Overview of the Results of the Decontamination Model Projects

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Fukushima regional contamination

- Off-site contamination mainly volatiles: initially concern focused on shorter-lived I isotopes ➔ evacuation and restriction of consumption of some foodstuffs

- After decay of shorter-lived isotopes, now dominated by Cs-134/-137 which is the focus for cleanup actions

- Cs tends to bind strongly to surfaces, especially clays. Doses are generally low and continually reduced by washoff / soil mixing.
Fukushima remediation overview

- A wide range of focused clean-up projects were rapidly initiated by municipalities and local communities for sensitive areas (schools, playgrounds, ...)
- 2 small test projects were initiated by JAEA in August: development and testing of technology (ended in March)
- Further technology demonstrations initiated in November in 11 municipalities, including those in the evacuation zone (ended in July)
- Parallel tests of novel decontamination technology (25 proposals funded) have been completed
- Regional decontamination is presently being initiated
Main Challenges for Implementation of Full-scale Decontamination

- There was little organised quantitative information based on actual data (cleanup effectiveness, costs, volumes of wastes generated, etc.) that could be used when selecting between various alternatives for decontamination, waste transport and storage methods.

- There was little documented guidance on decontamination for local governments, local residents and private sector companies on how to order decontamination equipment/services.

- Possibilities of development and upgrading of new decontamination technologies had not been examined.
Implementation Scheme for the Decontamination Model Projects

- Public call for proposals: Proposals for complete cleanup including planning, decontamination and evaluation stages were submitted by Joint Ventures (JVs). The 3 JVs shown above were selected after an examination* by JAEA.

- Implementation scheme: Each JV implemented its proposed technological activities and JAEA managed, supervised and evaluated the overall program.

- Target municipalities: Eleven municipalities in evacuated areas

- Sizes of the decontamination target areas: approx. 20ha per target municipality

- Total manpower effort for the model projects (excluding employees of JAEA): approx. 87,000 person-days

* An examination conducted by a committee appointed by JAEA
Activities within the Decontamination Model Projects

- Preliminary remediation planning
- Radiation survey before remediation
- Establish tailored remediation implementation plan
- Apply remedial measures
- Evaluate effectiveness of remedial measures, Review effectiveness and assess input for remediation guidelines

Utilisation as real-world examples (presented in the form of guidelines, manuals, etc.) that can be used as a source of reference by the national government, local governments, local residents and private sector companies when performing regional decontamination
Site characterisation

- Measurement approaches involved modification of existing technology and development of new methods
- When linked to appropriate data loggers, these provided rapid and user-friendly maps of radionuclide distributions
Data interpretation & synthesis

- Maps were particularly useful to guide remediation planning
- Depth profiles allowed assessment of benefits of different soil remediation approaches
- Options could be assessed using a model to predict effective dose reduction

Dose rate before clean-up based on monitoring results

Dose rate after clean-up based on a model prediction

Result of calculation of the air dose rates (at 1 m) before decontamination (by JAEA)

Result of calculation of the predicted air dose rates (at 1 m) after decontamination

Depth (cm)

Relative concentration

Schools and playing fields

Dense-graded pavements

Dose rate before clean-up based on monitoring results

Dose rate after clean-up based on a model prediction

Relative concentration

Depth (mm)

N=48

N=9
Clean-up technology

- Although the majority of the effort involved manual washing and contaminated material removal using conventional technology, methods that might improve decontamination while decreasing volumes of waste were tested.

- Radiation dose of clean-up workers was strictly controlled and always remained low (within the specified upper dose limit).
Scheduling of Decontamination

- Forest decontamination
- Farmland decontamination
- Decontamination of playing fields and large buildings
- Decontamination of residential houses
- Decontamination of roads
Clean-up of Trees and Forest

removing and replacing hotspot soil

removing humus layer

clipping

water jet
Clean-up of Farmland

- ploughing
- turf stripping
- topsoil removal
- fixation
Clean-up of Buildings

- Pressure washing roofs
- Wiping and grinding roofs
- Cleaning gutters
- Removing drainage hotspots
- Stripping roof surfaces
Clean-up of Paving and Surfaces

◆ high pressure water

◆ surface stripping

◆ blasting

- road cleaner

- Iron shot blasting

- Ice blasting
Waste handling

- Waste was reduced in volume to the maximum extent possible – e.g. grinding / chipping of foliage, concentration of radioactivity from contaminated water, separation of waste by activity level,…

- In most cases, labelled heavy-duty flexible containers were used for solid waste transportation and storage.

Measurement of surface dose rates of decontamination waste in the shielding zone

An example of IC tag

An example of metal tag

An example of paper tag

Management of decontamination waste information (tags)
Waste Management

- Locations for temporary storage sites were selected taking into consideration topography, land use status, available areas of land, local government requests, etc., following checks that safety can be ensured.

- A range of different approaches were used for temporary storage of waste on the surface or in shallow pits.
Results of Dose Reduction by Wide Area Decontamination
[Example Tomioka Town (Yonomori Park area, 9 ha)]

### Land use status

<table>
<thead>
<tr>
<th>Land use status</th>
<th>Dose rate before clean-up (mean μSv/h)</th>
<th>Dose rate after clean-up (mean μSv/h)</th>
<th>Dose reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential area</td>
<td>8</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>Large buildings</td>
<td>9</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Playing field</td>
<td>11</td>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>Roads</td>
<td>9</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Forests</td>
<td>10</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>Outside the decontamination target area</td>
<td>8</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>
Estimated annual dose reduced to less than 20 mSv/y, for areas with 20 – 30 mSv/y before decontamination

Estimated annual dose could not be reduced below 20 mSv/y, for areas exceeding 40 mSv/y before decontamination

In case of agricultural and residential area of Ottozawa, Ohkuma, the dose rate reduced by 70 %. However, estimated annual dose could not be reduced below 50 mSv/y

The fractional dose rate reduction was smaller in areas of relatively low dose rate, compared with high dose rate areas
The decontamination model projects have provided:

- Experience and tools for planning and coordinating efficient, safe and cost-effective remediation programmes
- Evaluation of the applicability of remediation technology with an assessment of the pros and cons of different approaches
- Guidelines for tailoring of projects to the conditions found in different sites

Practical experience has shown that stakeholder involvement in implementation of clean-up activities is essential:

- Material for explaining remediation to stakeholders and providing the basis for establishing dialogue with them has been developed
During future remediation:

- Experience can be used to constantly update the cleanup knowledge base with the intent of continuous improvement of methodology and toolkits.
- An advanced communication platform can be implemented to facilitate information exchange between all those involved and, in particular, encourage dialogue with local communities and their involvement in decision-making.
- Waste management will be a special focus for R&D to support optimisation in terms of both volume reduction and easing/increasing safety of temporary storage, interim storage and eventual final disposal.

The regional work will:

- Allow displaced populations to return home to normal lifestyles as quickly as possible.
- Provide the knowledge and experience needed for later decontamination of the Fukushima Dai-ichi site.