4. Management of decontamination projects

4.1. Flow of the Decontamination Process

The basic flow of the decontamination process is shown in Figure 4-1.

Targets for decontamination extend over a wide range, including soil, houses, roads, fields and forests (only within living spaces). Decontamination was first focused on buildings and residential areas necessary for the protection of human health. Therefore, the first thing to do was to investigate ownership of land plots and buildings.

The next things to do were to measure radiation dose and to survey the state of buildings and other structures in advance of the decontamination work, because the attachment conditions of radioactive substances differ depending on the material to which they are attached. Based on the investigation results, decontamination plans were prepared for each land plot and building that would ensure the most effective methods would be used.

The decontamination work was moved forward by getting the understanding of land and building owners for field surveys, their confirmation of decontamination methods, and finally their consent for conducting the decontamination work. More specifically, their consent to enter the land was obtained, the decontamination plans were explained (to obtain the consent to conduct the decontamination work and to report on commencement), and the results of the decontamination work and other related things were reported.

After the completion of the decontamination work, the effectiveness of the decontamination was checked, and this monitoring was continued to check that the radiation dose has been sufficiently reduced allowing the residents to return.

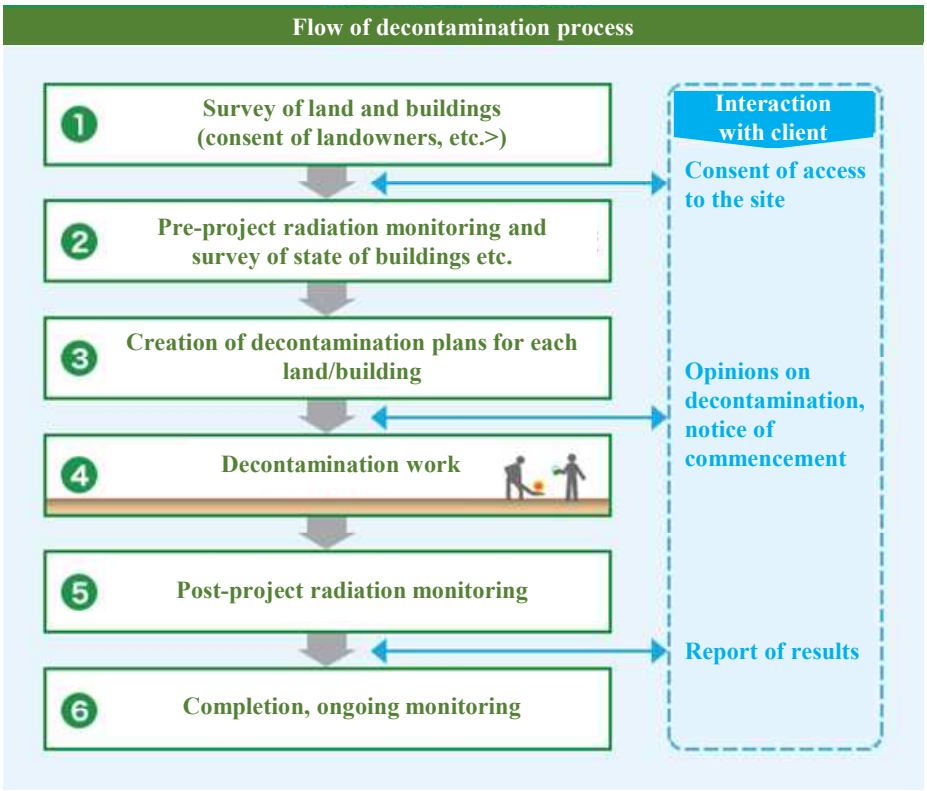


Figure 4-1 Flow of decontamination process[92].

[92]Source: Decontamination Information(http://josen.env.go.jp/about/method_necessity/method_area.html)

4.2. Contents of Decontamination Work

This section describes the specific contents actually implemented by the Ministry of the Environment (MOE) and decontamination business operators for decontamination and related works in the Special Decontamination Areas as ordered by the MOE.

(1) Knowing the air dose rates by detailed monitoring

(2) Issuing of decontamination work orders and related matters by the ordering party (MOE)

(3) Implementing decontamination work by decontamination business operators

(4) Securing necessary resources by decontamination business operators

4.2.1. Knowing the Air Dose Rates by Detailed Monitoring

The MOE carried out extensive monitoring between November 2011 and April 2012 in order to produce detailed air dose rate distribution charts and to prepare for formulating decontamination plans focusing on residential areas in the area that were subject to decontamination work by the national government (Special Decontamination Areas) under the Act on Special Measures Concerning the Handling of Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District Off the Pacific Ocean Earthquake That Occurred on 11 March, 2011 ("Act on Special Measures" in this report).

（1） Summary of implementation

The monitoring program was implemented under the direction and supervision of the MOE. The monitoring was carried out by the Japan Atomic Energy Agency (JAEA) mobile monitoring vehicles and drone helicopters, and by Tokyo Electric Power Co., Inc. (TEPCO) employees making hand-carry measurements over a 100 m grid as well as using mobile monitoring vehicles (TEPCO cooperated at the request of the MOE on these extensive monitoring activities), in the restricted area and the deliberate evacuation area where the air dose rates were 20 mSv and 50 mSv per year, respectively, as well as areas where the air dose rates were lower (1 mSv, 5 mSv and 10 mSv per year).

More specifically, based on the monitoring data in the restricted area and deliberate evacuation areas published by the Cabinet Office and the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the areas for detailed monitoring were selected on a 2 km x 2 km grid in each area corresponding to respective radiation dose ranges. Consideration was given to the distribution of residential areas in determining the extent of areas for detailed monitoring. Each section of 2 km x 2 km was then in principle zoned in a 100 m meshed grid, in order to gain a more extensive understanding of the air dose rate distribution.

Eleven municipalities were monitored: Tamura City, Minamisoma City, Kawamata Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Futaba City, Namie Town, Katsurao Village and Iitate Village.

Table 4-1 Summary of detailed monitoring[93]

Area	Implementation period	Method
Neighboring region of 50mSv per year	Dec. 15, 2011 to Dec. 21 Jan. 6, 2012 to Jan. 16	Monitoring by monitoring car and measuring personnel
Neighboring region of 20mSv per year	Nov. 7, 2011 to Nov. 24	Monitoring by monitoring car and monitoring personnel
Neighboring region of 10mSv per year	Feb. 17, 2012 to Feb. 28 Apr. 6, 2012 to Apr. 12	Monitoring by monitoring car and monitoring personnel
Neighboring region of 5mSv per year	Jan. 6, 2012 to Mar. 3	Monitoring by unmanned helicopter
Neighboring region of 1mSv per year	Feb. 17, 2012 to Feb. 28	Monitoring by monitoring car

（2） Measurement methods

In order to efficiently understand the radiation data at each point of the 100 m mesh grid, while using existing data, additional data were collected by monitoring vehicles (measurement instruments were mounted on cars), aerial monitoring (measurement instruments were mounted on drone helicopters) and persons walking through areas with hand-carry instruments.

The basic policy followed in selecting monitoring methods was to use mobile monitoring vehicles for the urban and residential areas and suburban roads, and to use drone helicopters or rely on persons walking for schools, parks and fields with no roads.

（3） Results of detailed monitoring

Detailed monitoring clarified the distributions of air dose rates, mainly in residential areas, and they were classified into three ranges: below 20 mSv per year (3.8 μSv/h), between 20 and 50 mSv per year (9.5 μSv/h), and above 50mSv per year.

[93]Source: Decontamination Information
(http://josen.env.go.jp/about/method_necessity/method_area_monitoring.html)

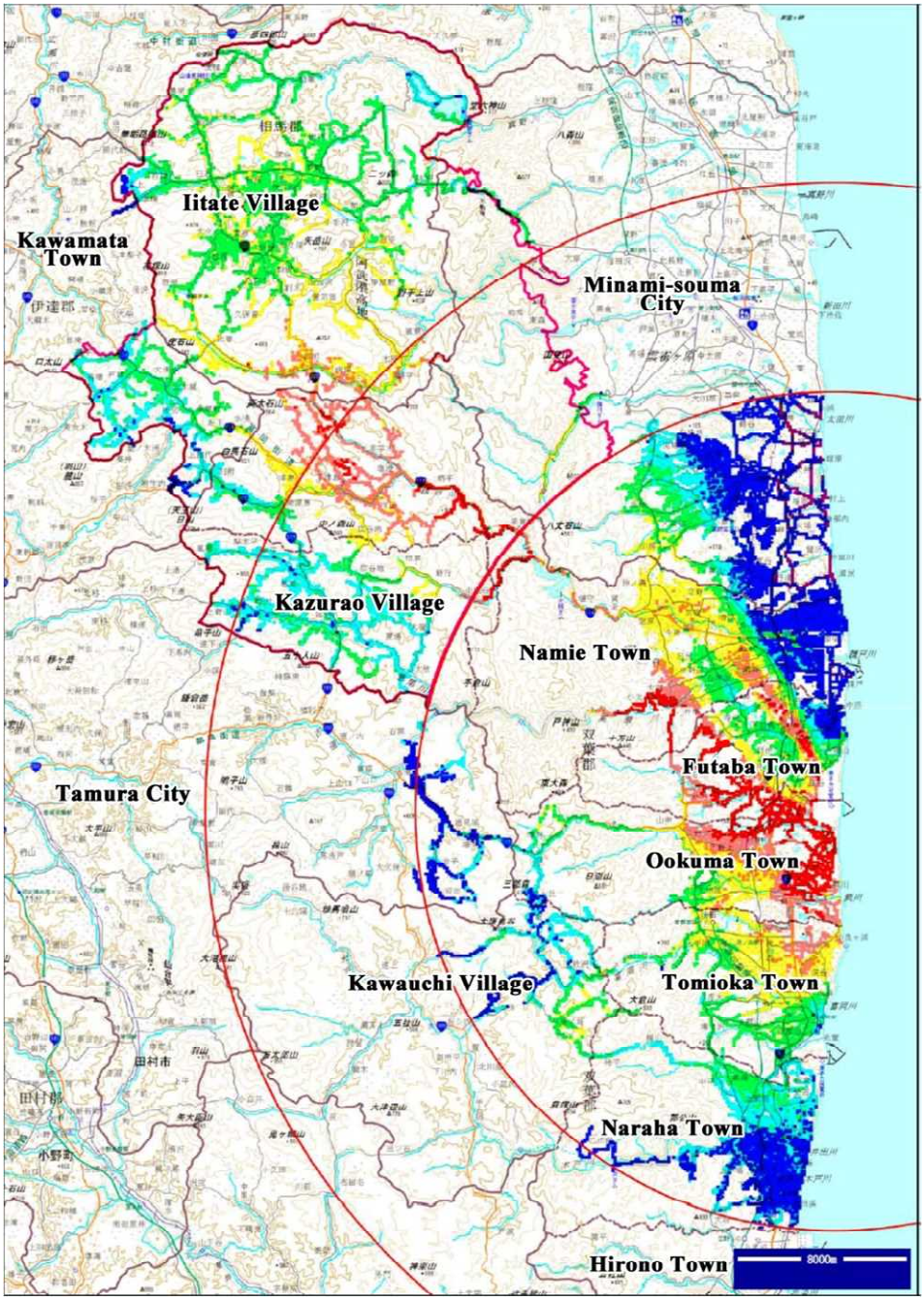


Figure 4-2 General map of the detailed monitoring results[94].

[94]Source: Decontamination Information (http://josen.env.go.jp/area/pdf/monitaring_zentai_final.pdf)

4.2.2. Decontamination Work Ordered by the Ordering Party (MOE)

Decontamination and related works in the Special Decontamination Areas ordered by the MOE followed the government procurement procedures, as in ordinary public works projects: relevant public notices were issued for procurement based on the specifications, decontamination business operators were selected and the orders were issued. Since many of the individual activities of decontamination work were similar to those in ordinary public works projects, the ordering framework for ordinary public works was applied with supplementary additions of matters specific to decontamination work.

The MOE presented common specifications for decontamination and related works for the Special Decontamination Areas (hereafter "Common Specifications"), and formulated common decontamination work specifications to ensure that the details of work agreements and design documents were interpreted and implemented in a uniform manner, and that, by setting out other necessary matters, the agreements were properly executed. In addition, special specifications setting out specific technical requirements (hereafter "Special Specifications") were formulated on an individual project basis for the actual conditions of the area or site subject to decontamination, and individual decontamination projects were carried out based on these Common Specifications and Special Specifications.

It would have taken a long time to commence decontamination projects upon acquisition of consent to the decontamination works and the decontamination methods for each object to be decontaminated from the stakeholders such as land owners, as is practiced in ordinary public works projects. Therefore, the MOE placed an order for decontamination and related works in the Special Decontamination Areas before fixing everything. By using the prior survey results, the order was made based on the estimated decontamination area sizes and number of decontamination target buildings for each type of target object and decontamination method. The quotes could be fixed after the decontamination methods for each target object were fixed and the decontamination area sizes as well as the number of buildings to decontaminate were fixed in the actual project operation. The MOE and decontamination business operators concluded an agreement to adopt a method of calculating payments based on work unit prices and the actual volume of work completed. For the actual operation, the MOE formulated provisional estimation standards of decontamination and related works in the Special Decontamination Areas (hereafter "Provisional Estimation Standards"), in which the unit prices for the work are defined in advance.

The following shows the Common Specifications, Special Specifications, Provisional Estimation Standards, and ordering system and procedures for decontamination and related works in the Special Decontamination Areas as ordered by the MOE.

1) Common Specifications

The Common Specifications describe general parts of technical requirements and work contents which are needed in implementing the work such as the work sequence, qualities of materials to be used, quantities, finished qualities, work methods, etc.

The MOE developed the Common Specifications by incorporating new decontamination work methods based on work experiences and the latest version of the Common Specifications (7th Edition) was issued in April 2014.

Tables 4-2 to 4-6 list the contents of Chapters 1 to 5 of the Common Specifications (7th Edition).

Table 4-2 Contents of "Chapter 1 General Provisions" in the Common Specifications (7th Edition)[95]

Section	Paragraph
Section 1 General Items	1-1-1 Application
	1-1-2 Definition of terms
	1-1-3 Works on Special Decontamination Areas
	1-1-4 Radiation work leader, operation leader
	1-1-5 Check with design document
	1-1-6 Breakdown of contract
	1-1-7 Schedule
	1-1-8 Implementing plan
	1-1-9 Registelation of work performance information
	1-1-10 Supervision personnel
	1-1-11 Commissioned supervisor
	1-1-12 Usage of work land, etc.
	1-1-13 Start of work
	1-1-14 Subcontract of work
	1-1-15 Ledger of working structure
	1-1-16 Cooperation of mutual contractor
	1-1-17 Cooperation for investigation and test
	1-1-18 Temporary halt of work
	1-1-19 Revision of schedule
	1-1-20 Examination committee for design change
	1-1-21 Supplied material and lent itams
	1-1-22 List of decontamination worker and identification card
	1-1-23 Provision of allowance
	1-1-24 Entrance into land and building
	1-1-25 Generated materials at construction site
	1-1-26 Investigation (including confirmation) and witness by supervision staff
	1-1-27 Investigation of work completion
	1-1-28 Investigations of previously finished portion
	1-1-29 Technical investigation
	1-1-30 Execution management
	1-1-31 Performance report
	1-1-32 Management of decontamination workers
	1-1-33 Security during work
	1-1-34 Security measurement for ionizing radiation
	1-1-35 Cleanup
	1-1-36 Accident report
	1-1-37 Environment measurement
	1-1-38 Coordination with peripheral residents
	1-1-39 Care for cultural property
	1-1-40 Management of traffic safety
	1-1-41 Compliance for laws and regulations

[95] Source: Decontamination Project Common Specifications (7th Edition) (http://tohoku.env.go.jp/fukushima/to_2014/data/0410ba.pdf) (Table 4-3 to Table 4-6 have the same source.)

Section	Paragraph
	1-1-42 Procedures to public office
	1-1-43 Revision of work duration and work time
	1-1-44 Submitted document
	1-1-45 Damage by inevitable force
	1-1-46 Patent, etc.
	1-1-47 Insurance and compensation for accident
	1-1-48 Measure for specific case
	1-1-49 Confidentiality obligation
	1-1-50 Handling of individual information
	1-1-51 Securement of information security

Table 4-3 Contents of "Chapter 2 Work materials" in the Common Specifications (7th Edition)

Section	Paragraph
Section 1 Application	—
Section 2 Quality and test of work material (including confirmation)	—
Section 3 Work material	2-3-1 Large sandbag, etc.

Table 4-4 Contents of "Chapter 3 Decontamination" in the Common Specifications (7th Edition)

Section	Paragraph
Section 1 Common items	3-1-1 Test of construction
Section 2 Explanation of decontamination method	1. Residents, etc.
	2. School
	3. Park (small)
	4. Park (large)
	5. Large facility
	6. Road
	7. Slope
	8. Farmland
	9. Grass field, Lawn
	10. Orchard
	11. Forest
	12. Deleted
	13. Temporary storage area, etc.
	14. Deleted
	15. Effluent processing

Table 4-5 Contents of "Chapter 4 Work management" in the Common Specifications (7th Edition)

Section	Paragraph
Section 1 Measurement of radiation dose	4-1-1 Common items
	4-1-2 Radiation measurement at measures for decontamination work
	4-1-3 Security, management and transfer of temporary storage area, etc.
Section 2 Management of temporary storage area, etc.	4-2-1 Management of storage area after completion of storage
Section 3 Confirmation of construction result	4-3-1 Confirmation of construction result with decontamination measures on residential district
Section 4 Confirmation investigation	4-4-1 General rule
	4-4-2 Decision of management value
	4-4-3 Implementation of confirmation investigation
Section 5 Handling of removed soil, etc.	4-5-1 Discretion
	4-5-2 Dose measurement
	4-5-3 Grant of identification number and tag, etc.
	4-5-4 Development of storage ledger

Table 4-6 Contents of "Chapter 5 Reporting" in the Common Specifications (7th Edition)

Section	Paragraph
Section 1 Report and submittal document	5-1-1 Submittal document
	5-1-2 decontamination management information
	5-1-3 Report of decontamination result on residential district, etc.
Section 2 Report of decontamination result to related persos	5-2-1 Report of decontamination result on residential district, etc. to related persons

(2) Special Specifications

The Special Specifications supplement the Common Specifications and specify details or specific technical requirements in individual decontamination tasks, considering the actual situations of the area or site to be decontaminated. The Special Specifications were presented as a supplement to the Common Specifications with specific notes in the procurement for individual decontamination tasks.

(3) Provisional Estimation Standards

The Provisional Estimation Standards was developed for estimating costs for decontamination and related works in the Special Decontamination Areas ordered by the MOE. The Provisional Estimation Standards may be excluded from application, when their application is extremely inadequate or difficult because of diverse conditions of the site or the natural environment.

The Provisional Estimation Standards specify materials and equipment needed, workload, unit prices of machinery, workforces, expenses, etc. required for implementing the decontamination and related works. The construction cost can be calculated based on these specifications.

The first edition was developed in May 2012. Thereafter the Provisional Estimation Standards were revised to match the actual site situations based on experiences in decontamination projects, e.g., incorporating new work methods. In April 2014, the 7th Edition was put into effect (Provisional Estimation Standards (7th Edition)).

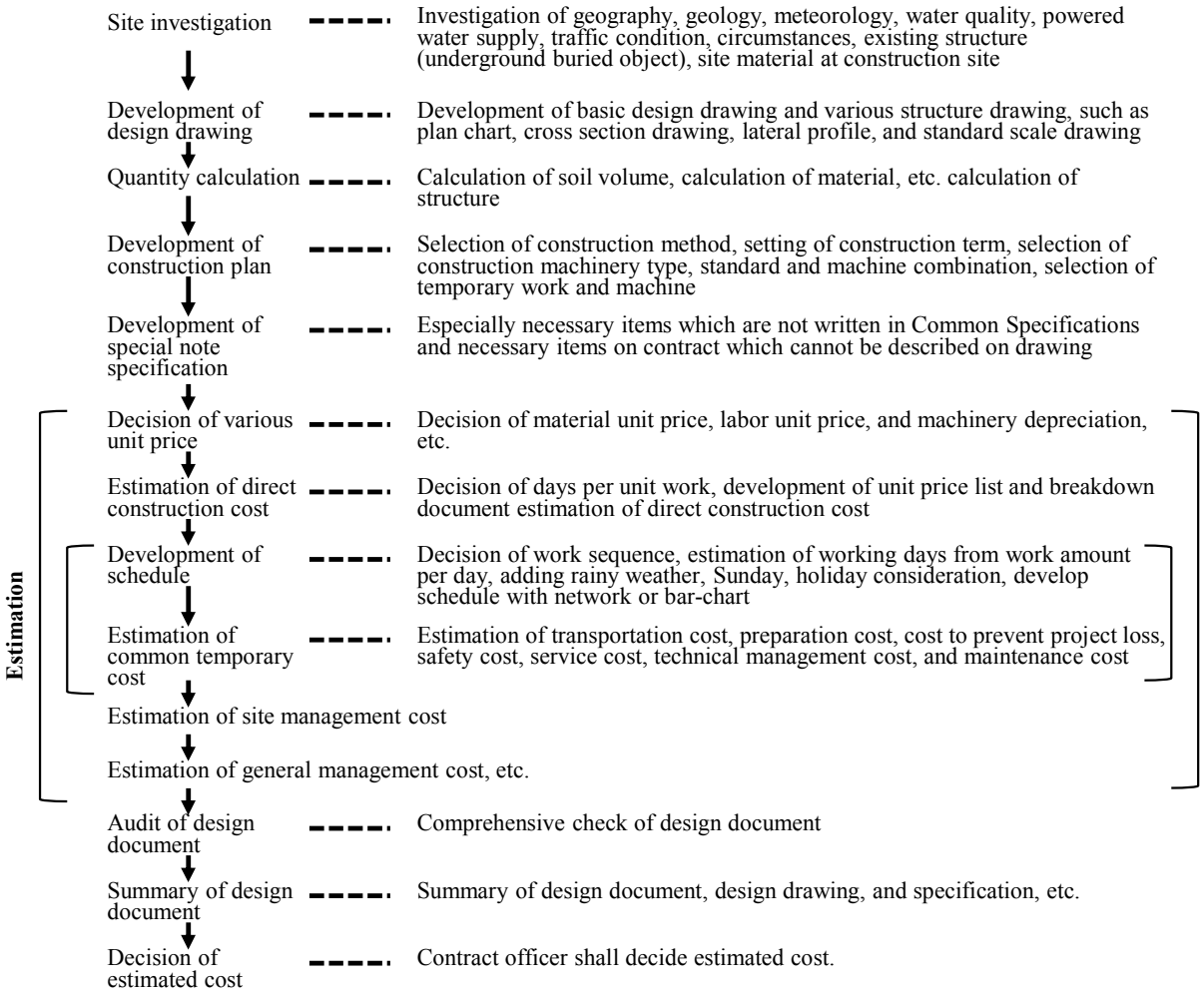


Figure 4-3 Construction cost estimation flow[96].

The Provisional Estimation Standards specify workload needed for each object to be decontaminated and the decontamination method in terms of workforce, quantities generated for removal, and materials and equipment required per unit area for decontamination tasks. An example of workload is shown below for the work of removing sediments from residential area roofs and the like (other than concrete roofs). It specifies 0.50 work supervisor and 3.20 decontamination workers are required per 1,300m^2 area to be decontaminated.

The workload developed in the Special Specifications by the MOE was based on two types of results: the results of the "decontamination model projects" performed by the JAEA

[96]Source: Decontamination Construction Project Management Standards in the Special Decontamination Areas (7th Edition) (http://tohoku.env.go.jp/fukushima/to_2014/data/0410aa.pdf) (Figure 4-4 has the same source.)

Fukushima Technology Headquarters in JFY 2011 under consignment by the Cabinet Office for verifying decontamination techniques required for effective decontamination in high-dose areas; and the results of independent decontamination projects performed by municipalities in Fukushima Prefecture.

Title	Standard	Unit	Quantity	Summary
●Labor cost				
Work supervisor		Person	0.50	
Decontamination worker		Person	3.20	
●Material cost				
Large sandbag		Bag		Later
●Miscellaneous cost				
Miscellaneous cost		%	1.0	1% of labor cost
Total				

Miscellaneous cost include pitchfork, etc. and added above percentage to labor cost.

Figure 4-4 Example of workload.
(Sediment removal from a roof in a residential area (roof material other than concrete))

It is difficult to show simply the cost of decontamination work, since it is affected by various factors such as: the size/extent of houses/land; materials of roofs and walls; extent and conditions of gardens (presence of garden trees, and others); availability of aerial lift (bucket crane) work vehicles; necessity to install temporary scaffolds; necessity to replace gravel; necessity to decontaminate surrounding forests; transfer of removed soil and the like to the temporary storage site, etc.

For ordinary residences, the workload per house is estimated at approximately 50 worker-days (about 10 workers working for five days)[97].

(4) Ordering of decontamination and related works

For the ordering of decontamination and related works in the Special Decontamination Areas, the MOE issued, in accordance with the government procurement procedures, a public announcement and notice of Common Specifications, Special Specifications, Provisional Estimation Standards and other relevant documents and publicly advertised for technical proposals. After reviewing the technical proposal documents, the MOE invited public bids and opened them. The decontamination business operators were selected by comprehensive evaluation of cost points and technical evaluation points.

For the public announcement and notice, the MOE coordinated estimation unit prices to decide its estimated price as the ordering party. The unit prices were estimated based on the past examples of public works and the results of decontamination model projects as mentioned in (3) above.

For the Intensive Contamination Survey Areas, the municipal governments developed decontamination work plans, as mentioned in Chapter 1.1.7, and they placed an order for decontamination and related works using the special grant for emergency work of radiation reduction measures of the National Government as the financial resource which was provided based on the decontamination work plans. The special grants cover decontamination methods to be used in relatively high dose areas and in relatively low dose areas. For example: for the

[97]Source: "On-site explanation of decontamination plan and request for understanding of implementation for decontamination works" (http://www.katsurao.org/uploaded/attachment/6.pdf)

work to decontaminate a stand-alone house in a relatively high dose area, such work methods are added as: (i) removing surface soil, covering with fresh soil, and consolidating for restoring the gardens and the like to the original state; (ii) upturning, (iii) removing contaminated soil, and covering with fresh soil from excavation for field storage development ; or (iv) covering with uncontaminated soil.[98]

4.2.3. Decontamination Work by Decontamination Business Operators

The following is an overview of the decontamination and related works performed by decontamination business operators for an order from the MOE to carry out decontamination in the Special Decontamination Areas.

（1） Development of work plans

Prior to the commencement of decontamination work, decontamination business operators develop a comprehensive work plan including all necessary steps and methods to complete the project, and submit it to the MOE supervisor.

It should be noted that this comprehensive work plan describes an overview of the work, the overall schedule, site organizational chart, work methods (including test work methods and evaluation methods), work management plan, safety management plan (including matters related to radiation protection, and methods to prevent the spread of contamination), and emergency systems and responses, etc.

（2） Development of organizational structure for implementation

1）Designation of the radiation control officer and work leaders

Decontamination business operators are required to designate a person to direct and supervise the radiation management of decontamination workers (radiation control officer), and a person in each work unit (work group) to lead the group's activities (work leader).

The radiation control officer is in charge of the following activities.

- Conducting special education for decontamination workers based on Article 19 of the Ionizing Radiation Ordinance for Decontamination
- Instructing decontamination workers thoroughly in proper wearing of protective clothes and equipment according to the work contents
- Instructing decontamination workers in thoroughly practicing proper operation of machines and equipment necessary to control ionizing radiation
- Inspecting in advance machines, equipment and the like which are necessary to control ionizing radiation, and securing necessary functions and quantities
- Inspecting in advance protective clothes, equipment and the like, and securing necessary functions and quantities
- Controling access of persons not engaged in the work to the site
- Supervising decontamination workers in using radiation measuring instruments
- Understanding the work sequence, work contents, and working environment such as the average air dose rate at the working location, and assisting the acting site manager and similar responsible person(s) at meeting(s) for work procedures before starting the work
- Administrating properly the decontamination workers' roster and their radiation passbooks
- Administrating the records of radiation exposure dose measurements of

[98]Source: Ministry of the Environment (MOE), "Radiation reduction measures special urgent project subsidyhandling instructions" (tentative translation)

decontamination workers

2）Preparation of rosters of decontamination workers and their identification cards

Decontamination business operators are required to prepare a roster of decontamination workers in which a record is made for each worker before they begin the designated decontamination work, their name, age, job title, and radiation passbook registration number. When the decontamination workers terminate their engagement in the designated work, the decontamination business operators remove them from the roster. Decontamination business operators are required to check decontamination workers have or do not have their radiation passbooks at the time they start the decontamination work. If workers have radiation passbooks, the decontamination business operator record the registration numbers in the roster; workers who do not have the radiation passbook are required to get it by the time they leave the designated work.

In addition, decontamination business operators are required to submit requests to the MOE supervisor for personal identification cards for each decontamination worker, and upon receiving the issued cards, ensure that decontamination workers always carry these cards with them while working.

（3） Test work

Test work is carried out for the purpose of choosing the most effective decontamination methods from candidate methods for particular target objects to be decontaminated, which are designated by the MOE supervisor, before commencing the actual decontamination and related works. Once no further significant reductions can be observed in radiation dose rates, even with repeated decontamination processes, the decontamination business operators report this to the MOE supervisor and proceed at his/her direction.

This is due to the reality that, unless test work is carried out in actual site conditions, the optimum parameters in decontamination work cannot be determined, for example, the number of steps for wiping work, the depth and speed of deep ploughing work, the water jet pressure and moving speed of high-pressure road surface cleaners, etc. Specifically, for example, the surface dose rate can be further reduced with two wiping steps than with only one, and further with three than with only two, but after a certain number of steps the rate of surface dose reduction declines. Increase of wiping steps has a disadvantage, too. A new paper towel or rag cleaning face is used in each step of wiping. Consequently, an increase in the number of steps of wiping causes not only increased work time but also an increase of materials and waste. In deep plowing work, the standard plowing depth is 30 cm for a good decontamination effect, but when the soil base is shallow, stones may be turned up in the surface layer or water leaks from rice fields may be caused. Coordination becomes necessary for setting the best parameter for a particular decontamination target. Also in deep plowing work, higher moving speeds of the machinery (tilling tractors) may shorten the work time, but this may not stir the soil enough to achieve a sufficient decontamination effect.

Test work should be implemented considering the following items.

(i) Decontamination business operators are required to prepare the test work plan and submit the document to the MOE supervisor; the document describes the decontamination flow, test locations, number of test points, measurement methods (including measuring equipment), number of tests, etc. for the decontamination objects and decontamination methods as designated by the MOE supervisor.

(ii) The decontamination flow should include several cases in which parameters possibly affecting the decontamination rates (e.g., work time per unit area, number of tests, test location, water pressure for high-pressure washing, and distance between the jet nozzle and ground, etc.) are changed.

(iii) Test locations and points for the target objects to be decontaminated and methods thereof designated by the MOE supervisor should be chosen with a good balance that

considers the situation in the area where the decontamination measures are to be implemented.

(4) Implementation of decontamination projects

The Common Specifications specify decontamination methods for each target object to be decontaminated. Prior to commencing the work, decontamination business operators prepare the comprehensive work (or construction) plans, including procedures, methods and all other necessary items required for completion of the project, and submit them to the MOE supervisor.

The decontamination work covers not only decontamination for reducing air dose rates in a narrow sense, but also the methods for pre-decontamination works and post-decontamination works for restoration. For example "cleaning by road sweepers" (6.1.2.6) has the purpose of being a prior preparation to decontamination work or the purpose of maintenance. "Restoration of soil fertility" (8.1.2.7-(1) and others) for farmland can be regarded as a post-process work (restoration to the state before contamination). On the other hand, there are such methods as "sediment removal" (1.1.1.1 and others), which, depending on actual site conditions, can be regarded as methods for reducing the air dose rate in a narrow sense of decontamination, or can be also regarded as a preparatory process before "wiping" (1.1.1.2 and others) or "brush cleaning" (1.1.1.3 and others).

Table 4-7 Decontamination methods for each decontamination target [99]

Target			Decontamination methods
1. Residential areas, etc.	1.1 Roofs, rooftops	1.1.1 Roofs (all materials except concrete)	1.1.1.1 Sediment removal
			1.1.1.2 Wiping
			1.1.1.3 Brush cleaning
		1.1.2 Roofs (concrete)	1.1.2.1 Sediment removal
			1.1.2.2 Wiping
			1.1.2.3 Brush cleaning
	1.2 Walls, Fences	1.2.1 Except earthen walls	1.2.1.1 Wiping
			1.2.1.2 Brush cleaning
		1.2.2 Earthen walls	1.2.2.1 Wiping
	1.3 Gutters	1.3.1 Eave gutters	1.3.1.1 Sediment removal
			1.3.1.2 Wiping
			1.3.1.3High-pressure washing
		1.3.2 Downspouts	1.3.2.1 High-pressure washing
	1.4 Gardens, etc.	1.4.1 Unpaved surfaces	1.4.1.1 Sediment removal
			1.4.1.2 Weeding, mowing
			1.4.1.3 Close mowing of lawns
			1.4.1.4 Peeling off grass and lawn top layer
			1.4.1.5 Sodding
			1.4.1.6 High-pressure washing of gravel and crushed stone

[99] Source: Decontamination Project Common Specifications (7th Edition) (http://tohoku.env.go.jp/fukushima/to_2014/data/0410ba.pdf)

Target			Decontamination methods
			1.4.1.7 Removal of gravel and crushed stone
			1.4.1.8 Covering of gravel and crushed stone
			1.4.1.9 Peeling off topsoil
			1.4.1.10 Covering the ground surface
			1.4.1.11 Topsoil removal in tree root vicinity etc.
			1.4.1.12 Pruning of garden trees
			1.4.1.13 Trimming of garden trees
			1.4.1.14 (Deleted)
			1.4.1.15 Upturning soil
		1.4.2 Paved surfaces	1.4.2.1 Sediment removal
			1.4.2.2 Brush cleaning
			1.4.2.3 High-pressure washing
			1.4.2.4 Peeling
			1.4.2.5 Abrasive material blasting
School buildings	2.1 Roofs, roof tops	－	2.1.1.1 Sediment removal
			2.1.1.2 Wiping
			2.1.1.3 Brush cleaning
			2.1.1.4 High-pressure washing
	2.2 Walls, fences	－	2.2.1.1 Wiping
			2.2.1.2 Brush cleaning
			2.2.1.3 High-pressure flushing
	2.3 Gutters	2.3.1 Eave gutters	2.3.1.1 Sediment removal
			2.3.1.2 Wiping
			2.3.1.3 High-pressure washing
		2.3.2 Downspouts	2.3.2.1 High-pressure washing
	2.4 Ground surfaces, etc.	2.4.1 Sediment	2.4.1.1 Sediment removal
		2.4.2 Grass areas, Lawns	2.4.2.1 Weeding, Mowing
			2.4.2.2 Close mowing of lawns
			2.4.2.3 Peeling off grass and lawn top layer
			2.4.2.4 Sodding
		2.4.3 Gravel, crushed stone	2.4.3.1 High-pressure washing of gravel and crushed stone
			2.4.3.2 Removal of gravel and crushed stone
			2.4.3.3 Covering of gravel and crushed stone
		2.4.4 Soil	2.4.4.1 Topsoil removal around drain outlets, eave

Target			Decontamination methods
			gutter outlets
			2.4.4.2 Peeling off topsoil
			2.4.4.3 Covering of ground surface
			2.4.4.4 Upturning
		2.4.5 Plantings	2.4.5.1 Topsoil removal in tree root vicinity etc.
			2.4.5.2 Pruning of plantings
			2.4.5.3 Trimming of trees
		2.4.6 Paved surfaces	2.4.6.1 Sediment removal
			2.4.6.2 Brush cleaning
			2.4.6.3 High-pressure washing
			2.4.6.4(1)、2.4.6.4(2) Scraping
			2.4.6.5 Abrasive material blasting
			2.4.6.6 Superhigh pressure flushing
			2.4.6.7 Resurfacing
	2.5 Play equipment, etc.	2.5.1 Play equipment, etc.	2.5.1.1 Wiping, Brush cleaning, Scraping
3. Parks (small)	3.1 Roofs, rooftops	－	3.1.1.1 Sediment removal
			3.1.1.2 Wiping
			3.1.1.3 Brush cleaning
			3.1.1.4 High-pressure washing
	3.2 Walls, Fences	3.2.1 Walls, Fences	3.2.1.1 Wiping
			3.2.1.2 Brush cleaning
			3.2.1.3 High-pressure washing
	3.3 Gutters	3.3.1 Eave gutters	3.3.1.1 Wiping
			3.3.1.2 Brush cleaning
			3.3.1.3 High-pressurewashing
		3.3.2 Downspouts	3.3.2.1 High-pressure washing
	3.4 Grounds, etc.	3.4.1 Sediment	3.4.1.1 Sediment removal
		3.4.2 Grass areas, Lawns	3.4.2.1 Weeding, mowing
			3.4.2.2 Close mowing of lawns
			3.4.2.3 Peeling off grass and lawn top layer
			3.4.2.4 Sodding
		3.4.3 Gravel, Crushed stone	3.4.3.1 High-pressure washing of gravel and crushed stone
			3.4.3.2 Removal of gravel and crushed stone
			3.4.3.3 Covering of gravel and crushed stone

Target			Decontamination methods
		3.4.4 Soil	3.4.4.1 Peeling off topsoil
			3.4.4.2 Covering of ground surface
			3.4.4.3 Upturning
		3.4.5 Plantings	3.4.5.1 Topsoil removal in tree root vicinity etc.
			3.4.5.2 Pruning of plantings
			3.4.5.3 Trimming of trees
		3.4.6 Paved surfaces	3.4.6.1 Sediment removal
			3.4.6.2 Brush cleaning
			3.4.6.3 High-pressure washing
			3.4.6.4 Peeling
			3.4.6.5 Abrasive material blasting
	3.5 Play equipment, etc.	3.5.1 Play equipment, etc.	3.5.1.1 Wiping, Brush cleaning, Peeling
3. Parks (big)	4.1 Roofs, Rooftops	—	4.1.1.1 Sediment removal
			4.1.1.2 Wiping
			4.1.1.3 Brush cleaning
			4.1.1.4 High-pressure washing
	4.2 Walls, Fences	4.2.1 Walls, Fences	4.2.1.1 Wiping
			4.2.1.2 Brush cleaning
			4.2.1.3 High-pressure washing
	4.3 Gutters	4.3.1 Eave gutters	4.3.1.1 Sediment removal
			4.3.1.2 Wiping
			4.3.1.3 High-pressure washing
		4.3.2 Downspouts	4.3.2.1 High-pressure washing
	4.4 Ground surfaces, etc.	4.4.1 Sediment	4.4.1.1 Sediment removal
		4.4.2 Grass areas, Lawns	4.4.2.1 Weeding, mowing
			4.4.2.2 Close mowing of lawns
			4.4.2.3 Peeling off grass and lawn top layer
			4.4.2.4 Sodding
		4.4.3 Gravel, Crushed stone	4.4.3.1 High-pressure washing of gravel and crushed stone
			4.4.3.2 Removal of gravel and crushed stone
			4.4.3.3 Covering of gravel and crushed stone
		4.4.4 Soil	4.4.4.1 Topsoil removal around drain outlets, Eave gutter outlets
			4.4.4.2 Peeling off topsoil
			4.4.4.3 Covering of ground surface

Target			Decontamination methods
			4.4.4.4 Upturning
		4.4.5 Plantings	4.4.5.1 Topsoil removal in tree root vicinity etc.
			4.4.5.2 Pruning of plantings
			4.4.5.3 Trimming of trees
		4.4.6 Paved surfaces	4.4.6.1 Sediment removal
			4.4.6.2 Brush cleaning
			4.4.6.3 High-pressure washing
			4.4.6.4 Peeling
			4.4.6.5 Abrasive material blasting
			4.4.6.6 Super-high-pressure washing
			4.4.6.7 Repaving
	4.5 Play equipment, etc.	4.5.1 Play equipment, etc.	4.5.1.1 Swabbing, cleaning, peeling
5. Large facilities	5.1 Roofs, Rooftops	5.1.1 Roofs, Rooftops	5.1.1.1 Sediment removal
			5.1.1.2 Wiping
			5.1.1.3 Brush cleaning
			5.1.1.4 High-pressure washing
	5.2 Walls, Fences	5.2.1 Walls, Fences	5.2.1.1 Wiping
			5.2.1.2 Brush cleaning
			5.2.1.3 High-pressure washing
	5.3 Gutters	5.3.1 Eave gutters	5.3.1.1 Sediment removal
			5.3.1.2 Wiping
			5.3.1.3 High-pressure washing
	5.4 Ground surfaces, etc.	5.4.1 Sediment	5.4.1.1 Sediment removal
		5.4.2 Grass areas, Lawns	5.4.2.1 Weeding, mowing
			5.4.2.2 Close mowing of lawns
			5.4.2.3 Peeling off grass and lawn top layer
			5.4.2.4 Sodding
		5.4.3 Gravel, crushed stone	5.4.3.1 High-pressure flush of gravel and crushed stone
			5.4.3.2 Removal of gravel and crushed stone
			5.4.3.3 Covering of gravel and crushed stone
		5.4.4 Soil	5.4.4.1 Topsoil removal around drain outlets, Eave gutter outlets
			5.4.4.2 Peeling off topsoil
			5.4.4.3 Covering of ground surface
			5.4.4.4 Upturning
		5.4.5 Plantings	5.4.5.1 Topsoil removal in tree root vicinity etc.

Target			Decontamination methods
			5.4.5.2 Pruning of plantings
			5.4.5.3 Trimming of trees
		5.4.6 Parking lots (concrete, asphalt)	5.4.6.1 Sediment removal
			5.4.6.2 Brush cleaning
			5.4.6.3 High-pressure washing
			5.4.6.4 Peeling
			5.4.6.5 Abrasive material blasting
			5.4.6.6 Super-high-pressure washing
			5.4.6.7 Repaving
	5.5 Play equipment, etc.	5.5.1 Play equipment, etc.	5.5.1.1 Wiping, Brush cleaning, Peeling
6. Road	6.1 Paved road	6.1.1 Sediment	6.1.1.1 Sediment removal
		6.1.2 Road, Sidewalk	6.1.2.1 High-pressure washing
			6.1.2.2 Peeling
			6.1.2.3 Abrasive material blasting
			6.1.2.4 Super-high-pressure washing
			6.1.2.5 Repaving
			6.1.2.6 Cleaning with road sweepers
	6.2 Unpaved roads	6.2.1 Road surfaces (soil)	6.2.1.1-(1) Weeding
			6.2.1.1-(2) Sediment removal
			6.2.1.2 Side ditches, etc.
			6.2.1.3 Covering of ground surface
			6.2.1.4 Upturning
		6.2.2 Road surfaces (gravel, crushed stone roads)	6.2.2.1-(1) Weeding
			6.2.2.1-(2) Sediment removal
			6.2.2.2 High-pressure washing of gravel and crushed stone
			6.2.2.3 Removal of gravel and crushed stone
			6.2.2.4 Covering of gravel and crushed stone
	6.3 Guardrails	6.3.1 Guardrails	6.3.1.1 Brush cleaning
			6.3.1.2 High-pressure washing
			6.3.1.3 Wiping
	6.4 Side ditches , etc.	6.4.1 Side ditches , etc.	6.4.1.1 Bottom sediment removal, etc.
	6.5 Pedestrian bridges	6.5.1 Pedestrian bridges	6.5.1.1 Sediment removal
			6.5.1.2 High-pressure washing
			6.5.1.3 Wiping

Target			Decontamination methods
			6.5.1.4 Brush cleaning
	6.6 Roadside trees	6.6.1 Sediment	6.6.1.1 Sediment removal
		6.6.2 Grass	6.6.2.1 Weeding, mowing
		6.6.3 Roadside trees	6.6.3.1 Soil removal around root area of roadside trees
			6.6.3.2 Debranching of roadside trees
7. Slopes	7.1 Slopes	7.1.1 Sediments (grass, fallen leaves, etc.)	7.1.1.1 Sediment removal
8. Farmland	8.1 Rice paddies	8.1.1 Grass	8.1.1.1-(1) Manual weeding
			8.1.1.1-(2) Machine weeding
			8.1.1.1-(3) Buildup of weeding material
			8.1.1.1-(4) Packing
			8.1.1.1-(5) Small transfer in site
		8.1.2 Soil	8.1.2.1-(1) Bump leveling
			8.1.2.1-(2) Surface fixation material dispersion
			8.1.2.2-(1)-①、8.1.2.2-(1)-②Peeling off surface soil (standard transportation method)
			8.1.2.2-(1)-③ Packing (standard transportation method)
			8.1.2.2-(1)-④ Small transport vehicles (standard transportation method)
			8.1.2.2-(2)-① Peeling off surface soil (suction method)
			8.1.2.2-(2)-② Packing (suction method)
			8.1.2.2-(2)-③ Small transport vehicles (suction method)
			8.1.2.3 Deleted
			8.1.2.4-(1) Reverse cultivation (plowing 30cm)
			8.1.2.4-(2) Reverse cultivation (plowing 45cm)
			8.1.2.4-(3) Base land preparation
			8.1.2.4-(4) Turn plowing
			8.1.2.5 Deep plowing
			8.1.2.6 Adding soil
			8.1.2.7-(1) Restoration of soil fertility (soil improvement agent

Target			Decontamination methods
			dispersal)
			8.1.2.7-(2) Restoration of soil fertility (zeolite dispersal)
			8.1.2.8 Upturning
	8.2 Fields	8.2.1 Grass	8.2.1.1 Weeding
		8.2.2 Soil	8.2.2.1 Surface fixation material dispersion
			8.2.2.2-(1) Peeling off topsoil (standard transportation method)
			8.2.2.2-(2) Peeling off surface soil (suction method)
			8.2.2.3 Deleted
			8.2.2.4 Reverse cultivation
			8.2.2.5 Deep plowing
			8.2.2.6 Adding soil
			8.2.2.7 Land power recovery
			8.2.2.8 Upturning
	8.3 Meadows	8.3.1 Grass	8.3.1.1 Weeding
			8.3.1.2 Deleted
			8.3.1.3-(1) Seeding (dispersion)
			8.3.1.3-(2) Seeding (suppression)
		8.3.2 Soil	8.3.2.1 Peeling off surface soil
			8.3.2.2 Reverse cultivation
			8.3.2.3 Deep plowing
			8.3.2.4 Adding soil
			8.3.2.5 Land nutrient recovery
	8.4 Water channels	8.4.1 Water channels	8.4.1.1-(1) Bottom sediments removal, etc. (earth and sand removal)
			8.4.1.1-(2) Bottom sediments removal, etc. (packing)
	8.5 Ridge fronts	8.5.1 Ridge fronts	8.5.1.1-(1) Sediment removal
			8.5.1.1-(2) Weeding
			8.5.1.2-(1) Peeling off surface soil
			8.5.1.2-(2) Packing
			8.5.1.3 Ridge front recovery
9. Grass areas, lawns	9.1 Shrubs (dense)	9.1.1 Shrubs (dense)	9.1.1.1 Trimming
	9.2 Shrubs (coarse)	9.2.1 Shrubs (coarse)	9.2.1.1 Trimming
10. Orchards	10.1 Orchards	10.1.1 Sediment	10.1.1.1 Sediment removal
		10.1.2 Grass	10.1.2.1 Weeding
		10.1.3 Orchard	10.1.3.1 Peeling off coarse

Target			Decontamination methods
		tree	bark
			10.1.3.2 High-pressure washing of tree bark
			10.1.3.3 Pruning of orchard trees
			10.1.3.4 Trimming of orchard trees
		10.1.4 Soil	10.1.4.1 Peeling off surface soil
			10.1.4.2 Adding soil
11. Forests	11.1 Evergreen needle-leaved trees	11.1.1 Organic sediments	11.1.1.1-(1)、11.1.1.1-(2)、11.1.1.1-(3) Removal of organic sediments
			11.1.1.1-(4) Removal of organic sediments (non-management zone)
			11.1.1.1-(5) Arrangement of cutoff chips
		11.1.2 Soil	11.1.2.1 Prevention of re-spreading (soil loading)
			11.1.2.2 Prevention of re-spreading (board rack)
		11.1.3 Timber	11.1.3.1-(1)、11.1.3.1-(2)、11.1.3.1-(3) Pruning of needle leaf trees, collection of branches
		11.1.4 Rough cutting	11.1.4.1 Pruning underbrush, shrubs
		11.1.5 Removal of residual organic sediments	11.1.5.1 Removal of residual organic sediments
	11.2 Deciduous broadleaf trees	11.2.1 Organic sediments	11.2.1.1 Removal of organic sediments
			11.2.1.2 Removal of organic sediments (non-management zone)
		11.2.2 Soil	11.2.2.1 Prevention of re-spreading (soil loading)
			11.2.2.2 Prevention of re-spreading (board rack)
		11.2.3 Timber	11.2.3.1 Fascine bonding
		11.2.4 Rough cutting	11.2.4.1 Pruning underbrush, shrubs
		11.2.5 Removal of residual organic sediments	11.2.5.1 Removal of residual organic sediments
	11.3 Bushes	11.3.1 Organic sediments	11.3.1.1 Removal of organic sediments
			11.3.1.2 Removal of organic sediments (non-management zone)

Target			Decontamination methods
		11.3.2 Soil	11.3.2.1 Prevention of re-spreading (soil loading)
			11.3.2.2 Prevention of re-spreading (board rack)
		11.3.3 Timber	11.3.3.1 Fascine bonding
		11.3.4 Rough cutting	11.3.4.1 Pruning underbrush, shrubs
		11.3.5 Removal of residual organic sediments	11.3.5.1 Removal of residual organic sediments
12. (Deleted)	—	—	—
13. Temporary installations, etc.	—	—	13.1.1.1 Groundwater investigation for storage area
			13.1.1.2 Weeding
			13.1.1.3 Trimming of shrubs (thick)
			13.1.1.4 Trimming of shrubs (coarse)
			13.1.1.5-(1) Logging, root removing (logging work)
			13.1.1.5-(2) Logging, root removing (root removing work)
			13.1.1.5-(3) Logging, root removing (accumulation work)
			13.1.1.6 Leveling
			13.1.1.7 Cutting earth, Filling earth
			13.1.1.8 Covering of gravel , crushed stone
			13.1.1.9-(1) Installation of bottom sheets (water blocking sheet)
			13.1.1.9-(2) Installation of protection layers
			13.1.1.9-(3) Installation of upper sheets (breathable waterproof sheets and water blocking sheets)
			13.1.1.10 Leachate collection channels, Leachate collection pipe facilities
			13.1.1.11 Installation of leachate collection facilities
			13.1.1.12 Installation of surface water collection facilities
			13.1.1.13 Deleted
			13.1.1.14 Storage carry-in,

Target			Decontamination methods
			installation
			13.1.1.15 Lateral shielding
			13.1.1.16 Upper shielding
			13.1.1.17 End treatment
			13.1.1.18 Ancillary facilities
			13.1.1.19 Installation of radiation tubes (gas-vent pipes), gas-vent outlets
			13.1.1.20 Installation of thermometers
14. Deleted	—	—	—
15. Effluent treatment	15.1 Effluent treatment	15.1.1 Effluent treatment	15.1.1.1 Treatment of discharged water (precipitation treatment)
			15.1.1.2 Sludge treatment
			15.1.1.3-(1) Installation of turbid water treatment facilities
			15.1.1.3-(2) Water treatment facilities for removal of turbidity

（5） Project management

The Common Specifications (7th Edition) specify the project management methods for radiation dose measurements, administration of temporary storage sites, and confirmation of the work results.

1）Radiation dose measurements

Decontamination business operators are required to select appropriate measuring instruments which have sufficient performance for measurements, taking into account the environment, use conditions, and other matters. Decontamination business operators also ensure that appropriate numbers of instruments are available and calibrated in advance. Decontamination business operators report to the MOE supervisor the name, serial number, date of calibration, term of validity and error values (the variance in measurements at the same measuring point) of the instruments, and conduct daily inspections of them.

When measuring air dose rates, radiation survey meters which meet JIS Z 4333 specifications and the following performance and requirements should be used.

- Type of radiation to measure: gamma rays, X-rays
- Reference radiation source for calibration: cesium-137
- Display unit: μSv/h
- Relative standard errors[100]: below ±15%
- Energy characteristics: energy range 60 keV to 1.5 MeV, sensitivity 0.85 to 1.15
- Directional characteristics: below ±25% (angular range of ±90°)
- Response time or time constant: to be specified

[100] The relative standard error is the deviation of readings of the instrument from the reference radiation dose, expressed in percent. (Some instruments use the terms “reading accuracy” or “relative readings error” with the same meaning)

- Service temperature range: covers -10 to +40 deg C

On the other hand, when measuring surface contamination densities, surface contamination survey meters which meet performance and other requirements specified in JIS Z 4329 should be used, and the results should be recorded as count rates (counts per minute, cpm).

The measurement of radiation dose rate should be done in principle under dry conditions (to avoid shielding influence of moisture), and should follow the specific sequence below.

- Set and fix the time constant at 10 s when measuring radiation.
- Read and record the readings 30 s after fixing the probe (detectors) of the measuring instrument at the measuring point.
- Keep the probe parallel to the ground surface, while facing east and holding the probe as far away from the body as possible for the measurement.
- Take the average of the readings as the measured value.

For those who are not specialists in using radiation measuring instruments, information is provided in the "Performance check-sheet of radiation measuring instruments" (Performance Check-sheet Committee, Japan Electric Measuring Instruments Manufacturers' Association, April 2013) to select the proper instruments.

2）Administration of temporary storage sites

Once all the removed soil and the like have been received, and shielding work above them has been completed, the decontamination business operators are required to commence administration of each temporary storage site and to continue this administration as appropriate in accordance with the direction of the MOE supervisor, until the responsibility of management of temporary storage sites is handed over to the MOE or other operators designated by the MOE.

3）Confirmation of project results

Upon implementation of decontamination and other measures in residential areas and the like, decontamination business operators are required to: compile a report on the work results of these measures; allow the responsible person (foreman or manager) of the operator to check whether the measures have been appropriately implemented in each residential area and the like based on the report; and submit the results to the MOE supervisor.

（6） Check surveys

The goal of decontamination work is to reduce radiation levels, and given that this cannot be confirmed visually, quality management methods are important. For example, it is difficult to judge visually the finished quality of wiping and cleaning after decontamination work. Therefore, MOE personnel randomly choose some part of the surfaces after decontamination, have the decontamination business operators perform their decontamination work again using the same method, and check if there is no further reduction in surface dose rates after this additional decontamination.

In the case of wiping and cleaning, the number of wiping steps and the cleaning speed are set from the test decontamination results as those values which can achieve no further significant radiation dose reduction. Therefore, where wiping and cleaning are finished, no further significant reduction will be anticipated, even if the work is repeated. To the contrary, if the radiation dose is found to have fallen in the check below the control value (the standard deviation of the dose reduction rate before and after the additional check of the decontamination measure), the decontamination measures should be repeated under the direction of the MOE supervisor.

The radiation dose measurements in the check surveys should be carried out before and after the decontamination work using lead blocks in order to shield measurement

instruments from radiation emitted by the surroundings. The same measurement instruments should be used before and after the decontamination work to measure the air dose rates at a distance of 1 cm from the surface being checked.

（7） Project management standards

The Decontamination Work Project Control Standards presented in the Common Specifications specify the schedule and progress control, finished quality control, material quality control and photo control.

1）Schedule and progress control

Decontamination business operators are required to perform appropriate schedule controls using maps, networks, bar charts, etc., and to prepare daily work reports from the day of work commencement until the day of its completion. The daily reports should include the weather, workplaces, work contents, list of workers on duty, quantities of finished work, machinery used, radiation dose rates in the work areas, etc. as well as the items instructed, approved, consulted about, etc., and should be accompanied by attachments such as work photos in accordance with the Photo Control Standards, the checklists of the results of decontamination related works.

2）Finished quality control

Decontamination business operators are required to measure the items as specified in the Finished Quality Control Standards for each type of work designated in the Common Specifications, and to prepare and control the Finished Quality Control Sheets which record the compared results of the measured values with the work plan values.

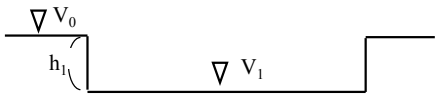
Work		Finished work quality measuring control		Regulated value (mm)	Remark
		Measuring criterion	Items		
Residential area	Removal of gravel and crushed stone (1.4.1.7)	・1 place per work area 1000m^2(1place per work site for equal and less than work area 1000m^2, ・Reference height is defined as the height above sea level lower than the height before work by regulated height (5cm) for the relevant place for each measuring point ・Direct measurement on the basis of the height above sea level for the ground surface after work	Reference height	±10	
	Removal of gravel, and crushed stone (1.4.1.8)	・1 place per work area 1000m^2(1place per work site for equal and less than work area 1000m^2, ・Reference height is defined as the height above sea level before work of "removal of gravel and crushed stone (1.4.1.7)"for the relevant place for each measuring point ・Direct measurement on the basis of the height above sea level for the ground surface after work	Reference height	±10	
	Scraping of surface soil (1.4.1.9)	・1 place per work area 1000m^2(1place per work site for equal and less than work area 1000m^2, ・Reference height is defined as the height above sea level lower than the height before work by regulated height (5cm) for the relevant place for each measuring point ・Direct measurement on the basis of the height above sea level for the ground surface after work	Reference height	±10	
	Covering over ground surface (1.4.1.10)	・1 place per work area 1000m^2(1place per work site for equal and less than work area 1000m^2, ・Reference height is defined as the height above sea level before work of "scraping of surface soil(1.4.1.9) "for the relevant place for each measuring point ・Direct measurement on the basis of the height above sea level for the ground surface after work	Reference height	±10	
	Upturn (1.4.1.15)	・1 place per work area 1000m2(1place per work site for equal and less than work area 1000m2). The following item①should be measured.			
		① ・Reference elevation is defined as the elevation lower than that (V_0) before the work by the standard value (10cm). ・Direct measurement on the basis of the height above sea level for the ground surface after scraping of surface soil 	Reference height	±10	

Figure 4-5 Finished Quality Control Standards (Excerpt)[101].

3）Material quality control

Decontamination business operators are required to ensure appropriately that the quality of materials used in decontamination and related works meet the Material Quality Control Standards.

[101]Source: Decontamination Construction Project Management Standards in the Special Decontamination Areas (7th Edition) (http://tohoku.env.go.jp/fukushima/to_2014/data/0410aa.pdf) (Figure 4-6 to Figure 4-7 have the same source.)

Type	Class	Category	Test item	Test method	Standard value	Test standard	Remarks
Residential area, School, Park, Large facility, Farm land	Residential area, school, park, large facility, farm land	Mandatory	Measurement of radioactive Cesium density	Gamma- ray spectrometry	Sum of Cesium 134 and Cesium 137 shall be under 400 Bq/kg	Once for each product district before carry-in	

Other quality control is based on "civil engineering work control criteria and its regulated value" (Ministry of Land, Infrastructure, Transport and Tourism).

Figure 4-6 Material Quality Control Standards.

4）Photo management

As a means of managing the construction work, decontamination business operators are required to take photographs, in accordance with the Photo Control Standards, at each construction stage, of the following items: the state of areas that cannot be visually confirmed after the completion of construction work; finished work measurements; material quality control conditions, and accidents during construction. Further, these photos are to be appropriately controlled, stored and submitted at the completion of construction work.

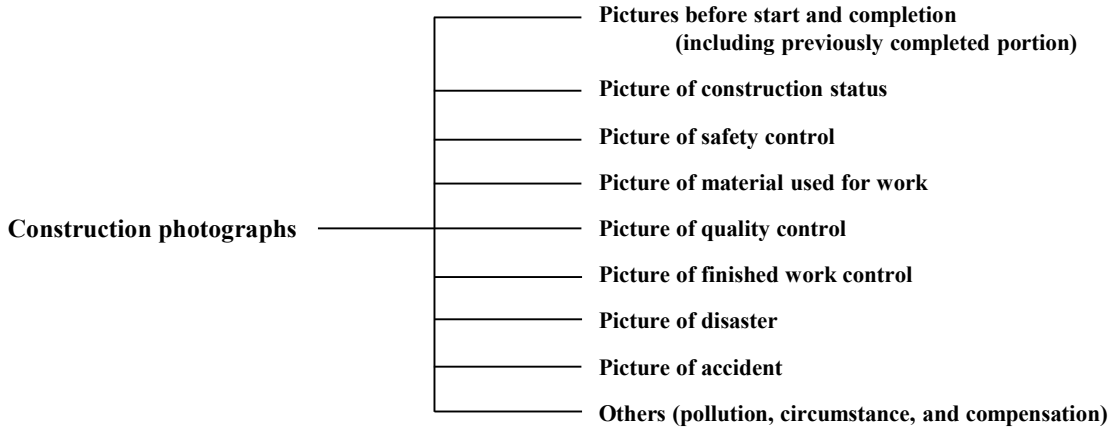


Figure 4-7 Classification of work photos (excerpt) in the Photo Control Standards.

4.2.4. Securing of Necessary Resources by Decontamination Business Operators

There were a number of issues faced by decontamination business operators in securing resources needed in the decontamination and related works ordered by the MOE in the Special Decontamination Areas. These issues and the methods for solving them are summarized below.

（1） Issues concerning radiation measurements

1）Procurement and operation of exposure dose measurement apparatuses for workers

External exposure dose of workers can be controlled based on measurements obtained using personal dosimeters (cumulative-type dosimeters or electronic dosimeters). Some decontamination business operators used an access management system and other systems related to the air dose distribution in the workplaces for exposure dose control. Measurements using whole-body counters (WBCs) were used for internal exposure dose control.

Decontamination business operators instructed each worker to wear personal cumulative-type dosimeters and to read the indications before and after the work day for measurement of the exposure dose for that day. The measured data were processed together with the information stored in the data base and used for personal exposure dose control.

On the other hand, individual workers are required to receive medical checks for ionizing radiation in decontamination and related works at the time of employment by the decontamination business operator or at the time of relocation, and periodically after that once in every six months. Internal exposure dose is measured by using WBCs or bioassays, or by evaluating measurement of the air-borne radioactive material concentrations. The WBCs installed in hospitals were used for the evaluations of community residents, too. Since the WBCs are costly, the MOE opened two WBC Inspection Offices, one in Minami-soma City and another in Naraha Town (this has since been moved to Tomioka Town).

The issues for decontamination business operators were the requirements: (i) to manage exposure dose control effectively for a huge number of workers, several thousand (1,000 to 6,000 people) per site; (ii) to manage screening processes of those workers which were concentrated exclusively at limited time spans of the day (lunch time, end of the day, etc.); and (iii) to handle a concentration of new workers and leaving workers at limited times of the year (for example, at the end of the fiscal year).

To cope with these issues, some decontamination business operators adopted a more efficient dose control system by mechanizing the screening equipment such as hand-foot monitors or the like by using IT tools. There was also a case in which one decontamination business operator donated a WBC to the local hospital and allowed it to be used for evaluation of local residents when not being used to evaluate the business operator's workers. Another decontamination business operator applied fingerprint authentication devices for its radiation control system (Fig.4-8).

Issues, however, remain in balancing cost and efficiency improvement by mechanization and automation in small-sized or short-term decontamination projects.

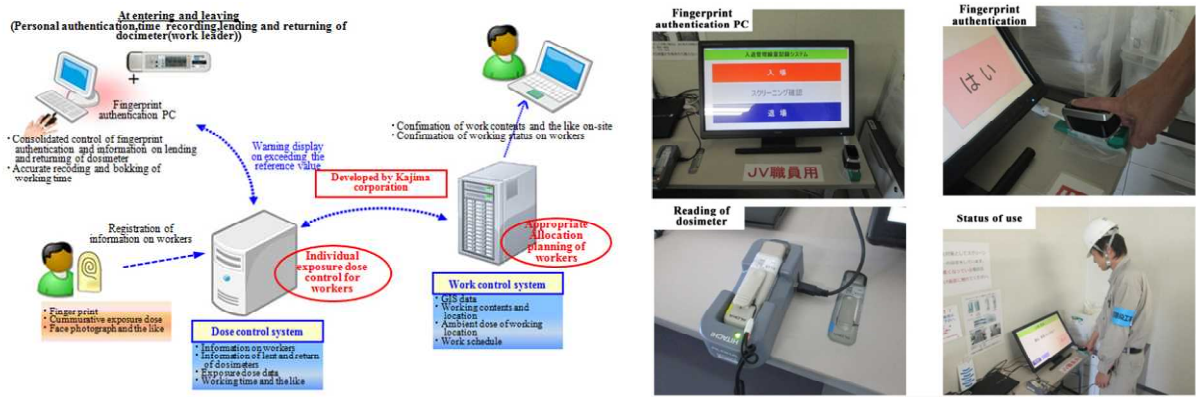


Figure 4-8 Example of radiation control using a fingerprint authentication device[102].

2) Measurement of air dose rates and other quantities

Scintillation survey meters were mainly used to measure air dose rates of gamma-rays and surface dose rates. GM survey meters were used to measure beta-rays emitted from the objects to be decontaminated in order to find the degree of the contamination of the surfaces and also to check the decontamination effects after decontamination.

Collimators were used in many cases in order to avoid the influence of background radiation from the surroundings, when using scintillation survey meters to measure the

[102]Source: Kajima Corporation (Figure 4-9 has the same source.)

degree of the contamination or to check the decontamination effects, and using GM survey meters to measure the surface contamination densities. For cases in which measurements were implemented without using collimators, these were for unstable places such as on walls or roofs where it was not possible to attach the collimators or there were risks of damage to the targets. Regarding the collimators, if they were used in the measurements before decontamination they had to be used in the measurements after it and vice versa.

The measurement positions must be known geographically which presents some issues.

- The conventional position measuring GNSS (global navigational satellite system; using a fixed type position checking apparatus) has good accuracy, but is bulky and so heavy that it requires two persons to carry it. On the other hand, the tablet-embedded global positioning system (GPS) is light and easy to handle, but it has poor accuracy and needs much time to locate the measurement points, especially for inaccurate data.
- One person reads the measurements while a second person records the data on paper or a tablet device. Such work flow is inefficient and has the risk of reading errors depending upon how proficient the persons are.

To cope with these issues, a wearable GNSS system was used by one decontamination business operator in measuring the air dose rates. The system had several advantages: (i) one worker instead of two was needed for measuring and recording data because the equipment weight was reduced to 1/5 that of the conventional apparatus and measured data were sent by a wireless transmitter to a recording unit; (ii) work efficiency was improved more than ten-fold by having a high-speed navigation system like that of a car-navigation system; and (iii) the progress of decontamination work can be visualized using the measured results and the geographic information system (GIS) (Fig.4-9).

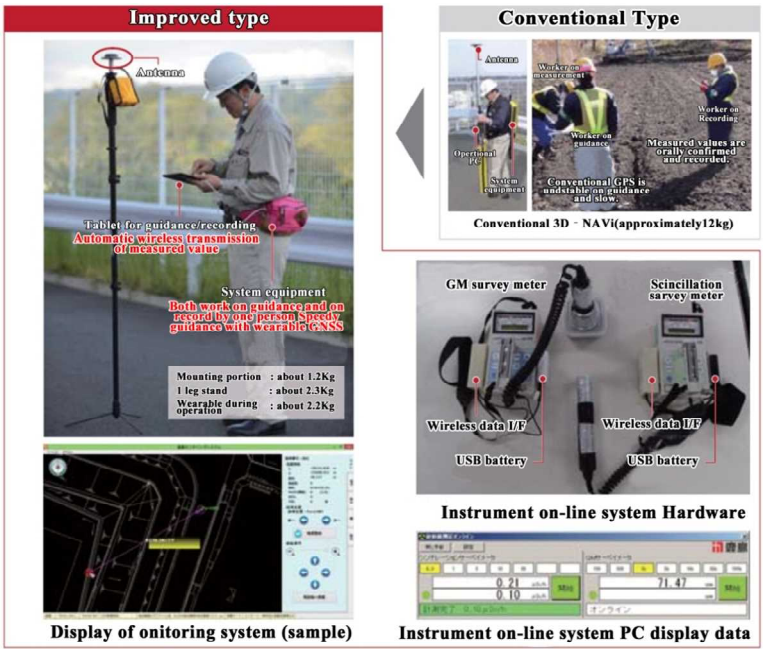


Figure 4-9 Example photos showing use of GNSS-based air dose rate measurement system.

(2) Materials and equipment for use in decontamination work

The "Decontamination Guidelines" requires tools be prepared that are necessary for decontamination and related works and for collection of removed soil and other wastes, depending on the decontamination target objects or work circumstances. Examples of decontamination tools for the work on structures like buildings are shown in Figure 4-10.

Restoration and reconstruction work from the damage by the Great East Japan Earthquake and ensuing tsunami (hereafter simply the "earthquake and tsunami") has been ongoing on the Pacific coast in parallel with the decontamination work. This situation sometimes caused problems to secure necessary quantities of special equipment to use in the decontamination work. Specifically, it became necessary to improve efficiency and to make a comparative study between the cost and effectiveness of special equipment, which is generally expensive. Second, equipment leasing companies showed reluctance to enter into lease contracts, being concerned about contamination of equipment by radionuclides, especially in the early days of the decontamination work.

One decontamination business operator was able to over these problems by using materials and equipment for ordinary general civil engineering work and to use agricultural machinery owned by local farmers; for the latter the decontamination business operator employed the farmers under a contract and used their agricultural machines for decontamination work.

Example of general equipment	Mower, hand shovel, grass sickle, broom, bamboo rake, dustpan, tongs, shovel, small shovel, metal rake, compact heavy machinery for scraping away topsoil, garbage bags (bags for burnable matter, burlap sacks for soil and sand (sandbags)), vehicles for transporting collected removed soil, etc. to the on-site storage location (truck, two-wheeled cart, etc.),ladder
Examples of equipment for cleaning with water	Hose, shower nozzle, high pressure water cleaner, brushes (scrub brush, brush for cleaning vehicles, brush for cleaning high places), scrubbing brushes (circular scrubber, steel wool brush, etc.), wire brushes, tools for pushing away water (broom, scraper, etc.), bucket, detergent, dustcloth, sponges, paper towels
Examples of equipment for cleaning metal surfaces	Brush, sandpaper, cloth, removing agents
Examples of equipment for cleaning wood surfaces	Brush, sandpaper, power sander, cloth, steam cleaner, water high pressure washer, tools for pushing away water (broom, scraper, etc.)
Examples of equipment for work in high places	Scaffold, mobile lift, aerial vehicle
Examples of equipment for scraping away	Grinding machine, equipment for scraping away, equipment needed to prevent dispersion (dust collector, curing mat)
Examples of equipment for covering the ground surface	Self-propelled surface compaction roller, plywood for surface compaction, sprinkling equipment

Figure 4-10 Examples of decontamination tools for work on structures like buildings[103].

[103]Source: Decontamination Guidelines (2nd Edition) (http://josen.env.go.jp/material/pdf/josen-gl-full_ver2_supplement1412.pdf) (Figure 4-11 has the same source.)

（3） Protective clothing, equipment and other items

The minimum suitable protective clothing, equipment and other items were used according to the Ionizing Radiation Ordinance for Decontamination and Guidelines of Ionizing Radiation Ordinance for Decontamination. By doing so, the amount of waste was limited by avoiding the excessive use of protective clothing, equipment and the like.

The Ionizing Radiation Ordinance for Decontamination and Guidelines of Ionizing Radiation Ordinance for Decontamination require that protective clothing, equipment and others be used depending on the radioactivity densities of the contaminated soil and the like, and the dust conditions (Table 4-8).

Table 4-8 Protective clothing, equipment and others[104]

	High contamination soil, etc. (exceeding 500 thousands Bq/kg)	Other than high contamination soil, etc. (less than 500 thousands Bq/kg)
High density dust work (exceeding 10mg/m3)	Entire body chemical protective suit over long-sleeved clothing (Tyvec etc.), rubber gloves (together with cotton gloves), rubber boots, dust protective mask with trapping efficiency above 95%	Long-sleeved clothing, cotton gloves, rubber boots, dust protective mask with trapping efficiency above 80%
Other than the above	Long-sleeved clothing, rubber gloves (together with cotton gloves), rubber boots, dust protective mask with trapping efficiency above 80%	Long-sleeved clothing, cotton gloves, rubber boots, dust protective mask with trapping efficiency above 80%

* Surgical masks, non-woven fabric masks and other practical masks also may be used when handling vegetation and leaf mold.

（4） Storage containers for removed soil and other wastes

Flexible containers and large sandbags of about 1m^3 capacity (dimensions: about 1.1 m in diameter by about 1.1 m in height) (hereinafter referred to as “flecon bags”) were mainly used as storage containers in the decontamination and related works in the Special Decontamination Areas ordered from the MOE. Durable materials were used for long-term storage (a few years) and for storing removed soil containing much water. Selection of containers was based on characteristics, weight, storage duration, etc. of the removed soil and other wastes. Examples of flecon bags include cloth-type containers (for one-time use) with a weather-resistant inner bag, running-type containers (for repeated use), and large weather-resistant sandbags with an inner bag (Figure 4-11).

Currently used are, as specified in the Common Specifications (7th Edition), those products which meet the specifications of “Flexible Containers Based on the Decontamination Guidleines” by the Japan Flexible Container Industries Association, the “Layer Stack Method Design and Construction Manual for Weather-resistant Large Sandbags” by the Public Works Research Center, and are certified by official test organizations, as meeting the performance standards required for materials and container bags.

[104]Source: Ionizing Radiation Ordinance for Decontamination and Guideline on Ionizing Radiation Ordinance for Decontamination (http://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000029897.html)

Type	Photograph	Characteristics
Flexible container (cloth-type)*1		• The assumption is that they will only be used once. • Not as good as the running-type in terms of weather resistance and waterproofness. • Some have improved weather resistance as a result of UV treatment and the like, while another type has improved waterproofness as a result of being lined with inner pouches and having an inner coating, etc.
Flexible container (running-type)*1		• The assumption is that they will be used by having soil repeatedly stored in and removed from them. • Outstanding weather resistance and waterproofness
Large sandbag	 *2	• Water permeable. • Some have improved weather resistance as a result of UV treatment and the like, while another type has improved waterproofness as a result of being lined with inner pouches, etc.

*1: Pursuant to JIS Z 1651.
*2: The photograph shows a weather resistant container.

Figure 4-11 Examples of flecon bags and large sandbags.

The Common Specifications stipulate that removed soil and other wastes generated in the decontamination work in the Special Decontamination Areas are to be stored in either of the following nine groups (i) to (ix).

- Combustibles:

  (i) Vegetation (pruned branches, fallen leaves, lawn grass, moss, weeds, litter layers, trimmed trees, roots, etc. Attached soil should be removed to the extent possible).
  (ii) Other combustible wastes (Tyvek coveralls, disposable work clothing, masks, filters, rubber gloves, paper, etc.)

- Incombustibles, mixtures:

  (iii) Soil and others (soil, gravel, small stones, etc. Vegetation should be removed to the extent possible.)
  (iv) Concrete and other materials (tiles, bricks, blocks, rocks, etc.)
  (v) Mixtures with asphalt
  (vi) Other incombustibles and mixtures (except dangerous objects, hazardous materials)

- Dangerous objects, hazardous materials

  (vii) Architectural material including asbestos
  (viii) Plaster boards
  (ix) Other dangerous objects, hazardous materials

The Common Specifications require that the tags attached to flexible containers and other similar containers be made of materials with corrosion resistance, weather resistance, good durability and not hazardous and the required information about contents, etc., should be machined into the tag surface so that it is legible for at least three years under the combined conditions of decontamination work, and transfer to and storage at temporary storage sites; finally the tags should be identified by color according to the individual contents.

Table 4-9 Correspondence between contents and tag colors[105].

	Color	Content
A	White	Soils, etc. (earth, small stone, gravel, etc.)
B	Green	Corruptive combustible material (pruning branch, fallen leaves, lawn, moss, weed, litter layer, trimmed tree, uprooting, etc.)
C	Yellow	Combustible material (Tyvec, waste clothe, mask, filter, rubber gloves, paper, etc.)
D	Blue	Incombustible (concrete, etc. (tile, bricks, block, rock, etc.), mixture with asphalt, sludge, etc.)
E	Black	Incinerated ash
F	Red	Dangerous article (Material including asbestos, soils polluted hazardous material)

There was a case in which one decontamination business operator developed a Quick Register (QR) code system and applied it for efficiently processing the information below as the decontamination work progressed:

- Read selectively necessary items and input dose data with a handy type input machine;
- Transfer the information to a small printer and issue the QR code; and
- Export the data to the decontamination information system in the format of a delivery.

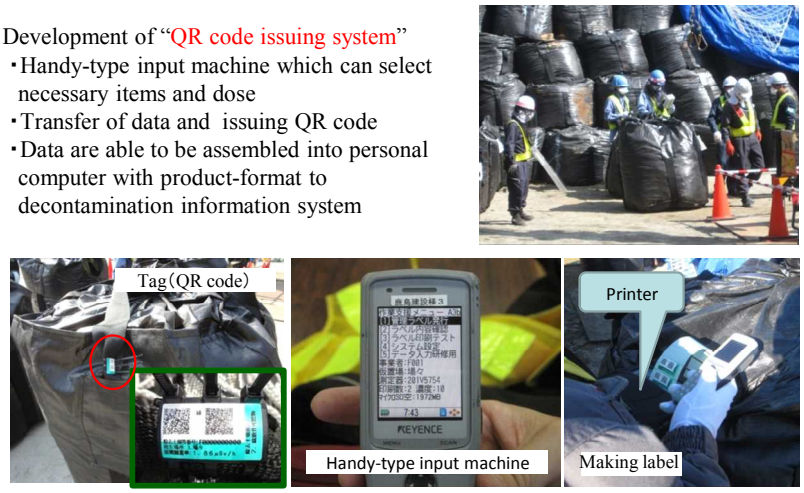


Figure 4-12 Examples of QR code issuing system[106].

(5) Issues associated with supervisors, skilled workers (with qualifications), and decontamination workers

Decontamination experts were quite limited among managers and employees (foremen and workers) of decontamination business operators. Also persons who were knowledgeable about radiation were limited. Quite a few workers had no field experience in civil engineering or construction work and they lacked knowledge about industrial health and safety practices, which was quite fundamental at such workplaces. The issue then was to provide education about basic work safety practices.

Some decontamination business operators had their own personnel educate the workers while the personnel themselves were learning about the topics, or the operators had the

[105]Source: Decontamination Project Common Specifications (7th Edition) (http://tohoku.env.go.jp/fukushima/to_2014/data/0410ba.pdf)
[106]Source: Kajima Corporation (Figure 4-14 has the same source.)

workers learn by actually doing the decontamination work.

To secure necessary numbers of decontamination workers with suitable qualifications, the rising market wage was an issue, too. This is because of the ongoing restoration and reconstruction work in parallel with the decontamination work on the Pacific coast from the damage by the earthquake and tsunami. In particular, the issue regarding decontamination workers was not only the big workforce required, but also the changing demand of workforce with the progress of decontamination work as illustrated in Figure 4-13. Some decontamination business operators, while emphasizing recruitment of local workers, tried also to acquire workers from prefectures outside Fukushima.

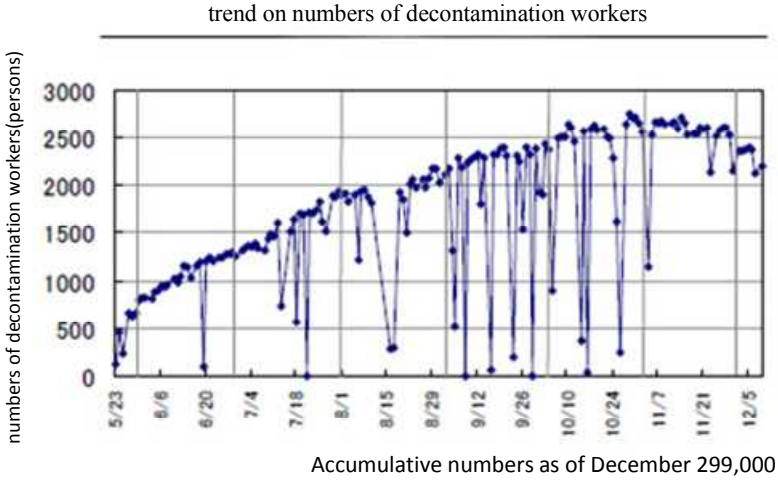


Figure 4-13 Monthly change of workforce (Example)[107].

[107]Source: Okumura Corporation (Figure 4-15 has the same source)

（6） Accommodation facilities for workers

The issue for a large number of the decontamination workers was to secure daily commuting means (limited available routes and subsequently, traffic jams) from outside the Special Decontamination Areas, since all the residents had been evacuated and all existing accommodation facilities and the like were not in service. Overnight stays are generally not allowed in the areas to which evacuation orders are being prepared to be lifted, but they were exceptionally allowed if needed for reconstruction. There was a case, in which accommodation facilities for workers were exceptionally built in the Special Decontamination Areasthrough coordination with the local municipality and the Nuclear Emergency Response Local Headquarters.

Some difficulties faced were as given below.

- Need to increase the capacity of accommodation facilities for increased number of workers subject to the work progress.
- Concerns of local residents about workers coming from outside and possible worsening of public morals (expressed as opposition to building the accommodation facilities).
- Opposition from the local residents when building an accommodation facility for those workers who were decontaminating a site different from their own municipality. Time loss by commuting over a long distance was another difficulty in this case.
- Traffic congestion along the route between the accommodation facility and the work site during commuting times.

To cope with these difficulties, the following measures were taken by some decontamination business operators.

- Making school buildings and public facilities, etc. the earliest decontamination targets so that they could be used as accommodation facilities close to the work site.
- Having local municipalities provide a piece of land in their possession to decontamination business operators for the purpose of building an accommodation facility for workers.
- Prioritizing contracts with local workers who can commute from their own residences.
- Implementing institutionalized patrols of accommodation facilities.
- Taking measures to mitigate the commuting burden by providing commuter buses, operating them on a time-shifted schedule (time-shifted duty hours of workers) and other means.

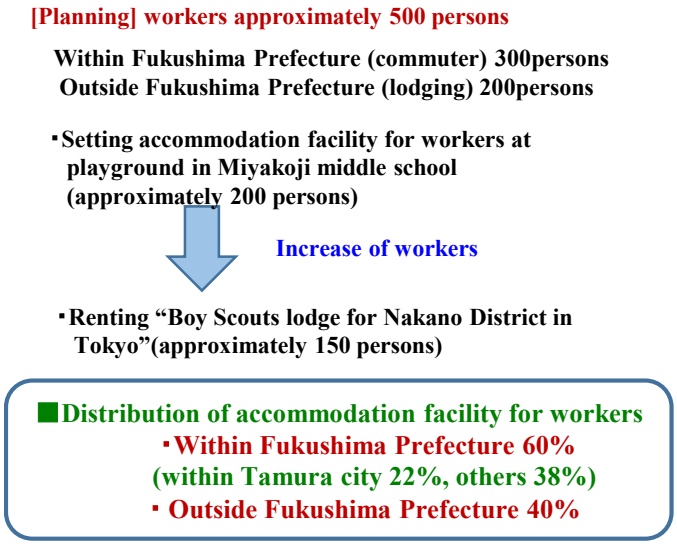


Figure 4-14 Example to secure accommodation facilities for workers (plan and result).

Figure 4-15 Example of an accommodation facility for about 350 workers.

（7） Processing of household wastes, foods, water, etc.

Special Decontamination Areas include the places damaged by the earthquake and tsunami. In such places, some of the infrastructures are still not available, including roads, water supply and sewerage systems, general waste treatment facilities, etc. and business activities such as retailing have been halted since the residents were evacuated.

In the usual situation, each business operator is responsible for disposing wastes produced by workers (lunch boxes and other garbage). However, general waste treatment facilities, industrial waste treatment facilities and sewage treatment facilities were out of service, having been damaged by the earthquake and tsunami and not restored. Neighboring treatment facilities had to bear the load instead, but their treatment capacities were exceeded. Consequently, the decontamination business operators were asked in the early stage to treat the garbage and sewage by themselves. In a later stage, the government, the ordering party, exchanged information with local treatment facilities, in which the amount of sewage and wastes was predicted together. Measures were jointly taken to coordinate the balance sheet of the volume to come from the decontamination work plan and the processing capacities of treatment facilities in order to avoid adverse impacts from the activity.

Regarding meals and water, an independent rest house was set near the working site of decontamination activities from the viewpoint of radiation protection. Workers were strongly instructed to stay inside the rest house while eating meals and drinking water, not outside on the decontamination site. If a rest house was not available, they were instructed to eat and drink inside a vehicle.

4.3. Acquisition of Residents' Consent

This section describes the efforts made in advance surveys, acquiring consent, and after-action reporting, and presents the challenges identified through these processes by the ordering party (MOE) and business operators for decontamination work in the Special Decontamination Areas.

4.3.1. Efforts Made by the Ordering Party (MOE)

In implementing decontamination and other related works, the MOE tried to acquire prior consent of stakeholders such as residential land owners (people who have the right to claim the authority to prevent the decontamination and other related works from being taken for the target objects to be decontaminated such as land, structures on it, or standing trees or other fixtures rooted on it) with regard to the details of said works.

In Tamura City, advance surveys and consent acquisition activities could start ahead of other municipalities. The MOE personnel involved themselves in the advance survey and consent acquiring initiatives. The knowledge and experience they obtained were applied and reflected in activities in other municipalities. Since the MOE personnel who could be allocated was limited, the advance surveys and consent acquisition were commissioned to private operators for cities other than Tamura City. The MOE personnel took the role to confirm the results of the commissioned work.

（1） Advance surveys

After collecting and organizing the relevant information on land, houses, etc., advance surveys of properties (field surveys) were performed prior to conducting the decontamination work.

1）Collecting and ordering information on land and houses

Stakeholders were identified, using such sources of information as real estate registers, land and house records, house drawings and land lot maps, and the relevant information was collected about land and houses by marking residential boundaries (on a land owner basis) and buildings onto maps and aerial photographs.

A great deal of effort was needed in solving the following issues for confirmation with the cooperation of local municipal personnel, local district officers, land planning unions, etc., in organizing the relevant information on land, houses, etc.

- Some house drawings were very old or did not exist.
- A particular stakeholder could have more than one piece of land and more than one house. It took time to consolidate registered owners to one name for identifying what properties were actually owned by that particular stakeholder.
- There were diverse cases with complicated relationship of rights, possibly because of inheritance: more than one owner had the right to one piece of land; registered information had not been revised after the death of stakeholder(s); a person or persons different from the registered owner(s) used and managed a piece of farmland for agricultural activities. In particular, it took much time to identify stakeholders and acquire their consent in a situation in which the stakeholders were not living at the site.

2）Property surveys prior to decontamination work

It was necessary to identify in the document of consent the target objects to be decontaminated by photos, drawings and other means. Therefore, decontamination business

operators conducted radiation monitoring surveys and damage surveys of buildings as part of their advance property surveys (field surveys) ahead of the drafting of the document of consent prior to decontamination work.

Decontamination methods to choose depend on the target object to be decontaminated and, the materials and state of the object's surfaces. As part of the radiation monitoring survey, measurements were made at selected points which could represent each target object to be decontaminated in the survey area.

It was necessary to confirm with the stakeholders the status quo of buildings and other properties prior to conducting the decontamination work. Given that they might have been completely or partially destroyed, or partially damaged due to the earthquake and tsunami, the state of damage to each building was visually inspected by qualified architects or emergency risk assessment officers, and photo records were prepared for each building subject to decontamination.

Prior consent was needed to enter the private land for advance property surveys (field surveys) ahead of decontamination work and the surveys could be conducted only where it had been granted.

(2) Drafting the document of consent

Personnel of the MOE or a private business commissioned for acquisition of consent prepared the "Building Current Condition Diagram," which used photos to explain to each stakeholder the appearance of buildings and damage conditions, and the "Decontamination Plan," which showed the buildings and the scope of land subject to decontamination and the decontamination methods to be used.

Figure 4-16 Example Decontamination Plan[108].

(3) Arranging special considerations, visiting the site

Upon drafting the document of consent, the stakeholder(s) was (were) invited to the site,

[108]Source: "On-site explanation of the Decontamination Plan and request for understanding of implementation for decontamination work" (http://www.katsurao.org/uploaded/attachment/6.pdf) (Figure 4-17 to Figure 4-18 have the same source.)

where the drafted document of consent was explained and the scope of the decontamination work was checked against the actual property. The stakeholder(s) was (were) then consulted on any special conditions for decontamination, the items that they wanted to include in the living spaces for decontamination (e.g., shrines built by ancestors on a nearby hill, mountain streams, access paths thereto, etc.) and the items that they did not want to decontaminate (gardens with garden trees and moss that had important personal meanings to the stakeholder(s)). Once all these were arranged, they were appended as special conditions in the draft document of consent (if necessary, the contents in the draft document of consent were revised).

（4） Acquisition of consent

When the stakeholder(s) could confirm the contents of the "Building Current Condition Diagram" based on its explanation using photos, the appearance of the buildings and the damage conditions, they were asked to sign and affix their personal seal to the "Current Conditions Report" (Figure 4-17). Further, when the consent was obtained to implement decontamination work in line with the scope of the target buildings and land and the decontamination methods thereof set out in the "Decontamination Plan" (including special considerations), stakeholders were asked to sign and affix their personal seal to the "Decontamination Implementation Consent Form" (Figure 4-18).

Stakeholders were asked to sign and affix their personal seal to the consent forms at the site, but in some cases follow-ups were needed when they wished to consult with their family or neighbors. There were also cases, in which their consent could not be obtained due to dissatisfaction with decontamination methods or other reasons.

Figure 4-17 Example of Current Conditions Report.

Figure 4-18 Example of Decontamination Implementation Consent Form.

(5) Post-work reports

Upon completion of the decontamination work, a post-work report was made on the work results based on the decontamination implementation plan. Post-work radiation monitoring was carried out immediately after the work completion in order to prepare for checking afterward whether the decontamination effect was maintained. With this, the decontamination work was considered to have been completed, but radiation monitoring was carried out thereafter on an ongoing basis.

In the meantime, sometimes difficulties arose with stakeholders originating from gaps between their expectations and the realities of decontamination work. Basically, these gaps in understanding should be solved through resident briefings and the decontamination consent acquisition processes, but actually there were cases which could not be solved; radioactive cesium could not be completely removed due to the conditions of the land in use and the limitations of decontamination methods used, or complete recovery was not possible after topsoil removal of agricultural land or the felling of ornamental garden plants. The following are some typical examples of issues raised by stakeholders from these gaps in understanding.

- There were locations where radiation doses did not decrease even after the decontamination work had been done.
- Some areas were not decontaminated, which included steep slopes and the like.
- No decontamination work was done if radiation doses were low before the work.
- Trees and branches were not cut down.
- Tiles were not replaced with new ones.
- Decontamination work did not recover the land to the condition suitable for commercial agriculture use.
- Unwanted household goods were not removed as trash.
- Houses damaged by the earthquake and tsunami were left as they were being

contaminated by radioactive materials. They should have been dismantled and removed, since they could not be used.

If decontamination work were to be done beyond pre-defined standards at the request of particular stakeholders, such exceptional service could impact the implementation of the entire decontamination project in terms of the relationships with other stakeholders. Steps were taken for work supervisors themselves, not the decontamination workers, to listen to the stakeholders' claims, consult with MOE supervisors on decisions and leave a record of the decisions, in order to ensure consistent and rational decisions concerning the project as a whole.

4.3.2. Efforts Made by Decontamination Business Operators

Tamura City could undertake advance surveys and consent acquisition activities ahead of other municipalities, as described before. The MOE personnel involved themselves in these activities, and the knowledge and experience they obtained were then used and reflected in the work in other municipalities. In some other cases, private entities commissioned by the MOE carried out advance surveys, field surveys and consent acquisition activities prior to the decontamination work ordered by the MOE.

（1） Advance surveys

In some cases, private entities (e.g. entities having measurement technologies or IT/data processing technologies) carried out advance surveys upon consignment by the MOE, before decontamination work in the Special Decontamination Areas was started upon order of the MOE. In one example, the data relevant to land and houses were processed, using GIS technologies in the procedures shown below. By creating a database, the next steps of field surveys and preparation and distribution of the document of consent were carried out more efficiently.

- Creating ortho-images for the target area, with roads, coverings, vegetation, land and house outlines in a scale of 1/1,000.
- Assigning building management numbers for each building on housing maps.
- Creating residential boundaries (in units by land ownership) using ortho-images and lot number maps.
- Extracting the lot numbers of buildings from existing lot number maps, and matching them with housing tax master maps to compile building data and attribute data[109]

（2） Field (site) surveys

In some cases, private entities (e.g. entities having GIS technologies) implemented field (site) surveys, upon consignment by the MOE, before decontamination work in the Special Decontamination Areas was started upon order from the MOE .

Some entities used PDAs (personal digital assistants) equipped with GPS and input map information in advance into the PDAs so that on-site the survey workers could more efficiently input any additional information obtained as they conducted their field surveys[109].

（3） Consent acquisition activities

There were also cases where the MOE commissioned private businesses (for example, environment consulting companies) to conduct consent acquisition activities in parallel with the decontamination work ordered by the MOE[110].

Specifically, private business firms commissioned by the MOE conducted the following activities under the guidance and supervision of the MOE Fukushima Office for Environmental Restoration.

- Notifying stakeholders of the results of advance survey activities.
- Investigating views on methods for local briefings and other procedures in relation to consent acquisition.
- Arranging schedules for local briefings.
- Acquiring consent from stakeholders for decontamination work.

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[109]Source: Asia Air Survey website "Environmental Rehabilitation Assistance Efforts" (https://www.ajiko.co.jp/dl/pdf_tf2014/p12-15.pdf)

[110]Source: Namie Town "Request for Cooperation in Acquiring Consent for Kitatanashio Administrative District Decontamination Work" (http://www.town.namie.fukushima.jp/site/shinsai/20140501-01.html)

4.4. Communication with Local Residents and Local Municipalities

This section presents an overview of challenges, means for solving them, measures taken, etc. with regard to communication between the MOE, decontamination business operators, local residents, local governments, etc. in relation to the decontamination work ordered in the Special Decontamination Areas by the MOE.

4.4.1. Securing Temporary Storage Sites

Securing temporary storage sites involved a number of challenges and much time to settle, as it required the understanding of landowners and local residents in order to proceed. This was the same in Intensive Contamination Survey Areas as it was in Special Decontamination Areas. The following challenges were encountered in securing temporary storage sites.

- Questions over why TEPCO or the National Government did not receive soil and other things removed.
- Concerns over the safety of temporary storage sites.
- Concerns about the possibility that the temporary storage sites would end up being used as disposal sites without such an agreement having been finalized.
- Doubts that even if a temporary storage site was necessary, it would be used for storing soil removed from other areas, too.

The MOE investigated the feasibility and coordinated the use of state-owned land for temporary storage sites, and there were cases in which national forests were used as temporary storage sites. But in many cases, that was not practical. Many state-owned forests are designated by the Forest Act as forest reserves for conservation. In order to use this land as a temporary storage site, relevant documents describing the state of trees and the current state of the forest would have to be examined and necessary procedures would have to be taken to remove the land from designated forest reserves for conservation. Such procedures needed a great deal of time and cooperation between relevant organizations. Furthermore, since the state-owned forests are generally mountainous, construction work was needed to flatten the land and new access roads needed to be developed and improved in some cases. It took a very long time to prepare for use of a state-owned forest as a temporary storage site. Furthermore, much of the secured land was sloped, resulting in less area available for storage. In other cases, no sufficient place other than the constructed temporary storage site was available for treating trees felled during construction and cut vegetation. Thus, the available area for storing was reduced.

4.4.2. Launching of the “Decontamination Dial 110 (Hotline)” to Receive Information about Questionable Decontamination Work

A contact point has been established to receive information by telephone or online from local residents upon witnessing decontamination work that they suspected to be inappropriate (hereafter refferd to as the “Decontamination Dial 110 (Hotline)”).

The MOE checks the information received, issues cautions to decontamination business operators if the information is correct, and provides explanation on handling of the matter on its homepage.

4.4.3. Efforts Made by Decontamination Business Operators

The following issues were encountered in communication between decontamination business operators and local residents or local governments in conducting decontamination

work in the Special Decontamination Areas ordered by the MOE.

- It was important not only to reduce air dose rates in the living spaces by decontamination work, but also to mitigate or remove the concerns of residents through sincere risk communication.
- There were many occasions where it was impossible to move forward unless the cooperation of local residents and local governments was available.
- People could not be sure how much radiation dose rates would drop under the MOE decontamination specifications, because there were no specific target values (standards) for radiation dose rates after decontamination.
- There were requests not related to decontamination made at the time of site visits prior to the decontamination start.
- Residents could not be present on the decontamination site when the decontamination work was ongoing. It was thus important for decontamination business operators to be trusted to carry out the items properly as agreed in advance at the time of site visits (no improper decontamination work).
- Reluctance of owners to let construction companies from outside of the area conduct decontamination work.
- Indefinite terms for operating the temporary storage sites under unclear site conditions.
- Mass media and other news sources did not necessarily convey a complete picture of decontamination activities, or the detailed considerations of decontamination business operators when dealing with the local community.

In response, efforts as described below have been taken by decontamination business operators (Figures 4-19 to 4-28).

- Pursuing residents' understanding of the decontamination specifications through site visits prior to the decontamination work start. MOE personnel joined the advance site visits, and sincerely explained to them what could be done and what could not be done.
- Presenting relevant information on homepages and in town papers jointly published in cooperation with the town staff, as part of information disclosure on work status and progress; these presentations were done with the consent of the ordering party.
- Supporting local checks by residents (e.g., decontamination workers carried elderly residents to site checks).
- Opening resident consultation windows and call centers for decontamination work matters, and sincerely responding to requests and questions from residents.
- Arranging site visit tours of decontamination work in each district of a town where all townspeople had evacuated.
- Providing a "common room (chatting room)" and "public restroom for townspeople"who returned home on a temporary basis to the evacuation area.
- Responding sincerely to residents who came to observe the work upon request and permission.
- Eliminating anxieties of residents by making the staff visible and accessible.
- Communicating on a regular basis, building a relationship of trust through a build-up from small things.
- Volunteering to remove snow for home-bound elderly people in areas with heavy snowfalls.
- Holding social gatherings such as rice cake making or golf tournaments for residents living in temporary housing.
- Participating in, supporting and sponsoring events held in the area.
- Conducting "blue light" (voluntary) security patrols.
- Conducting patrols with safety patrol vehicles (including checks of litter), and patrolling villages and residences.
- Installing traffic safety banners at dangerous curves and narrow roads as traffic safety measures.

- Decorating fences enclosing temporary storage sites with photos or having high school students draw pictures in order to improve the image of the temporary storage sites.
- Installing banners on roads in the decontamination work area, indicating that the decontamination work was being carried out.

Figure 4-19 Removing concerns by face-to-face communication with responsible staff[111].

Figure 4-20 Goodwill exchange with local residents (example) [112].

Figure 4-21 Call center (example)[113].

Figure 4-22 A town paper jointly published with the town staff (example).

Figure 4-23 Homepage (example).

[111]Source: Taisei Corporation
[112]Source: Obayashi-Gumi Corporation
[113]Source: Maeda Corporation (Figure 4-22 to Figure 4-24 have the same source.)

- **Institutionalizing a dedicated safety management system and patrol activities**
- **Institutionalizing a dedicated safety management system with executive class members of 3 JVs for proper safety and decontamination works**
- **Daily patrols by the system members**
- **Regular patrols by the personnel of head office and branch offices**

【Flow of safety patrols by the system members】

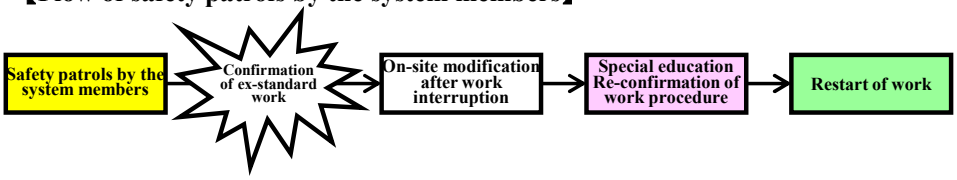


Figure 4-24 Dedicated safety management system (example).

A"Blue light" security patrol car

Departure for security patrol

Security patrol by the personnel including former Fukushima Prefectural Police Department personnel as key members (Appreciation prize awarded on December 28, 2012 and December 27, 2013)

Figure 4-25 "Blue light" (voluntary) security patrol (example)[114].

- Monthly security patrol (1st and 3rd Friday)
- Area to patrol: Prefectural and national highways, wide area agricultural roads

In-village patrol
- Area to patrol: Katsurao village (crushing facilities and others)
- Frequency: Sunday, all day long

Residence patrol
- Dormitory for decontamination workers to patrol: 4 places
- Frequency: Monday to Sunday, unscheduled patrol twice a day, from evening to mid-night at dormitories

Security patrol car

Litter checks

Patrol route in a village

Security monitoring at a dormitory for decontamination workers

Figure 4-26 Safety patrol (example)[115].

[114]Source: Taisei Corporation and Maeda Corporation
[115]Source: Okumura-Gumi Corporation (Figure 4-27 has the same source)

A banner for safe driving (in Katsurao village)
- 21 banners at 9 places on 3 nearby highways
- 30 banners at 14 locations on village roads/forest roads

- Traffic safety moral-up campaign: Monday to Wednesday of the first week every month
- Traffic safety campaign week: attendance at the patrol departure of the Tamura Police Station (September 20)
- Traffic safety flyer (September 27)

Traffic safety banners in poor-sighted curves (Shikiihata district)

Traffic safety banners in narrow roads (Oozasa district)

Traffic safety moral-up campaign

Traffic safety campaign week: patrol departure

Figure 4-27 Traffic safety banners and activities to encourage good driving manners (example).

Paintings on loading and unloading places for the temporary storage site
Paintings on the fences for the sandbags working place for volume reduction as part of decoration

Figure 4-28 Decorating fences surrounding temporary storage sites with colorful photos and drawings (example)[116].

4.4.4. Provision of Wide-ranging Information to Local Residents, and related activities

In moving forward with decontamination projects in the Intensive Contamination Survey Areas, in addition to the Special Decontamination Areas, it was absolutely necessary to respond to all kinds of concerns and frustrations of local residents about the decontamination methods and work, and concerns about safety and other issues with regard to establishing temporary storage sites. The MOE cooperated with Fukushima Prefecture and set up the "Decontamination Information Plaza" in January 2012, near Fukushima Station, in order to disseminate relevant information on decontamination and radiation and to provide an operation base for experts to carry out informational activities. The Decontamination Information Plaza has been promoting communication with local communities by providing various exhibits and pamphlets, arranging workshops or opinion exchange meetings, dispatching registered experts to local governments or communities upon request, or responding to consultations from the local residents. The MOE has also made efforts to facilitate people's understanding through its website (Decontamination Information Site (in Japanese): http://osen.env.go.jp) and a call center, and through information dissemination via the mass media.

In JFY2014, the MOE joined in an advertisement project "Thanks, Helmet" arranged by the "ONE Fukushima" program by eight local mass media entities (newspapers, TVs and radio broadcasting) in Fukushima Prefectre. This project was planned in order to eliminate

[116]Source: Maeda Corporation

negative image toward the decontamination work and decontamination workers, and to facilitate the understanding of local residents toward decontamination. In the project, "Thanks messages" being addressed to decontamination workers were solicited, mainly from evacuees of Futaba District (Gun) and school pupils in Koriyama City (elementary schools and junior high schools). The messasges expressed and conveyed their feelings of thanks and support to the decontamination workers. Those messages were distributed to the decontamination workers in a form of stickers to be attached to their helmets (more than 1,000 messages were collected and more than 3,000 decontamination workers received them). Many decontamination workers expressed their willingness to return their messages. They responded in the form of sending large poetry cards with their return thanks messages, donating planters, volunteer service of paining playing equipment, etc. to the schools. The activities were widely disseminated through mass media in the prefecture. The project could facilitate motivating the decontamination workers and raising their morales through heart-warming communication with local residents and children.

4.5. Project Management Executed by Decontamination Business Operators

Decontamination business operators encountered various issues in implementing decontamination and related works in the Special Decontamination Areas, upon orders being placed by the MOE. The problem solving approaches taken by the decontamination business operators and the ideas behind them are outlined below.

4.5.1. Schedule Control

There are snowbound areas in winter season in the Special Decontamination Areas. In such areas, no decontamination works is scheduled during snowbound months because there are special difficulties as listed below.

- Big uncertainties cannot be avoided in air dose and surface dose density measurements in snow-covered environment.
- The quality of decontamination work may drop due to difficulty in confirming the effectiveness of the work results in a snow environment.
- The efficiency of surface soil removal work, weeding or other tasks drops because weeds are knocked down by the snow.
- Snow may attach to the soil and other things removed, and the added moisture causes an increase in weight and volume.
- Snow and ice melt when the temperature increases in temporary storage sites and the water content oozes out and accumulates in the sites. Volume changes of the filled bags at the sites will occur and may damage the cover sheets and other things.
- Transportation by trucks on the slopes to the temporary storage sites in mountainous or hilly locations becomes impossible, and removed materials, which should be transferred to the temporary storage sites, must be left in the work areas.

Also when it rains more than a preset amount, the decontamination work is halted, because rainfall causes uncertainties in air dose and surface dose density measurements; removed materials may be carried away or swell and increase in weight; water contents ooze out and accumulate in the temporary storage sites; rainwater accumulates in the temporary storage sites once the temporary cover sheets are removed for bringing in new waste materials, etc.

The project schedule had to be managed in consideration of those days when decontamination work could not be done due to adverse weather conditions. Beside weather conditions, following issues arose for schedule control.

- Decontamination work should be completed the soonest in the living spaces.
- There would be delays in obtaining residents' consent and securing temporary storage sites.

- Responses would need to be made to requests to complete decontamination of shrines and graveyards before mid-August for O-bon.

Examples of measures to meet these conditions by one decontamination business operator were:

- Intensive deployment of large workforce.
- Workforce control depending on the decontamination work progress.
- Schedule control subject to the request of the local communities.

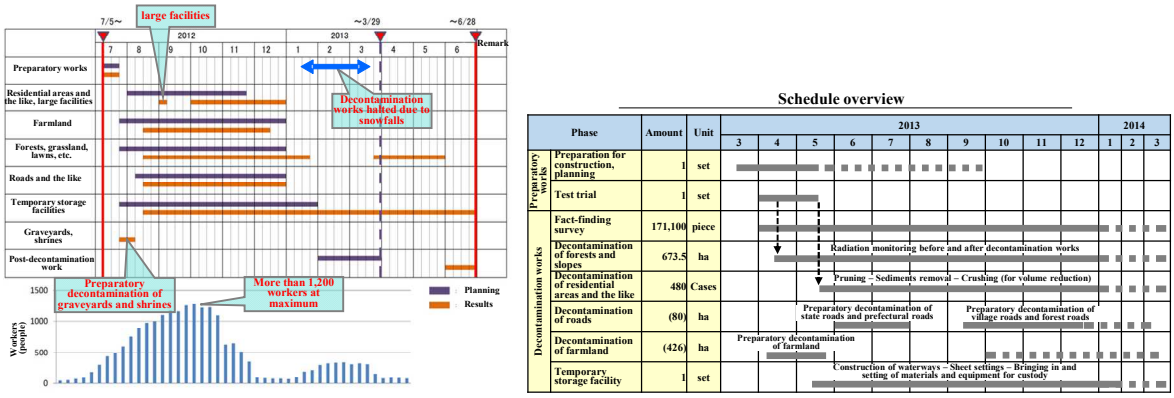


Figure 4-29 Example of decontamination schedule[117].

4.5.2. Operational Framework for Decontamination Work

As was mentioned briefly in Chapter 4.2.4 (5), the issues encountered in the decontamination operation include:

- Large workforce of thousands (1,000 to 6,000) needed at one work site[118].
- Workforce management depended strongly upon the schedule and progress of decontamination works.
- Rapid turnover of workers.
- Qualities of workers.
- Obtaining the radiation exposure history and health conditions of workers upon recruiting them.

For instance, there was a case in which the daily maximum number of workers needed was 1,200, far above the planned workforce at the beginning as shown in Figure 4-31, in the decontamination work for an area with about 120 houses in a residential area, about 1,300,000m^2 of farmland, about 1,900,000m^2 of forests and about 96 km of roads. In such circumstances, the decontamination business operator took such measures as follows.

- Promoting recruitment of local workers.
- Employing local farmers (utilizing agricultural machinery already in their possession).
- Recruiting workers nationwide.
- Providing periodic and continuing education of new workers for the field work.
- Providing full medical check-ups at designated hospitals with costs paid by the primary contractor.

[117]Source: Kajima Corporation and Okumura-gumi Corporation (Table 4-30 has the same source.)

[118] Examples: About 2,700 workers were needed at the peak in a site of about 17,000,000 m^2 for decontamination work (about 470 houses as well as farmland, roads and other items were included), while about 3,000 workers were needed in a site of about 14,000,000 m^2 (including about 1,270 houses) or about 2,200 workers in a site of about 8,300,000 m^2 (including about 1,180 houses).

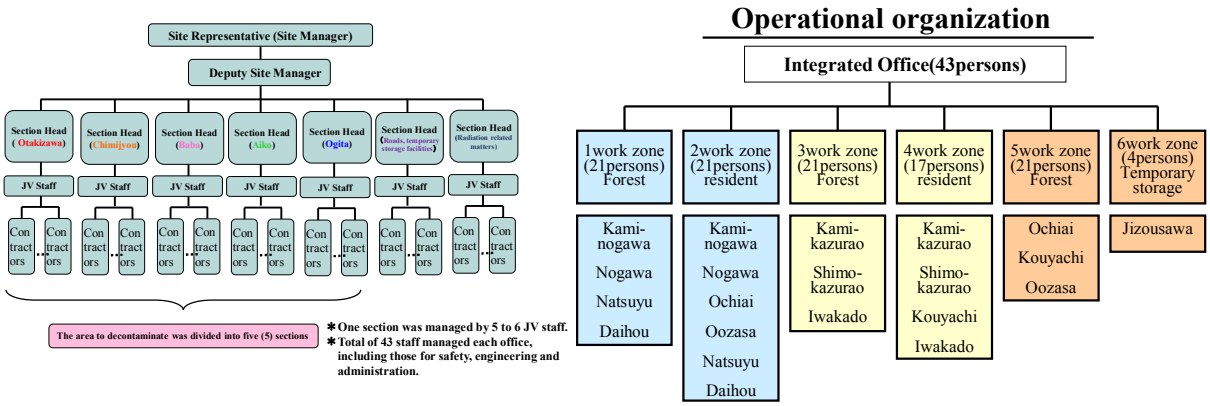


Figure 4-30 Example of operational framework for decontamination work.

[Planned] total workforce: about 70,000
The site divided into five (5) sections.
About 100 workers per each of five sections,
totaling about 500 workers at daily maximum

- **Difference in workload is outstanding in forests and others**
- **Small transfer to vehicles for transport (hand carry, by machines)**
- **To keep the goal of "completing decontamination by the yearend"**

[Record] total workforce: about 120,000
The site divided into five (5) sections.
Daily maximum of 1,200 workers deployed for the site.

Figure 4-31 Example of recruiting and deploying workers (plan and result)[119].

Figure 4-32 Example of employing local farmers[120].

[119]Source: Kajima Corporation
[120]Source: Obayashi Corporation

4.5.3. Sharing of Information and Safety Precautions

One issue was how the relevant information and safety precautions could be shared completely between many contractors and the large number of workers involved, not only with the primary contractors (some of which were Joint Ventures (JVs)) and their personnel. The complete sharing of relevant information between relevant organizations was also a challenging issue. An example to solve such issues can be found in the following case for one decontamination business operator.

- Information sharing meetings were periodically held with relevant organizations concerning the decontamination work, its progress and other relevant information. Participating organizations were: the MOE Fukushima Office for Environmental Restoration, local municipalities, the Labour Standards Inspection Office, police and fire stations, and the primary contractors (JVs).
- Plenary or separate morning assemblies and daytime assemblies were regularly held for thorough dissemination and sharing of information at different levels between the primary contractors (JVs), subcontractors and individual work sections.

Progress review meetings

The project progress was regularly checked and relevant information was shared between the Fukushima Office for Environmental Restoration, Naraha Town, the Tomioka Labour Standards Inspection Office, Futaba Police Station, and the relevant decontamination business operators.

Figure 4-33 Photo taken at a project review meeting[121].

[121]Source: Maeda Corporation

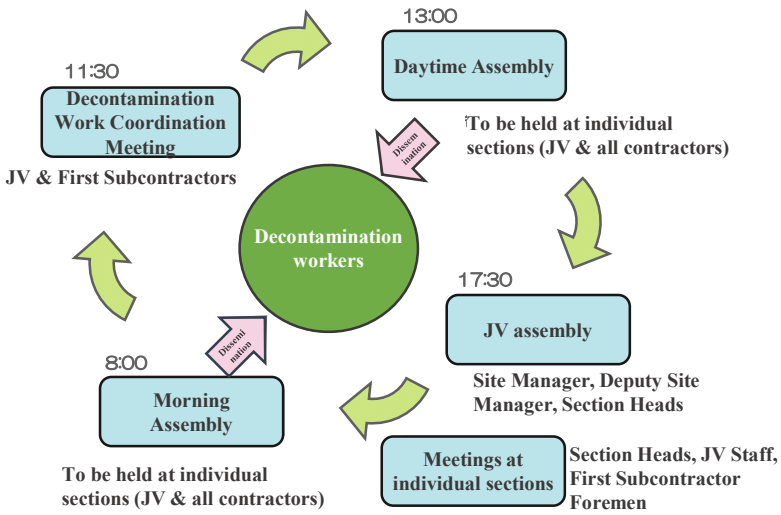


Figure 4-34 Example flowchart of dissemination and sharing of information and safety precautions[122].

Some decontamination business operators prepared specific work procedures for decontamination workers to refer to during actual work. These work procedures elaborated on the decontamination methods presented in the Decontamination Guidelines, technical specifications and other relevant documents. The work procedures also provided information concerning, not only the decontamination skills, but also the supervising responsibilities of decontamination business operators, application methods of materials and equipment of decontamination work, safety checks and precautions to be taken, and responses to be taken in an emergency or unusual situations, etc.

These work procedures are updated based on experience and knowhow obtained from the actual decontamination work. When updated, actions are taken to disseminate the new information to the decontamination workers on the job (for instance, holding a meeting for disseminating and sharing the information).

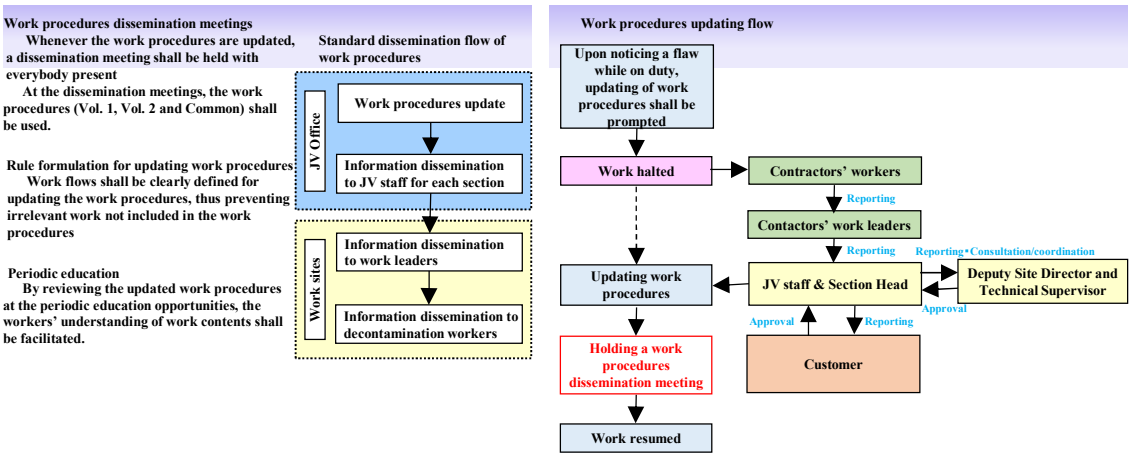


Figure 4-35 Example flowchart of information dissemination and sharing of updated work procedures[123].

[122]Source: Kajima Corporation
[123]Source: Maeda Corporation

4.5.4. Hiring and Separation Management of Workers

In the hiring and separation management (upon recruitment and upon separation) of workers, the decontamination workers are required by law, as mentioned earlier, to receive internal exposure measurement for radiation protection and exposure control before and after the employment by the decontamination business operators. For the internal exposure measurement, the whole body counters (WBCs) installed by the MOE were available at no charge to the workers and decontamination business operators.

Newly employed workers are to receive basic and special education upon beginning the decontamination work, including:

- To recieve internal exposure measurements by a WBC.
- To receive eduction about decontamination and related works by using educational slides, DVDs and the like.
- To receive education on and learn the matters concerning safety principles, safety rules and the like through lectures given by JV safety personnel at the site office.
- To learn specific work procedures through attending the work procedures dissemination meetings held at the site office, assembly halls, or the like.

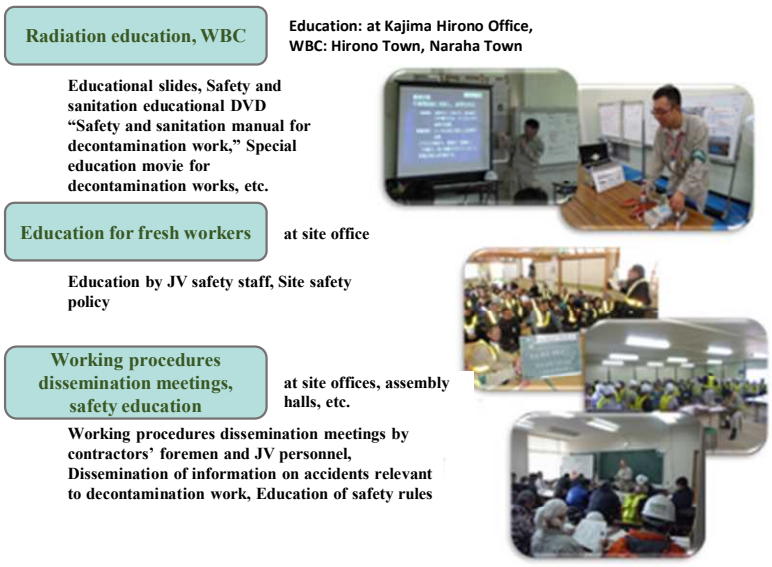


Figure 4-36 Example flowchart of education flow for decontamination workers[124].

4.5.5. Protection from wildlife

Concerns about protecting from wildlife also existed. There were cases in which decontamination business operators removed beehives and had to prepare protective equipment and medications in advance, or they consulted with the municipal offices for how to deal with livestock such as cows that had been abandoned by owners when evacuation orders were given.

[124]Source: Kajima Corporation

4.6. Radiation Protection Measures

4.6.1. Ionizing Radiation Ordinance for Decontamination

As mentioned earlier, the Ministry of Health, Labour and Welfare (MHLW) issued the "Guidelines on Prevention of Radiation Hazards to Workers Engaged in Decontamination and Related Works" on December 22, 2011, as the measures required to ensure the safety of workers, in combination with the Ionizing Radiation Ordinance for Decontamination (The Guidelines were partly amended on June 15, 2012.). The Guidelines specify the following: personnel subject to exposure dose control; methods of control administration of exposure dose measured; measures to decrease exposure dose; measures to prevent contamination from spreading; measures to prevent internal exposures; education for workers; measures to ensure health; and safety and sanitation management system.[125]

In the decontamination work, radiation protection measures are provided to the decontamination workers pursuant to the Ionizing Radiation Ordinance for Decontamination. The MOE arranged the following measures in order to ensure that decontamination workers and operators observed those measures set in the Ionizing Radiation Ordinance for Decontamination.

- Holding workshops for potential decontamination workers.
- Stipulating in the decontamination order contract the condition that the decontamination business operators must observe the Ionizing Radiation Ordinance for Decontamination.
- Preparing methods to estimate necessary expenditures and reserve budgets for necessary equipment for radiation protection.
- Requiring decontamination business operators to include relevant descriptions concerning technological concepts of workers' radiation protection in the decontamination plan documents when applying for National Government work under direct jurisdiction of the MOE.

In the meantime, the decontamination business operators took the following measures for radiation protection.

- When designating a new decontamination work area, the air dose was measured before workers engaged in the decontamination work. If micro hot spots were recognized, they were clearly so indicated by markings or setting fences, or the access to the hot spots was controlled.
- Where the air dose rate exceeded the level to cause 50 mSv/y, the workers were instructed to wear full-face masks, protective clothing and other items in order to prevent dust containing radioactive materials from attaching to the workers.
- In work areas, where the air dose rate was below the level to cause 50 mSv/y, too, workers were instructed to wear half-face masks.

4.6.2. Surface Contamination Inspection (Screening)

The Ionizing Radiation Ordinance for Decontamination obligates decontamination business operators to conduct surface contamination inspections (screening) in order to prevent contaminants containing radioactive nuclides from being brought out from the work areas.

The difficulty in the actual screening operation was to conduct the screening inspections for a large number of workers, particularly at some specific time periods (lunch time, at the end of the day, etc.). There was a case in which the screening process was automated for better efficiency and worker-power saving at the times for breaks, lunch or the end of the day.

In measuring the surface contamination densities, as mentioned in 4.1.3 (5) 1), it is required to use surface radiation contamination survey meters which meet the performance

[125]Source: Ministry of Health, Labour and Welfare (MHLW), Guidelines for Prevention of Radiation Hazards for Workers Engaged in Decontamination and Other Radiation Works (June 15, 2012)

requirements and other conditions specified in JIS Z 4329 and the measured data by such survey meters are to be recorded as the counting rate (cpm). In reality, however, the data varied among measurement devices depending on their respective measurement efficiencies and areas of measurement.

Screening facility at the Tomioka Town gymnasium (place for recess)

Finger print authentication device

Figure 4-37 Photos of workers undergoing automatic screening[126].

4.7. Education and Health Care for Decontamination Workers

4.7.1. Education of Workers

Decontamination work does not usually require ordinary workers to be highly experienced or have special skills; although it is true that only certified workers with particular qualifications or skills may be engaged in operating heavy machinery for carrying heavy objects or scraping soil off, transferring wastes, etc., or for tasks done at high places using aerial lifting equipment, such as needed in washing and wiping processes for roofs and others.

But even ordinary workers are required to understand the basics of decontamination and follow the pre-determined working procedures. Otherwise, the expected decontamination effects may not be obtained, the decontamination effects may even drop, the amount of materials to remove may increase or even trouble may take place with the local residents. Furthermore, it was foreseen that most of these ordinary workers had no prior experience in decontamination and lacked knowledge or experience in radiation protection.

Before the Great East Japan Earthquake, ordinary citizens in Japan did not usually have knowledge of radiation nor were they familiar with decontamination. It was impossible to secure a large workforce consisting of workers who had had experience and knowledge about radiation and decontamination.

Certain qualities are also required of decontamination workers, not only their availability in large numbers. Education was the only way to foster knowledge about decontamination and promote the necessary qualities among the workers. Before commencing decontamination works, the decontamination business operators provided new workers with basic and special education pursuant to the Ionizing Radiation Ordinance for Decontamination. In addition, workshops, training and other activities were periodically held about safety as well as daily morning activities on risk potential prediction and mutual checks of protective equipment before commencing the day's work. Other activities included collection of success stories and failures in order to develop the workers in broad areas. The decontamination business operators promoted special education smoothly and easily using educational movies on the YouTube produced by the MHLW for decontamination and related works. Workshops on

[126]Source: Kajima Corporation

decontamination work arranged by the Fukushima Prefectural Government and MOE for the workers and work leaders also facilitated the education activities done by the decontamination business operators.

Education activities should be repeated. Decontamination methods and knowhow of site works are improved day by day. Successful experiences as well as failures, near-miss cases and other experiences from work sites were used for ensuring safety through periodic education opportunities after decontamination work was started by new workers. A system was developed that allowed supervisory personnel to check on-site that each worker took notes when attending the education activities, submitted reports after workshops and recorded their attendance at the educational programs on their worker ID cards.

The following are examples of educational programs conducted for decontamination workers[127].

[127]Source: Maeda Corporation (Figure 4-38 to Figure 4-44 have the same source.)

（1） Educational programs upon beginning the jobs

1）Safety education for newly employed workers

Safety education for newly employed workers included: explanation of the jobs to do using flowcharts, safety policies at the work place; basic rules of safety and sanitation; activities relevant to safety and sanitation; safety rules when on duty; instruction to be checked using the WBC; and items to consider with respect to residents.

	Program	Key contents
1	Confirmation of employment contract	Confirmation of the company to belong to, minimum wages, special duty allowance, medical checks
2	Outline of the jobs	Explanation of an outline of jobs to do
3	Safety policies at the working place	Explanation of safety policies at the working place Prevention of falling down Prevention of minor collision between men and heavy machinery Prevention of minor collision between men and mowers Radiation and health cares Other related topics
4	Basic rules of safety and sanitation	Explanation of basic rules of safety and sanitation Consideration to give to local residents Dose measurements and contamination inspections Safety equipment Practice to carry Identification Card and armband Information on work plans and work procedures Smoking, eating and drinking Responses to take when injured Traffic rules
5	Activities relevant to safety and sanitation	Explanation of activities relevant to safety and sanitation
6	Tidiness and order	Explanation of the rules to keep working places tidy and in order
7	Risk potential prediction “KY”	Explanation of the process to predict risk potential for sharing KY: an acronym of “Risk potential prediction” in Japanese)
8	Harmonization with the community	Explanation of consideration to give to local residents
9	Safety rules on duty	Explanation of “22 musts in safety rules” which assembled the cases experienced and the results found during patrol for each of selected cases
10	Instruction to receive WBC checks	Instruction of receiving the WBC check and considerations to give.

Figure 4-38 Example program of safety education for newly employed workers.

2）Safety and work education

Safety and work education is conducted by: (i) clarifying concrete work procedures and key items to ensure safety at the workplace; and (ii) providing a safety manual, which collected cases of experience and results found during patrols and compiling the information into "mandatory workplace safety rules."

2. Working policy at workplace
Provide sufficient qualities to meet expectations of the customer and local communities in reliability, credibility and satisfaction by the work with due consideration to the environment. The work is based on the concept of "Quality first" and "Customer first" with the fundamental philosophy of "Grasp the customer's credit by the work in good quality." Achieve zero disaster over the whole period of work by upgrading motivation of the personnel and workers toward safety

Key execution items for safety at the workplace

1. Prevention of falling down
- **To secure the safe working floor and to wear a safety belt and fall arresting devices/equipment for a fixed rope (Brand name Rolip, for instance) when working at an elevated place.**
- **To fix the ladder and to prohibit a stepladder**

2. Prevention of minor collision between men and heavy machinery
- **To designate the "Keep out" zone around the machine operation area before commencing the work**
- **To arrange a traffic controller and a guard**

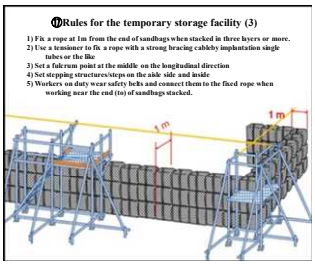
3. Prevention of minor collision between men and mowers
- **To keep out of the dangerous zone (5m from the mower, 15m between mowers)**
- **Mutual calls of attention**

4. Radiation control and health care
- **To wear dust masks**
- **To practice gargling, hand washing**
- **To practice routine conditioning of body rhythm**

5. Not to give any concerns to the local people

Figure 4-39 Example chart of work policy posted at a workplace.

Safety rules for decontamination	
①Rules for drags for cart wheels	⑪Rules for scaffold elevators (1)
②Rules for construction vehicles (1)	⑫Rules for scaffold elevators (2)
③Rules for construction vehicles (2)	⑬Rules for using stepladders
④Rules for working with heavy machinery	⑭Rules for using roof Rolip and fixed ropes (1) (note) Rolip (a brand name of fall arresting device/system for a fixed rope)
⑤Rules for access to heavy machinery	⑮Rules for using roof Rolip and fixed ropes (2)
⑥Rules for the temporary storage facility and others	⑯Rules for water supply
⑦Rules for unifying wireless (voiced) call signs	⑰Rules for the temporary storage facility
⑧Rules for working shoes	⑱Rules for garbage trucks
⑨Rules for using knives	⑲Rules for seat belts when using construction machinery of vehicle type
⑩Rules for using mowers	⑳Rules for iron plate floors for cranes



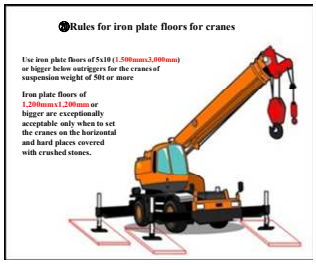


Figure 4-40 Example chart of safety rules for decontamination work.

3）Dissemination of information on work plans and work procedures

Work procedures are based on manuals for individual tasks and disseminated at meetings for that purpose.

4）Proper decontamination education

Education for items to note in proper decontamination is conducted at the start of a new job as well as at the time of regular safety education.

5）On-site education

For better understanding by workers, practical training is implemented on-site.

Figure 4-41 Photo of workers getting practical training at a work site.

6）Other related matters

Special education for decontamination work, which is legally compulsory, is conducted based on the "Materials for Special Education on Decontamination and Related Works" (Compiled by the Health Measures Office for Ionizing Radiation Workers, MHLW), separate from the education for newly employed workers. Theoretically, respective contractors should provide such education to their workers, but the primary contractors (JVs) directly provided it to all workers as their responsibility.

Newly employed workers wear a special band on their helmets for the first week of work for easier identification; and responsible personnel and work leaders promote continuous education and training.

Figure 4-42 Photo showing a newly employed worker wearing the special helmet band for easier identification.

（2） Periodic safety education program

Through providing periodic safety education opportunities, workers are reminded repeatedly about safety-related items and a safety mindset is strengthened by repeating the items to note, checking seasonal concerns (e.g., freezing in winter) and exchanging opinions on safety among workers.

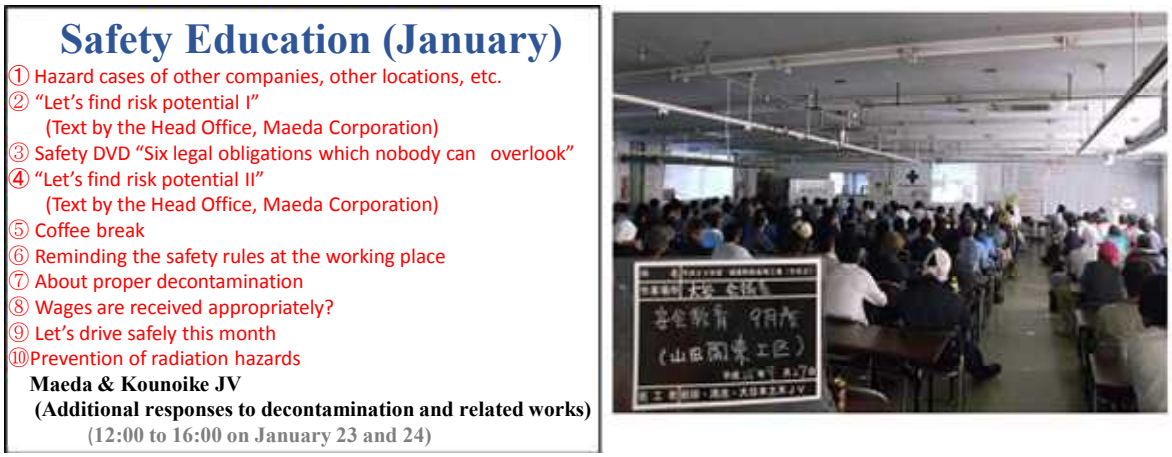


Figure 4-43 Example of a periodic safety education program.

Issues in providing education for workers included the following.

- Among managers and other employees on practical level (foremen, workers) of the decontamination business operators, there were few decontamination experts who could be instructors. There were also few persons who were knowledgeable about radiation and could be instructors.
- Quite a few workers had no field experience in civil engineering or construction work. Education on basic safety management, which is quite common at such work places, was also needed.
- Safety education of workers was especially important, because the work environment could not be simplified or made uniform due to the size and diversity of the work areas, for instance, house roofs, forests, slopes, roadside embankments, etc.
- A large number of workers had to be educated.

To cope with such difficulties, the following efforts were made by decontamination business operators.

- The decontamination business operators' personnel were engaged in educating workers while learning themselves.
- Education was conducted every day to a group of about 100 workers.
- Engagement of the decontamination business operators' personnel themselves in decontamination work functioned as an effective education system.
- Merit awards were given to conscientious workers.
- Video films or other illustrated materials were used for facilitating easy learning.
- Group leader training was practiced as the best model group. This training facilitated decreased quality differences among groups and improved skills of the leaders.
- Periodic meetings were organized to exchange opinions between group leaders.
- Periodic study meetings were organized for workers.
- Patrols and inspections were made by the quality manager and model group leaders.

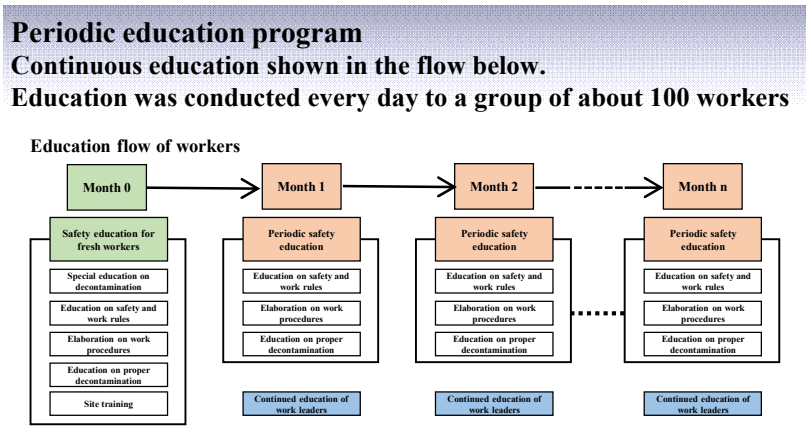


Figure 4-44 Example flowcharts of educational programs for decontamination workers.

◆ Education by using video films and illustrations for easy learning

Education is provided to all workers whenever fresh workers join, or work contents or working areas are changed, by using video films or illustrations which elaborate on work procedures in an easily understandable manner. Decontamination procedures are well disseminated to the workers because the materials are compiled in an easily understandable manner.

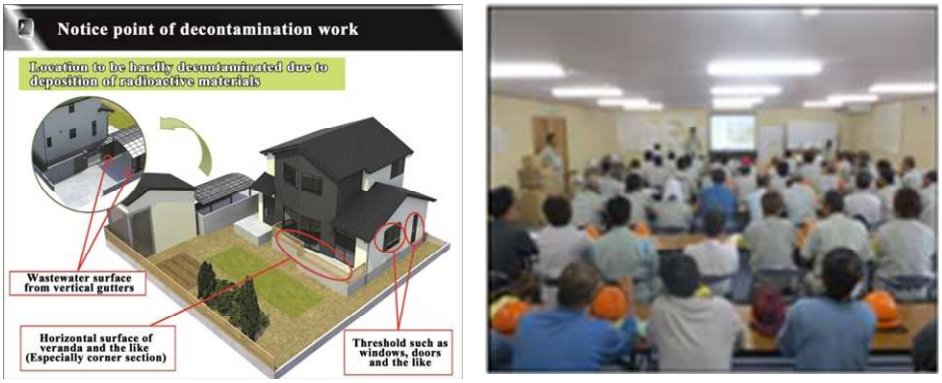


Figure 4-45 Example of an education session for decontamination workers by using video films or drawings[128].

Figure 4-46 Example scenes of safety activities[129].

[128]Source: Shimizu Corporation
[129]Source: Maeda Corporation

4.7.2. Morale and Conscientiousness of Workers

Decontamination work is more or less similar to cleaning work, being different from ordinary civil engineering or construction work to build structures. Decontamination workers cannot easily get the pleasure of achievement obtained by producing something or completing construction of something. It is a concern that decontamination workers may be demoralized in conducting huge numbers of boring tasks while paying attention to radiation protection. Such factors may cause deterioration in the quality of the decontamination work.

On the other hand, decontamination workers were encouraged by the responses of local residents to the outcome of decontamination work such as weeding, soil scraping or soil replacement. In such decontamination work, the apparent changes led to the people's positive responses: "Fields looked nicer after decontamination"; or "Fields helped me recover hope to return home, when weeds fully covering the fields were removed and the surfaces of rice fields and dry fields became visible after decontamination.

In the earlier stage of MOE decontamination works in the Special Decontamination Areas, the needs of the decontamination workforce were limited and a significant portion of decontamination workers were local residents under contract. They had high morale and were conscientious with clear aims to decontaminate their own land. It can be said that they brought about good tension in the work groups.

One decontamination business operator placed importance on sharing empathy with the local residents and developing teamwork spirit among decontamination workers. The operator took the following measures in order to upgrade the quality of decontamination work by clearly identifying the objective of the work as recovering environmental conditions for the residents to return home.

- Expressing strong hopes toward restoration by placing banners in public places.
- Reading slogans about the decontamination work out loud, with all workers responding, at daily morning assemblies.
- Encouraging mixing with other work group members at safety campaign events.
- Facilitating understanding of the construction workers (primary contractor's personnel, secondary contractors' personnel and other workers) toward restoration by having them live in the area to be decontaminated and arranging for them to mix with the local people.

Figure 4-47 Banners expressing hope and progress toward restoration of the area[130].

[130]Source: Taisei Corporation

Figure 4-48 Photos showing daily morning assemblies with reading of a slogan and response by all workers[131].

4.7.3. Personal Exposure Dose Management for Workers

For external exposure dose management, some decontamination business operators used, besides personal dosimeters, the access management system and other systems connected to the air dose measurement in the workplaces. Specifically, individual workers wore personal dosimeters, and read the indication before and after the day's work for measurement of the exposure dose for that day. The measured data were processed together with the information stored in the database and used for personal exposure dose management.

For internal exposure dose management, WBCs were used. Decontamination workers are required to receive periodical medical checks for ionizing radiation when engaged in decontamination and related works as well as the WBC measurement for internal exposure management. Decontamination workers are also required to receive such checks upon employment, upon transfer to different work locations and every six months. The measured data were processed together with the information stored in the data base and used for personal internal exposure dose management.

Figure 4-49 illustrates the results of personal cumulative exposure dose of decontamination workers in decontamination model projects in the Difficult-to-return Area (the area where it is expected that the residents have difficulties in returning for a long time). The decontamination model projects in the Difficult-to-return Area were conducted in Futaba Town and Namie Town where the air dose rate before decontamination had been as high as the level to cause about 50 to 100 mSv per year. Protective measures were taken such as not to have particular individuals work in high dose areas for a long time. Consequently, the maximum average personal exposure was 71.5 μSv/d over the work period of September 1, 2013 to February 22, 2014. This shows that, even if the person continues to work under similar conditions for 240 days (the average work days per year), the cumulative personal exposure dose would be 17.2 mSv, not exceeding the legally set annual dose limit of "100 mSv per five years AND 50 mSv per year."

[131]Source: Shimizu Corporation, Maeda Corporation

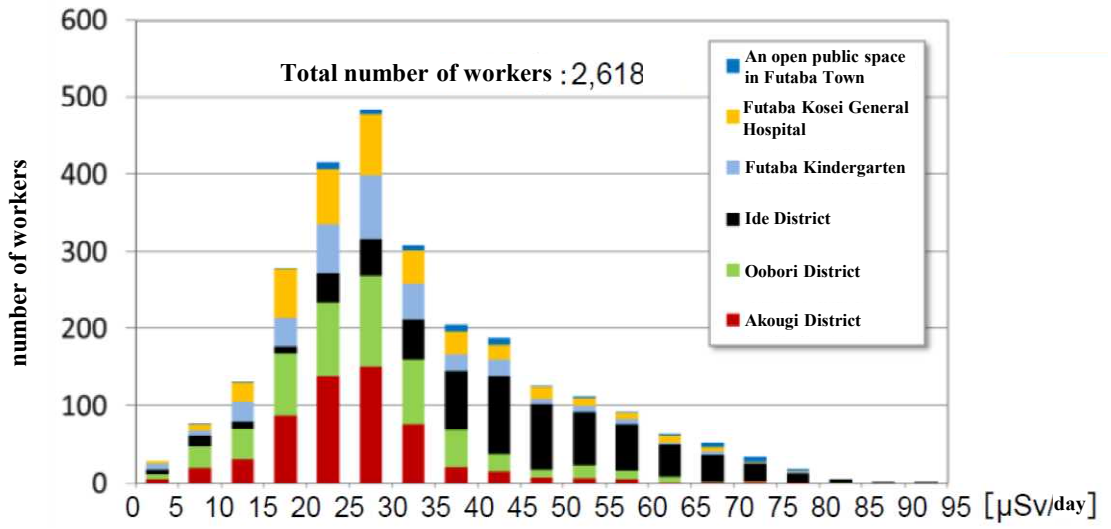


Figure 4-49 Example graph showing personal cumulative exposure dose of decontamination workers(From the decontamination model projects in the areas where it is expected that the residents have difficulties in returning for a long time)[132].

4.7.4. Medical Checks for Ionizing Radiation and Use of Whole Body Counters

The MOE opened two WBC Inspection Offices, one in Minami-soma City and the other in Naraha Town (having been moved to Tomioka Town) in order to make sure that workers of the decontamination business operators received WBC measurements before and after employment.

[132]Source: Ministry of the Environment (MOE), Results of decontamination model projects in areas where it is expected that the residents have difficulties in returning for a long time (June 10, 2014) (https://josen.env.go.jp/area/model2.html) (in Japanese)