assistance and Training Center of Japan Atomic Energy Agency (JAEA) in research conducted in 2011 and sponsored by the cabinet office. The study essentially confirmed the validity of the results [4].

Guideline for Transport Emergency

The government issued "Guideline for establishing manuals for safe nuclear material transport" for nuclear material carriers based on the guide. It prescribes that instruments be carried for emergencies, and specific response procedures and roles are specified for transport emergencies. It also stipulates that an off-limit area is to be set up at a minimum of 15 m and a restricted area around 100 m along roads to prevent public exposure in the event the release of radioactive material is detected.

Based on the guideline, all carriers formulate their transport plans to include the emergency response and any necessary measures and equipment for such emergency. These plans, which are approved by the CA as required, are used for the nuclear materials' safe transport.

2. Emergency Responses during Transport

(1) Transport Practice in Japan

In Japan, nuclear material, especially back-end material such as spent fuel or radioactive waste, is mainly transported by sea in dedicated ships. The ships are equipped with various safety features (reinforced structure and multiple communication tools) and satisfy special domestic requirements, which are stricter than international requirements (INF code). One important feature is dose rates monitors installed in the holds where packages are stored to easily detect any unusual changes in dose rate.

Regarding to land transport type B packages for back-end material are very heavy and dedicated vehicles are used at restricted speeds. The packages are often transported in convoys

Dedicated Ship

Dedicated Vehicle

Fig.3 Typical conveyances for Type B packages comprising several vehicles, including escort vehicles with experts in radiation monitoring and packaging. Therefore, it is unlikely that ships or vehicles in the convoy might encounter a severe accident, but carriers must prepare an emergency response plan in accordance with the guideline and submit it to the CA as requested.

(2) Carrying Equipment during Transport

Carriers bring equipment to be used during the initial response to a transport emergency. Typical equipment is shown in Fig. 4, and also includes several survey meters to measure dose rates and ropes to cordon off a restricted area around any damaged packages. Experts in radiation monitoring and packaging also accompany the convoy. Such provisions make it easy to identify the situations in a timely and precise manner, and measure the dose rates around packages if an incident or accident occurs during transport. The communication route established in advance allows for ease in providing notification and sharing information about any situations that arise.

Survey meters   Barrier rope   Fire extinguisher   Masks

Fig.4 Typical equipment brought along during transport

(3) Training and Drills

The Fukushima Accident once again brought to light the importance of emergency responses and preparedness. We conducted a variety of activities, including additional risk assessments [5, 6], and enhanced our emergency equipment based on the lessons learned from the Fukushima accident [7].

Emergency response team training   Drill of emergency port departure for tsunami

Fig. 5 Examples of training and drills conducted by carriers

Furthermore, we have improved our emergency trainings and drills based on realistic and reasonable conditions to ensure flexibility during unexpected emergency situations. For example, Fig.5 shows emergency response team training on board a ship, and drill of emergency port departure in preparation for tsunami [8].

We have continuously endeavored to make improvements based on lessons learned about such activities as well as activities taking place in the international community [9].

4. Conclusion

In Japan, the emergency response framework for transport accidents has been improved based on lessons learned from a variety of experiences. In particular, the "Act on Special Measures Concerning Nuclear Emergency Preparedness" was enacted, which covers potential disasters during transport of nuclear material. Radioactive consequences which may result from transport emergencies were estimated, and the guide prescribed a safe distance of 15 meters from a damaged cask to protect the public. Although various safety measures (dedicated conveyances, convoy system, etc.) have been adopted for the transport of nuclear material with potentially high risks in Japan and a severe accident during transport seems unlikely, it is important to assume that such an accident may occur and prepare adequate equipment for responding to such a transport emergency. Along with additional equipment preparations, drills and exercises are also crucial to improve the flexibility of any emergency response. We make various efforts to continuously improve our emergency preparedness and capability to respond in order to enhance safety during transport.

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