

# Decontamination and Recovery Aspects of the Fukushima Accident

A. McGarry<sup>1</sup> and T. Lazo<sup>2</sup>

<sup>1</sup>Radiological Protection Institute of Ireland, 3 Clonskeagh Square, Clonskeagh Road, Dublin 14, Ireland

<sup>2</sup>OECD Nuclear Energy Agency, 12 boulevard des Îles, 92130 Issy-les-Moulineaux, France

## Abstract

As a result of the Fukushima reactor accident many countries and international organisations have offered assistance to the Japanese government to address radiological consequences of this tragic situation. The OECD Nuclear Energy Agency, conscious of the need to provide its expertise to the Japanese government while appropriately managing national and international resources, organised a workshop in October 2011 to address aspects of decontamination and recovery in the affected Japanese areas. Experts from other NEA member countries with direct experience in addressing contamination events participated in the conference and exchanged experience with their Japanese counterparts. The topics addressed included the use and evolution of protective criteria for affected populations; the management of areas contaminated with alpha-emitting radionuclides; the management of contaminated foodstuffs for internal use, for import and for export; and the decontamination of agricultural lands. Approaches, mechanisms and experience with the appropriate involvement of affected populations in all of these aspects were also discussed.

This paper will provide an overview of the topics that were discussed, and of the outcomes and ways forward that were devised as a result of these discussions.

## 1. Introduction

Since the very beginning of the Fukushima accident, the Japanese Government has been actively involved in the management of consequences. In order to collect additional, relevant information and experience to assist in this crucial work, the Cabinet Office of the Japanese Government organised an international symposium to discuss decontamination and recovery aspects of large contamination events.

The objective of the Symposium was to share the experience and the best practices in the remediation of the land contaminated with radioactive materials, and to contribute to the planning and effective management of the decontamination activities in Japan.

The symposium was organised by the Cabinet Office of the Japanese government, with the cooperation of the OECD Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA), and with the support of the Japan Atomic Energy Agency (JAEA) and the Japan Nuclear Energy Safety Organization (JNES).

The Symposium was held on Sunday the 16<sup>th</sup> of October, at the Palse Iizaka Convention Hall, in Fukushima-city, Fukushima-prefecture. A large and varied audience of approximately 360 people participated in the Symposium, which included presentations from Japanese and foreign experts on the subjects of decontamination and recovery following large-scale contamination events.

## 2. Symposium Organisation

The Symposium was honoured by high-level participation, including welcome remarks from the Japanese Minister of the Environment, the Governor of Fukushima Prefecture, and the Director Generals of the OECD Nuclear Energy Agency and of the International Atomic Energy Agency (via video presentation). Subsequent presentations were broadly organised in five sessions, including the

Symposium welcome and opening; Session 1) activities of international organisations; Session 2) experience in decontamination and remediation; Session 3) Japanese recover efforts; and Session 4) a panel discussion.

### **3. Symposium Welcome and Opening**

The symposium was opened by a presentation from the Japanese Minister of the environment, Mr. Goshi Hosono, and then by the Governor of Fukushima Prefecture, Mr. Yuhei Sato. Both speeches noted that the earthquake and tsunami had caused vast devastation, which was compounded by the Fukushima nuclear power plant accident. They stressed the need to decontaminate, and that many practical problems are in need of solutions. In particular, it was noted that the two principal activities of the region, agriculture and tourism, had greatly suffered. However both the Minister and the Governor spoke of the enormous efforts that the Japanese government, the local government and the affected people were undertaking to foster recover as quickly as possible. Experience from other countries and from the NEA and the IAEA to address these serious issues was welcomed.

The Director Generals of the NEA, Mr. Luis Echávarri, and of the IAEA, Mr. Yukiya Amano, then spoke, Mr. Amano appearing in a pre-recorded video. Both pledged their organisation's full assistance to ease the consequences of this tragic situation.

The key messages that were passed through these opening welcome remarks were:

- The Japanese government is dedicating a huge amount of money (220 billion yen this fiscal year) and effort to recovery activities.
- The Prefectural government is actively involved in helping local residents to return to their homes as quickly as possible, and to decontaminate public facilities, with schools as a top priority.
- There are numerous practical problems that remain to be addressed. The affected citizens of the region, and of all Japan, are concerned for their safety and that of their children. The future of the region, and to a large extent of Japan as a whole, depends on an effective recovery from this tragic accident.
- The NEA and the IAEA will continue to bring, as requested, international assistance and advice to the Japanese government. The extensive resources of these international organisations are broadly available to support recovery efforts.
- There is a need to work locally with stakeholders (affected population, businesses and shops, local industry, etc.) to rebuild trust and develop local solutions that are adapted to local needs. This can be a long process, but is essential to rebuild the social and physical infrastructures of the affected regions.

#### **Keynote Speech: Remediation Efforts in Japan**

The current status and plans for decontamination efforts were presented by Mr. Masaru Moritani of the Fukushima Decontamination Promotion Team. He gave a thorough overview of the radiological situation as it is understood, and presented recovery plans and objectives.

The key messages that were passed in this Keynote presentation were:

- The Japanese government is using the latest ICRP recommendations as the framework for its approach to recovery.
- The central government will be take the initiative for recovery efforts, in cooperation with municipalities, for those areas where the dose rate has been assessed to exceed 20 mSv/a. The objective of decontamination will be to reduce public exposures by 50% in 2 years, and doses to children by 60% in 2 years
- Municipalities will be responsible for developing plans for recovery in areas where the dose rate has been assessed to be between 1 mSv/a and 20 mSv/a. Municipalities will develop, with central government expert assistance, approaches and goals for decontamination efforts.

- The Japanese government has dedicated 220 billion yen to these decontamination efforts for the fiscal year ending in April 2012.
- Many pilot projects for decontamination of various types of contamination are under way, and extensive cleanup of schools has been affected.

#### **4. Session 1: Activities of International Organizations**

The objective of the first technical session of the conference was to present relevant activities of international organisations working to address problems resulting from the Fukushima accident. Presentations from the ICRP, the IAEA and from NEA/CRPPH provided a broad overview of the policy framework recommended for this situation, of the relevant international requirements documents providing guidance, and of national experience to involve stakeholders in consequence management efforts to achieve acceptable and sustainable recovery decisions.

The key messages that were passed in Session 1 were:

- The most recent ICRP recommendations suggest a radiological protection policy based on the situation under consideration (e.g. planned, emergency or existing).
- As the need for urgent actions to protect health decreases, an emergency situation becomes an existing situation. At the time of the conference the Fukushima plants still not fully under control, and as such it was considered to be near the end of the emergency situation.
- The transition to an existing situation requires the selection of a reference level (in the band from 1 to 20 mSv in a year), above which you plan not go and below which you would like to move doses through optimised protection measures.
- Decisions will increasingly need stakeholder involvement in order to make appropriate judgements well reflecting concerns of affected individuals.
- This framework is presented, from a practical standpoint, in the IAEA Safety Fundamentals as policy statements, and in the IAEA Basic Safety Standards as requirement statements.
- The objectives of stakeholder involvement in such situations are to incorporate public values into decisions; increase the substantive quality of decisions; resolve conflict among competing interests; build trust in institutions; educate and inform the public and identify and build acceptance for sustainable decisions.
- Extensive experience in achieving effective stakeholder involvement exists, has been studied through many NEA programmes, and can be made available to the Japanese to be adapted to address their circumstances.

#### **5. Session 2: Experience in Decontamination and Remediation**

The second technical session of the conference addressed national experience in decontamination and remediation experience. Papers covered a wide variety of situations and circumstances, including the emergency management approaches during the Chernobyl accident, management of contamination in ground and surface waters, management of plutonium contaminated soils, management of food and agriculture aspects of Chernobyl contamination, and policy approaches to emergency management.

The key messages that were passed in Session 2 were:

- At the time of the Chernobyl accident, little international recommendations existed for addressing long-term aspects of contamination (now called existing exposure situations).
- The Russian approach to emergency management evolved significantly over the 10 to 15 years following the Chernobyl accident.
- Numeric criteria for the management of protective measures, broadly based on dose and expressed as contamination levels or dose rates, evolved significantly also, reflecting a reduction of acceptable population exposure with time.
- Numerous approaches to decontamination, around homes and of agricultural lands, exist and

can be effective at reducing dose rates.

- There are several approaches to preventing or limiting contamination movement into groundwater and into water bodies. It is most effective to address the movement of Cs contamination early, before it has travelled too deep or far.
- Many countermeasures have been tested to reduce contamination levels in foods. These measures include: the clean feeding of animals before slaughtering; adding of giese-salt (AFCF) or clay minerals to the feed if not clean; removing of growth in autumn from fields (before ploughing); discard compost from first two years post-contamination; fertilization and liming of cultivated soil; ploughing; crop rotation (if possible); treatment of meat and milk for removing Cs by salting of meat/fish (Cs is transferred to salt liquid), make cheese from milk (Cs is retained in the whey). Acceptability of these actions must be discussed with farmers, the food industry and consumers.
- Caesium contamination in freshwater tended to move quickly to sediments. The effective half-life in fresh water is between 4 and 8 years, and fish tend to concentrate caesium.
- Mushrooms concentrate caesium significantly (up to several thousands of Bq/kg), but being managed appropriately they contribute very little to exposure.
- Forest plants (trees, berries) and animals tend to concentrate caesium. The use of fertiliser can decrease uptake by plants.
- Over 10 years only approximately 2% of the caesium in freshwater rivers in Finland was transported to the sea.
- The effective half-life of caesium in the Baltic sea is approximately 10 years. Concentrations of caesium in Baltic sea fish tend to be less than in freshwater fish in Finland.
- The dose to the average Finn, in the 18 years from 1986 to 2004, from the Chernobyl accident is on the order of 1.5 mSv. No increase in childhood leukaemia, childhood thyroid cancer, or total cancer in the entire population has been detected.
- In developing countermeasures and protection approaches in Finland, stakeholder involvement was essential to the success of planning and implementation activities.
- The French national emergency management strategy is based on the assumption that accidents will have a release phase and a post release phase. The release phase includes pre-release during which an accident is building but may not happen (although not for accidents that develops very quickly) and release phase, during which radionuclides are released into the environment. The post-release phase includes a transition phase where characterisation is broadly accomplished, and a long-term phase where rehabilitation is undertaken.
- In planning a national strategy for post-emergency management, the French felt that several areas should be specifically explored by working groups, including: lifting emergency public protection actions and reducing contamination in urban areas; food, agriculture and life in rural areas; evaluation of radiological consequences; response to health issues after a radiological accident; indemnification; waste management; organization of public authorities; and communication.
- French national post-accident policy involves the creation of two management zones immediately after the accident:
  - A Public Protection Zone (ZPP): including, if appropriate, a relocation area, the ZPP is designed for health reasons. Inside the ZPP work is done to reduce the doses that people living or working in the zone are likely to receive.
  - A Territorial Heightened Surveillance Zone (ZST): more relevant to economic management, within which specific surveillance of foodstuffs and agricultural products intended for sale will be established.
  - To support this policy, two key tools are required before the accident: the existence of monitoring capabilities (to measure the radioactivity); and the availability of calculation models (to forecast the radioactive fallout).
- The development of this national French policy has only been possible through the extensive involvement of local stakeholders, and their development of approaches to implement policy.

## **6. Session 3: Recovery Activities in Japan**

The third session of the symposium was dedicated to presentations by the Japanese of the decontamination efforts that have been planned and undertaken to improve radiological conditions. Presentations of decontamination activities by JAEA, decontamination of farm land by Ministry of Agriculture, Forestry and Fisheries and decontamination Activities by municipalities by the Mayor of Date City.

The key messages that were passed in Session 3 were:

- the assessment of the radiological contamination situation in Japan has been implemented with detailed measurements and mapping of ground surface deposition density, distribution of radionuclides using monitoring vehicles, aircraft radiation monitoring and an autonomous unmanned helicopters;
- decontamination techniques for public facilities, such as schools, parks and swimming pools have been tested by JAEA, and found to be effective;
- JAEA has published a user-friendly handbook “Handbook for Decontamination of School Swimming Pools” based on a series of tests (uploaded on JAEA website);
- JAEA officials have fostered a trusted relationship with school officials, municipalities and local people through dialogue and decontamination work;
- JAEA is demonstrating decontamination measures for residential areas and presented the overview of approaches to establishing a remediation plans, and is also implementing research projects for decontamination technologies;
- JAEA has initiated communication activities in July to provide reliable information on environment contamination to Fukushima citizens;
- following a request from the Fukushima Prefecture, JAEA has performed whole-body counts of the residents of the ten towns within the deliberate evacuation area and restricted area, using the Whole Body Counter (WBC) in Tokai Laboratory - A total of 8,000 persons are scheduled to be measured by the end of December, 2011. About 100 persons are measured per day;
- the Ministry of Agriculture, Forestry and Fisheries is in charge of a project for the development of technologies for removal of radioactive materials from agricultural soil. They began the research project in Iitate Village and Kawamata Town from late May with national institutions, prefectural agricultural experiment stations, universities and private enterprises;
- the Japanese are experimenting with several different technologies, such as topsoil removal with or without using soil hardener, removal of turf and grass pasture, removal of soil after paddling with water, inverting plowing, phytoremediation by high absorbing plants;
- the main decontamination method in place is removal of topsoil but practical measures to deal with the waste arising are not fully in place – for example, topsoil removed from school yards is stored at the side of the yard as an interim measure;
- the Mayor from Date reported that while all school yards in the city have been decontaminated, parents do not yet allow their children to play in the school yards.

## **7. Session 4: Panel Discussion – Towards the future**

The fourth session of the conference was a discussion between Mr. Volodymyr Berkovskyy, from IAEA, Ms. Nataliya Shandala, from FMBC, Russian Federation, Mr. Yasuo Onishi, from PNNL, USA, Ms. Tarja Ikaheimonen from STUK, Finland, Mr. Junichiro Ishida, from JAEA, Mr. Takashi Omura, from Ministry of Environment, Mr. Jean-Luc Lachaume, from ASN, France, Mr. Shuichi Chayama, from Nuclear Accident Victims Support Team chaired by Mr. Kenkichi Ishigure, Emeritus Professor, University of Tokyo. The Panel Discussion highlighted the report from the IAEA review team and the advice given. The chairman of the Panel Discussion focused on the problems associated with the management of waste produced by decontamination efforts.

The key messages that were passed in Session 4 were:

- The invited foreign experts suggested that it is necessary to provide better public to allow them to better understand their risks, in particular it is indispensable for the public to know the contamination levels of the food they eat so that they can estimate themselves the doses they receive;
- JAEA suggested that it is difficult for people to understand Bq and Sv. They have provided lectures for local groups and particularly for schools, and have established hot-lines for phone queries;
- The need to implicate the local populations in their own dose management was strongly highlighted;
- The need to focus on the reduction of individual's doses was suggested as a priority, rather than simply decontamination. This was suggested as important in terms of restoring public confidence.
- Concerning the management of waste :
  - in Finland, 4 categories of waste are identified, and all material need not be stored as waste. Some materials can be “recycled”, however, while the RP issues with this approach can be relatively straightforward, the actual recycling must be on the basis of social and ethical discussions;
  - the IAEA has established clearance levels for planned situations but not for existing situations;
  - in France there are no clearance levels – each situation is dealt with on a case by case basis;
  - There is no internationally agreed waste classification system;
  - the question of final disposal of waste was raised, and is a key matter for central government. There is a need to limit the time that wastes are temporally stored;

## **8. Closing**

Mr. Tadahiro Matsushita, Senior Vice Minister of Economy, Trade and Industry closed the symposium, announcing that beginning very shortly his government would begin the implementation of the IAEA's recommendations.

**Ann McGarry**  
**Notes from International Symposium on Decontamination held in Fukushima, Japan,**  
**16-17<sup>th</sup> October 2011**

Key points from presentations:

Advices:

- In addition to setting a final dose level it may be necessary to establish “temporary permissible levels”
- The importance of undertaking a comprehensive justification for each decontamination method cannot be overstated – in particular it is necessary to carefully quantify the amount of waste that may be generated and to take managing this waste into account in the justification
- Public communication is an essential part of any decontamination programme
- Before embarking on a decontamination programme, it is necessary to have a clear assessment of the radiation levels and their distribution. Maps showing the distribution and concentration of radionuclides must be available
- For all decontamination measures considered, protection of the groundwater must be included
- The speed of response is crucial in building stakeholder confidence
- Dose is the most important parameter; contamination levels are an operational tool to achieve dose reduction. The primary goal must be to reduce doses
- The importance of cost benefit analysis and the necessity of reaching agreement with the local population was stressed throughout the presentations
- Public understanding of risk is very important in achieving successful outcomes
- The factors used in exposure estimates need to be realistic
- Detailed information about contamination levels and their meaning must be made available to the public
- The importance of setting priorities was stressed
- Exposure of workers needs to be taken into account in justifying decontamination methods
- Consideration of the waste arising and how it will be dealt with is very important. Incorrect consideration of this issue could lead to a new legacy
- The starting point for any decontamination programme should be a “safety assessment” that includes all relevant factors
- The local population needs to be involved in consideration of waste issues from the outset
- Waste material could be stored close to the nuclear power plants
- It is not necessary to have the same reference level at the same time in all areas. The target can be progressively reduced

Comments:

- From the Japanese presentations, there is a lot of knowledge gathered about decontamination measures available and many technical solutions are possible – it was not clear how much the stakeholders have been engaged.
- There is a clearly established goal of 1 mSv/yr for the post remediation scenario
- The Government has decreed that where the contamination is estimated to lead to an exposure of >20 mSv per year (equivalent to 2.3 microSv per hour) the population must be evacuated
- Cost is an issue for many of the decontamination techniques identified
- The possibility of “immediate decontamination” rather than evacuation was presented

- The main decontamination method in place is removal of topsoil but practical measures to deal with the waste arising are not fully in place – for example, topsoil removed from school yards is stored at the side of the yard as an interim measure
- In some cases the removed topsoil can be buried deep
- An example of how to decontaminate a swimming pool was presented but while the swimming pool has been cleaned, the effort does not have public support
- The Mayor from Date reported that while all school yards in the city have been decontaminated, parents do not yet allow their children to play in the school yards
- The Panel Discussion highlighted the report from the IAEA review team and the various advices given
- There was some confusion about the meaning of “reference levels”. Are they standards or are they more fluid?
- There is a lot of industry experience available on clean up
- In Finland, 4 categories of waste are identified. All material need not be stored as waste. Some can be “recycled”. However, while the RP issues with this approach can be relatively straightforward, the actual recycling must be on the basis of social and ethical discussions
- The IAEA has established clearance levels for planned situations but not for existing situations.
- In France there are no clearance levels – each situation is dealt with on a case by case basis
- JAEA- it is difficult for people to understand Bq and Sv. JAEA provide lectures for local groups and particularly for schools. They have also established a phone line for queries
- The IAEA highlighted means of good communication
- The question of final disposal was raised. This is a matter for central government
- There is an issue with contaminated sewage
- France has a lot of experience in disposal of low level rad waste.
- There is no uniform classification of waste at the international level

#### Comments from local residents

- There is no trust in Government
- All of the focus is on the evacuation zone. People living close to, but outside the zone are concerned but there is very little information available
- The different zones keep changing but it’s not clear why, causing a lot of confusion and mistrust
- Compensation is a real issue
- Fukushima province is one of the poorest provinces in Japan – there is a sense that people in Tokyo and distant from the area do not care
- The main industries in the area were fishing, tourism and agriculture – all of these have been devastated by the combination of the tsunami and nuclear accident
- Japan has an aging population. There is a real sense that young people will not live in the Fukushima Prefecture causing concern for the future.
- Applications to the Fukushima University have dropped considerably since the accident
- There is concern about release of radioactivity to the sea
- There is very little monitoring data available for people living just outside the evacuated zones
- The monitoring seems to be very random – the results are not reassuring people

A. McGarry  
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