Radioactivity Decontamination in and around School Facilities in Fukushima

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IAEA International Experts' Meeting on Radiation Protection after the Fukushima Daiichi Accident
Vienna, 17-21 February 2014

JAEA's Activities for Environmental Remediation

1. Radiation monitoring and mapping
2. R&D on environmental restoration
3. Communication activity
4. **Decontamination demonstration**

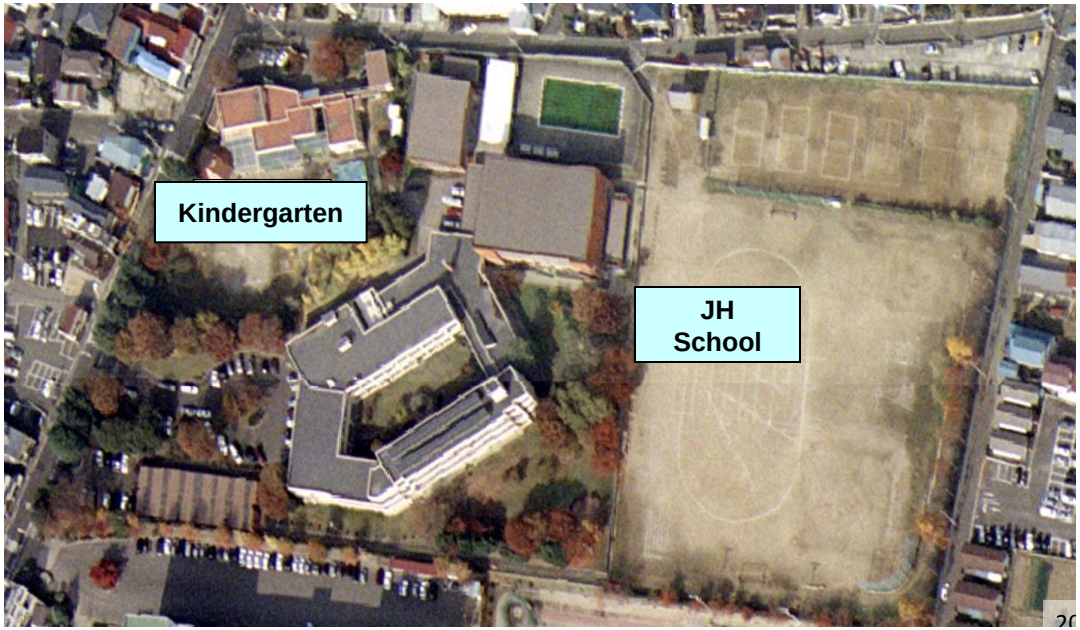
- **School facilities** (schoolyards, pools, playground equipment)
  - *Effectiveness of methods*
  - *Required manpower*
  - *Required radiation protection measures*
  - *Cost and time, etc.*

Topsoil Removal of Schoolyards

- Fukushima University Kindergarten, Junior High School -

Kurikami et al., JAEA-Review 2012-045 (2013).

- May and June 2011
- Topsoil was removed and put into trenches to reduce radiation dose.



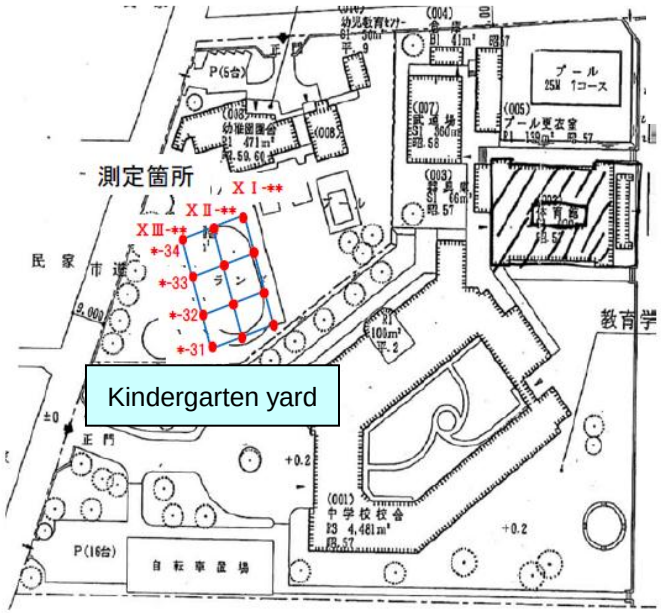
Method

- Topsoil down to 5 cm was removed.
- Removed soil was put into two 1 m-deep trenches. Trenches were covered with 50 cm-deep uncontaminated soil excavated from a deeper part of the schoolyard and with soil from another uncontaminated area.
- Trenches were lined with water sealing sheets.

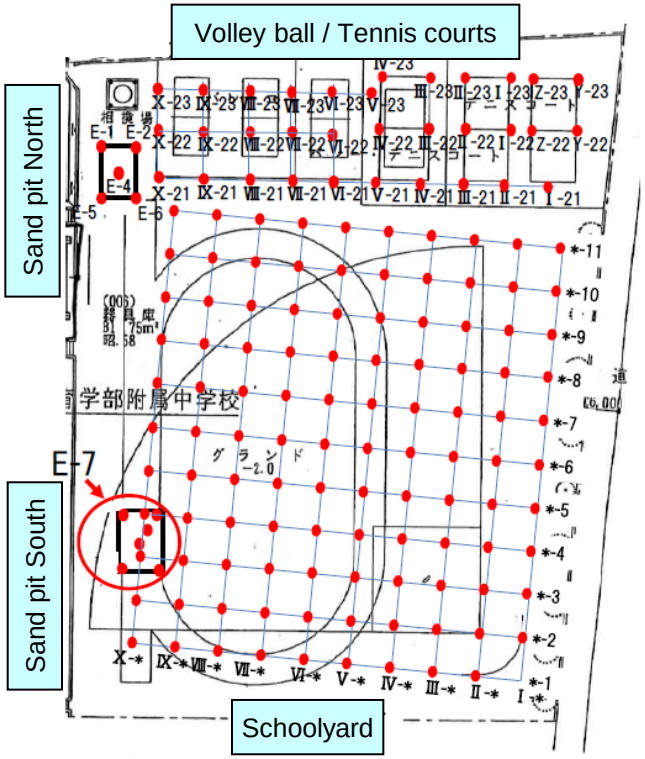
Measurement of Dose Rates

Dose rate measurement

Ambient dose equivalent rates at 1 cm, 50 cm and 100 cm above the ground surface were measured at the Kindergarten and JH schoolyards, with 10 m interstices.



Kindergarten



JH School

Sand pit north: 5 points

Sand pit south: 6 points

Schoolyard: 109 points

Volley ball / tennis courts: 33 points

Topsoil Removal — Results

- Dose rates significantly decreased by factors of 10 to 20.
- Dose rates were higher near the ground surface before decontamination, and vertically uniform after decontamination.
- Radiocesium concentration of removed soil: ~ 27 kBq kg^{-1}.
- Follow-up monitoring one year after the action showed no obvious evidence of recontamination.

Comparison of dose rates

Height	Dose rate (μSv h^{-1}) Before	After	Reduction rate (%)
Kindergarten			
100 cm	1.9±0.2	0.21±0.06	89
50 cm	2.8±0.2	0.22±0.08	92
1 cm	3.1±0.4	0.19±0.09	94
JH School			
100 cm	2.5±0.3	0.15±0.07	94
50 cm	2.9±0.3	0.16±0.06	94
1 cm	3.1±0.5	0.16±0.06	95

Decontamination of Swimming Pool

- Outdoor School Pools in Fukushima and Date Area -

Saegusa et al., Health Phys., 104, 243 (2013).

- Many school suspended water discharge for fear of contamination of farmlands.
- Simple decontamination method was required for mitigating both scientific and social impact of pool water discharge.
- Flocculation-coagulation method was developed for purification of water.

Test fields

Swimming pool	Capacity (m^3)
Fukushima Univ. Kindergarten	17
JH School	350
Date city Tominari Elementary School	260
Hashirazawa Elementary School	240
Shoyo JH School	450
Tsukidate Elementary School	360
Hobara Elementary School (Small) (Large)	150 300

Before: over 200 Bq L^{-1} (Cs)

After: N.D. (Cs)

Reference Level for Discharge of Pool Water

- No legal standard on radioactivity concentration for discharge of pool water.
- Reference value on concentration often helpful during discussion among relevant communities (local community, agrarian organization, river administrator) on water discharge. §

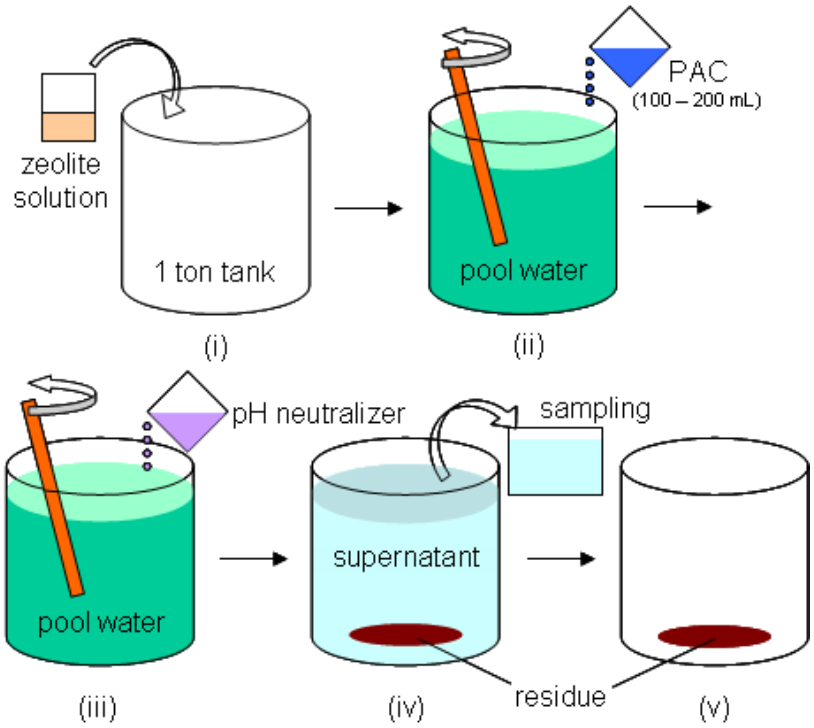
  § Reference value was set at **200 Bq L^{-1}** (for radiocesium), corresponded to the "provisional regulation values (2011)" for drinking water.

- Hydrogen-ion concentration (pH) also continuously monitored and controlled in accordance with national regulation value (pH: 5.8 to 8.6).

Water Purification

Flocculation-coagulation method

1) Add zeolite (100 g) and flocculant (150 ml) to pool water (1 ton).
2) Stir well and wait 15 - 30 min..
3) Radiocesium absorbed by zeolite, then flocked with soil grains and green alga in pool by the flocculant.
4) Discharge supernatant and collect sludge.



Overview of tank work

Inside a 1 ton plastic tank

Handling of Residue

Collection and dehydration

burlap sack (coarse)

Cotton sheets (fine)

Dehydration

Temporary storage

Put residue in burlap sacks. The sacks are folded and stacked on a water sealing sheet

The burlap sacks are covered with another sheet

Sandbag the burlap sacks for radiation shielding

Radiocesium concentration
3.6×10^5 Bq kg^{-1}
Total deposition of radiocesium
130 MBq/pool

(Tsukidate El. School pool, as of Aug 2011)

Ambient dose rate (μSv h^{-1})

- Background : 0.7 - 0.9
- With residue : 13 - 21
- After sandbag residue : 1.0 - 1.2

(Hashirazawa El. School pool as of Aug 2011)

Decontamination of Playground Equipment

- At a Playground Lot in Fukushima -

Tagawa, Trans. At. Energy Soc. Jpn., 11, 111 (2012).

- A broad range of investigations carried out to find out effective but easily applicable decontamination methods.

Example of decontamination effectiveness for horizontal iron bars

Count rates by surface contamination monitor		Water washing	Neutral detergent	Sandpaper	Orange-oil detergent
Before	Gross (cpm)	200	180	230	270
	Net (cpm)	100	80	130	170
After	Gross (cpm)	100	100	100	100
	Net (cpm)	0	0	0	0
Reduction rate (%)		100	100	100	100

Decontamination of Playground Equipment

Decontamination effectiveness for sandbox wood frame

Count rates by surface contamination monitor		Water washing	Orange-oil detergent	Sandpaper	Electric sander
Before	Gross (cpm)	4,500	4,500	4,500	4,500
	Net (cpm)	4,200	4,200	4,200	4,200
After	Gross (cpm)	3,000	2,100	1,250	330
	Net (cpm)	2,700	1,800	950	30
Reduction rate (%)		36	57	77	99

- Effectiveness considerably varied depending on material, paint/coating condition and assembly structure.
- JAEA has been dispatching staff members to schools to providing site-specific technical advice and support.

Dissemination of Results, Public Relations

- Reports, Handbooks and National/Local Guidelines
- Knowledge transfer by collaborative works with local people
- Fostered a trustful relationship with local people through dialogue and works

Decontamination with schoolchildren's parents

Guideline and handbooks

"Kizuna" (bond) team and JAEA staff for decontamination

Summary — Accumulation of Knowledge

School-facilities' decontamination demonstrations

- *Schoolyards*: Topsoil removal brings significant dose-rate reduction.
- *Pools*: Water successfully purified by flocculation-coagulation method.
- *Temporary storage spaces*: Dose increase is very limited.
- *Playground equipment*: Effectiveness and simplicity considerably varied.

Large-scale demonstrations

"Decontamination Pilot Projects"
http://fukushima.jaea.go.jp/english/decontamination/index.html

Knowledge

Regional environmental remediation in Fukushima