Commentary

Environmental Remediation Cost in Fukushima Area
−Trial Calculation Using the Unit Cost Factor Method−

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Environmental remediation in Fukushima must be pursued in an appropriate and timely fashion using the right resource allocation and with a clear idea of the overall costs. A highly accurate cost estimate for the remediation of Fukushima cannot currently be made because appropriate methods for the decontamination of the target areas as well as treatment and disposal of the resultant soil and waste have yet to be determined. The latest findings should be applied so that the accuracy of rough estimates for the overall costs can be gradually improved. Given this, the Cleanup Subcommittee of the Atomic Energy Society of Japan (AESJ) has developed its own basic scenarios for trial calculations performed based on the announced workflow for the environmental remediation and the relevant unit costs. More specifically, the soil removed in the decontamination process was delivered to either interim storage facilities or controlled disposal sites depending on the level of contamination. An additional scenario involving restricted reuse was also considered. The approximate costs for these basic scenarios amounted to between 6 and 9 trillion yen.

I. Scope and Method for Estimating the Environmental Remediation Costs

1. Goal

A trial calculation was carried out for the areas contaminated by the disaster that occurred at the Fukushima Daiichi Nuclear Power Plant to roughly estimate the overall costs that would be incurred in conducting the decontamination, treatment, and storage offsite (i.e., outside the premises of the power station), thereby establishing basic case studies for the cost estimate. The decontamination of the target areas is aimed at reducing the annual dose rate to 1 mSv. A rough estimate of the overall costs was made for all zones with an annual dose rate of 1 mSv or more, while taking into consideration any treatments and disposal necessary to reduce the dose rate. In each zone with an annual dose rate of between 1 and 5 mSv, the decontamination efforts are focused only on those areas that have a high level of contamination (spot contamination) rather than the entire zone.

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2. Scope of Estimate

The cost estimate covers soil, specified waste (e.g., sludge from the water supply and sewerage systems specified in the Act on Special Measures concerning the Handling of Pollution by Radioactive Materials), and other waste materials produced by the total decontamination of areas with an annual dose rate of 5 mSv or more, which are mostly distributed throughout Fukushima, as well as that produced by the spot decontamination of areas with a rate of between 1 and 5 mSv. The scope of calculation extends from the decontamination process through to storage in industrial waste disposal sites (controlled disposal sites) or interim storage facilities, excluding final disposal after interim storage.

3. Estimation Method

The estimated overall costs were classified into decontamination costs, treatment costs, and storage costs. Based on the unit cost factor method, the cost of each item was calculated as a product of the unit cost and the quantity before being totaled according to the classification system to obtain a total figure for each category. The estimated cost items are presented in **Figure 1**.

The unit cost factor method is commonly used for estimating costs. In the early 1980s, the United States adopted this method to produce simple estimates of the costs involved in decommissioning. Later, the Nuclear Energy Agency (NEA; part of the Organisation for

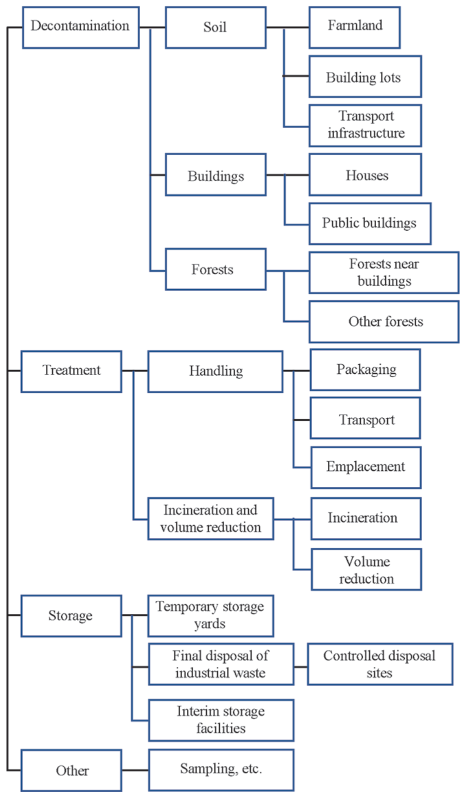

Figure 1 Estimated cost items

Economic Co-operation and Development (OECD)), the International Atomic Energy Agency (IAEA), and the European Union established and adopted an international standard for expense structures to enhance the accountability and transparency of decommissioning costs. In the mid-1980s, Japan adopted this method for estimating the costs involved in carrying out demolition work during the decommissioning process.

The accuracy of an estimate made using the unit cost factor method can generally be enhanced by applying more detailed and precise quantities and unit costs for more segmented cost items.

II. Scenarios for Waste Treatment

In this cost estimate, waste treatment is conducted in accordance with the Treatment Workflow for the Specified Waste and Other Waste Materials Produced by Decontamination [1] which was established by the Japanese Ministry of the Environment (MOE), (hereinafter referred to as the "MOE's workflow"). The following original policy was additionally instituted.

1. Waste Disposal Sites and Classification Thresholds

MOE sets forth key radiation thresholds for treating the specified waste and soil and any other waste materials produced during the decontamination process in the MOE's workflow. Thresholds of 100,000 and 8,000 Bq/kg are clearly specified for the storage of the specified waste. The workflow stipulates that any soil removed during the decontamination process shall be transported to either interim storage facilities or controlled disposal sites via temporary storage yards without any particular thresholds. The only exception is soil that can be incinerated. A safety assessment was conducted to verify the possibility of using storage for waste that clears the abovementioned threshold of 8,000 Bq/kg, which corresponds to an annual dose rate of 1 mSv or less for workers who work at a disposal site under normal waste treatment conditions throughout the operation period [2]. In this estimate, the soil and other waste materials produced in the decontamination process were assigned a threshold of 30,000 Bq/kg for radioactive cesium to decay over the course of 30 years to the level of 8,000 Bq/kg. Overall, the following thresholds were assigned (**Figure 2**).

- 100,000 Bq/kg: Lower limit for interim storage facilities
- 30,000 Bq/kg: Upper limit for controlled disposal sites

If soil and other waste materials within the range of between 8,000 and 100,000 Bq/kg are stored together at one disposal site in accordance to the MOE's thresholds, it would require rigorous monitoring for as long as 90 years or so [3] for waste to reduce the concentration of 100,000 Bq/kg to a level below 30,000 Bq/kg. As a solution, an original scenario was adopted for the decontamination and segregation of waste with a concentration of no more than 30,000 Bq/kg from that of 100,000 Bq/kg or greater. More specifically, any soil and waste materials produced during the decontamination process that have a concentration of no more than 30,000 Bq/kg are stored at controlled disposal sites for radioactive cesium to decay over the course of 30 years to a level below 8,000 Bq/kg, which is the storage period maintained by interim storage facilities. The key here is the use of a decontamination technology that can reliably treat the waste to reduce the concentration of 100,000 Bq/kg to a level below 30,000 Bq/kg. Volume reduction units (for the reduction of radioactivity through

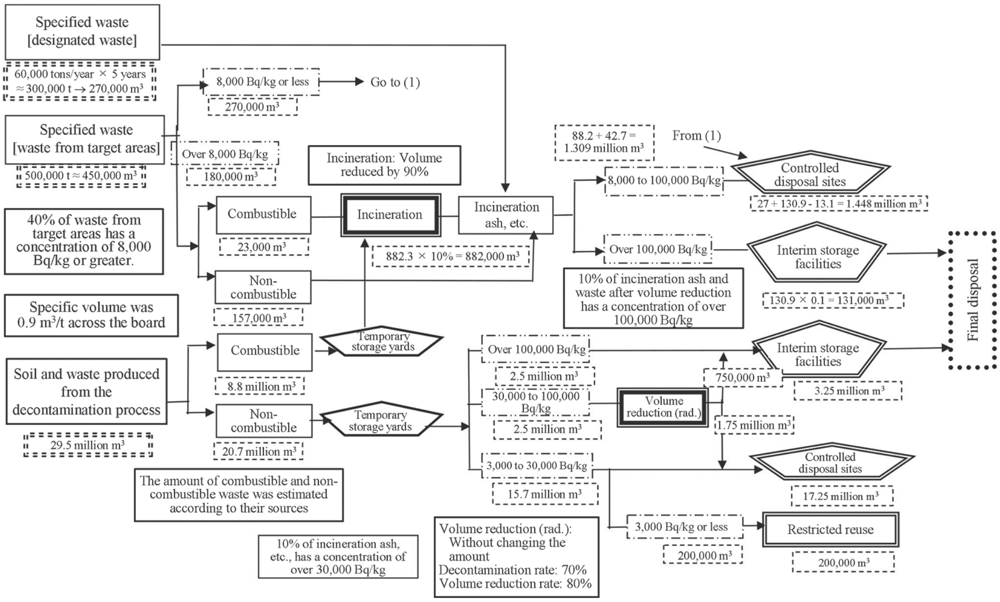

Figure 2 Workflow of waste amounts for treatment process

decontamination) are currently being developed and demonstrated with their practical application on the horizon. One example of this is the demonstration of a decontamination technology (hereinafter referred to as the "decontamination demonstration") by the Japan Atomic Energy Agency (JAEA)[4, 5]. Realistically, not all of the waste with a radioactivity level of between 30,000 and 100,000 Bq/kg is eliminated. In this estimate, such waste would be accepted by interim storage facilities.

2. Scenario with Restricted Reuse

The MOE's workflow does not provide explicit instructions concerning the reuse of waste. However, it does specify an average concentration of up to 3,000 Bq/kg as a guideline for the reuse of radioactive cesium under certain conditions[6]. Given that an enormous amount of waste is generated in areas outside the disaster site, its partial reuse is an effective solution even if the concentration exceeds the clearance level, provided proper shielding and containment are maintained for the targeted areas.

III. Amount of Treated Waste

In this estimate, the amount of waste was calculated according to the contaminated area corresponding to each dose rate classification stipulated in the MOE's Estimated Amounts of Soil and Other Waste Materials Generated by Decontamination on a Case-by-Case Basis[7] (hereinafter referred to as the "basic waste data"). The decontamination rate, volume reduction rate, and other parameters related to the treatment process were adopted from, among other things, the actual performance during the decontamination demonstration conducted by the JAEA (e.g., efficiency in terms of incineration and volume reduction). Consequently, the workflow of the amount of the process was defined as shown in **Figure 3** based on the

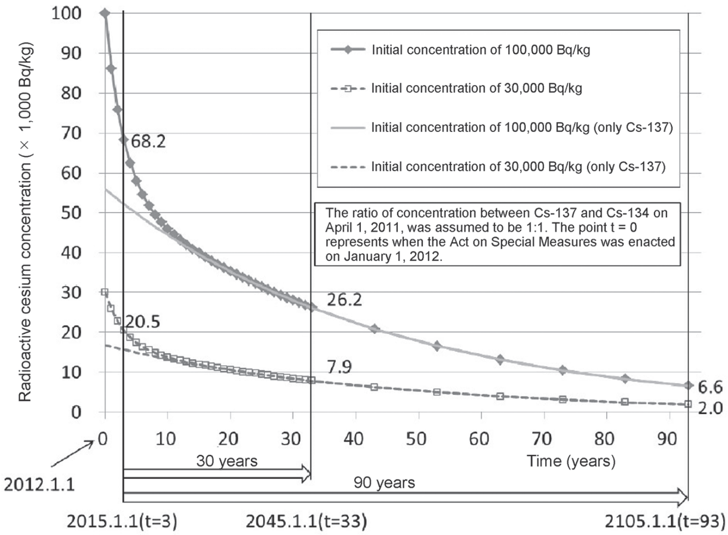

Figure 3 Reduction in radioactive cesium concentration over the years

following assumptions.

1. Amount of Decontamination Target

As mentioned above, the amount of treated waste was based on the basic waste data. Nonetheless, comparisons were made with other available data, such as that released by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) with regard to contaminated areas broken down by the dose rate category. These comparisons indicated that, in terms of the vast forests and farmland areas that require decontamination, the amount estimated based on the basic waste data was mostly higher, with only a slight difference in the calculated target areas. In contrast, the amount calculated based on other data tended to be higher in terms of land covered by buildings and building lots. Accordingly, the estimate based on basic waste data was considered appropriate due to the smaller share of costs involved in the decontamination of buildings and building lots and the higher costs incurred for farmland and forests.

2. Decontamination Methods

The decontamination targets were identified in accordance with the MOE's classification of land use [7]. The contamination methods were chosen accordingly for land (farmland, building lots, roads, and forests around housing), buildings, other forests, other infrastructure (schools, parks, etc.), and areas with spot contamination. Importantly, for farmland (paddies and fields), an effective method was applied to decrease the radioactivity in highly contaminated areas, whereas another method that produced much less waste was used for less contaminated areas.

The following decontamination methods were employed according to the intended targets (see **Table 1**).

(1) Farmland (paddies and fields): Topsoil removal, soil dressing, or other relatively robust

Table 1 Assessment of decontamination technologies and associated costs

No.	Target area	Annual dose rate (mSv/y)	Area or length (km^2, km)	Main material to be removed (/Volume 1,000 m^3)		Applied technology	Unit cost	Addition rate for high dose rate	Addition rate assigned for other related expenses	Total (trillion yen)
1-1	Farmland (paddies and fields)	20 or more	88 km^2	Soil	4,387*	Stirring of soil with water and removal (paddies); removal of topsoil and dressing of soil (fields)	950 million yen/km^2	70%	50–90%	0.213–0.270
1-2		5–20	261 km^2	Soil	13,038*	Topsoil removal and deep ploughing	400 million + 100 million = 500 million yen/km^2	–	50–90%	0.196–0.248
1-3		1–5	899 km^2	–	–	Deep ploughing, etc.	100 million yen/km^2	–	90%	0.171
2-1	Buildings and building lots	20 or more	10 km^2	Soil	193*	Buildings: Washing Building lots: Topsoil removal, soil dressing, and vegetation removal	650 million + 375 million + 250 million = 1.275 billion yen/km^2	70%	50–90%	0.033–0.041
2-2		5–20	41 km^2	Soil	831*			–	50–90%	0.078–0.099
3-1	Key transport infrastructure (262 km/km^2)	20 or more	4 km^2* ⇒ 1,050 km	Sludge	17*	Washing of road surfaces and cleaning of side ditches (both)	2.4 million yen/km	70%	50–90%	0.006–0.008
3-2		5–20	9 km^2* ⇒ 2,360 km	Sludge	33*			–	50–90%	0.008–0.011
4-1	Forests around housing (1%)	20 or more	41* × 1/10 = 4 km^2	Vegetation Soil	37 200	Removal of fallen leaves, pruning of trees, removal of topsoil, and dressing of soil	760 million + 580 million + 375 million = 1.715 billion yen/km^2	70%	50–90%	0.017–0.022
4-2		5–20	93* × 1/10 = 9 km^2	Vegetation Soil	84 450			–	50–90%	0.023–0.029
5-1	Forests (10%)	20 or more	41 km^2*	Vegetation	367	Removal of fallen leaves and mulch layer (on slopes), pruning of trees, construction of road networks, clearance of removed materials, and construction to prevent topsoil runoff	760 million + 580 million + 500 million = 1.84 billion yen/km^2	70%	50–90%	0.192–0.244
5-2		5–20	93 km^2*	Vegetation	839			–	50–90%	0.257–0.325
6-1	Forests (remaining 90%)	20 or more	367 km^2*	Vegetation	2,295	Pruning	580 million yen/km^2	70%	50–90%	0.543–0.688
6-2		5–20	842 km^2*	Vegetation	5,257	Pruning		–	50–90%	0.733–0.928
7-1	Other infrastructure (schools, parks, etc.)	20 or more	5 km^2*	Soil	245	Topsoil removal, soil dressing, and vegetation removal	375 million + 250 million = 625 million yen/km^2	70%	50–90%	0.008–0.010
7-2		5–20	18 km^2*	Soil	883			–	50–90%	0.017–0.021
8	Spot contamination	1–5	642 km^2	Sludge	399*	Cleaning of side ditches, removal of topsoil, etc.	375 million yen/km^2	–	90%	0.457
	Subtotal	Annual dose rate	Area subtotal	Contaminated material and property/Subtotal		20 or more	5–20	5 or less		2.952–3.572
		20 or more	519 km^2	Soil	Non-combustible/20,227	5,025	15,202	0		
		5–20	1,273 km^2	Sludge	Non-combustible/449	17	33	399		
		1–5	1,541 km^2	Vegetation	Combustible/8,879	2,699	6,180	0		
9	Temporary storage yards	–	–	29,500		–	32 million yen/1,000 m^3	–	–	0.944
–	Total	–	–	–		–	–	–	–	3.896–4.516

Note: (1) Figures marked with an asterisk are assigned based on Cases 1-3, 2-3, and 3-1 in Table 5 (area) and Table 6 (amount of removed soil, etc.) in Reference 7). The figures in Sections 1-3, 4-1, and 4-2 in the table were determined according to the original policy.

(2) The addition rate assigned for other related expenses in the table was 50% for decontamination in concentrated areas and 90% for decontamination in dispersed areas. The addition rate of 90% was assigned across the board for a more conservative estimate with greater expenses. These addition rates were assigned with reference to the MOE's standards for the formulation of provisional cost estimates for decontamination and other work performed in special decontamination areas (May 2012).

methods were employed in areas with an annual dose rate of 20 mSv or more. In areas within the range of 5 to 20 mSv/year, methods such as topsoil removal and deep ploughing were employed. In dealing with spot contamination, deep ploughing was chosen to minimize the amount of waste that was produced.

(2) Building lots (including public facilities): Topsoil removal, soil dressing (or the construction of simplified temporary storage yards), and vegetation removal.

(3) Buildings (houses and public facilities): Washing (cleaning, wiping, scrubbing, etc.)

(4) Key transport infrastructure (roads and side ditches): Washing of road surfaces and cleaning of side ditches (both).

(5) Woods around housing: Vegetation removal (pruning and the removal of fallen leaves), topsoil removal, and soil dressing were employed within about 20 m of the housing. These methods were applied to about 1% of the total target forest area.

(6) Forests: Forests fulfill a variety of functions, such as recharging groundwater, preventing landslide disasters, and helping to conserve soil, biodiversity, and the global environment. Extending from areas located near settlements into the remote mountains, they are used in many different ways [8]. These functions may be impaired if a thorough decontamination is performed with the sole aim of reducing exposure. Each forest should be classified according to how contaminated its trees are and the way people use it (i.e., how frequent they access or approach it). Once forests have been divided into the following categories, the decontamination methods should be chosen after a comprehensive assessment of the migration of contaminants to the forest floor and their impact on water sources: forests near houses and the like; forests regularly accessed for use by people; and other forests. As of the time of writing, no reliable assessment findings were available. Hence, this estimate assumed that 10% of the total forest area (134 km^2) would require prioritized decontamination, which consists of the removal of vegetation (pruning and the removal of fallen leaves), the construction of road networks for carrying out decontamination, the clearance of removed materials, and the protection of road surfaces with gravel and other such measures for preventing sediment runoff. The cost estimate for the remaining forests (90%) was performed by taking into consideration all of the expenses in a batch and assuming that the decontamination would be performed simply by pruning and the like. The determination of specific decontamination methods was left for future development. Decontamination may need to be repeated because forest contamination tends to migrate from elevated terrain to low terrain.

(7) Other infrastructure (schools, parks, etc.): As was the case for building lots, the methods chosen were topsoil removal, soil dressing (or the construction of temporary storage yards), and vegetation removal.

(8) Spot decontamination: Mainly the removal of sludge from locations where radioactive materials tend to accumulate (e.g., water collection points leading from gutters and moss clumps), the cleaning of side ditches, and the removal of topsoil were chosen.

3. Temporary Storage Yards

The MOE's workflow stipulates that the soil and waste produced by the decontamination process shall be collected at a temporary storage yard before transportation to interim storage facilities (in Fukushima Prefecture) or controlled disposal sites (outside Fukushima Prefecture). Accordingly, this estimate also assumed that temporary storage yards would be established.

4. Waste Treatment Methods

As stipulated in the MOE's workflow, this estimate assumed that waste would be treated by incineration or volume reduction.

(1) Incineration

Incineration can be divided into high-temperature incineration and low-temperature incineration. With reference to the decontamination demonstration conducted by the JAEA, the most common value of 10% was assigned as the volume reduction rate. Radioactivity was concentrated into incineration ash.

(2) Volume reduction

Many types of methods and systems can be used to reduce the volume of waste. In this estimate, taking the JAEA's decontamination demonstration into consideration, the two methods indicated below were postulated for use in the case of radioactive materials exceeding a certain level of concentration. The total amount of waste was assumed to remain the same before and after the volume reduction.

- Sorting and washing of soil by grain size
- Thermal and chemical treatment applicable to common materials

The performance and costs vary according to the method used. Nonetheless, moderate performance has been achieved with the relatively inexpensive sorting and washing of soil by grain size (decontamination rate: 70%; volume reduction rate: 80%). At the same time, high performance has been achieved with the relatively expensive thermal and chemical treatment (decontamination rate: 90%; volume reduction rate: 95%)[5]. In terms of their decontamination and volume reduction performance, these two methods proved to incur almost the same total costs for volume reduction and subsequent storage. The difference in total costs between these two methods was marginal, although they did vary depending on certain conditions. In this estimate, therefore, the figures from sorting by grain size were assigned because that method has been tested in other areas. The cost estimate was given a wide range in anticipation of the development of high-performance volume reduction technologies (e.g., chemical treatment) for waste that has complex properties and is hard to decontaminate.

5. Storage

(1) Properties of waste and storage

Specified waste can be divided into combustible waste and non-combustible waste. In principle, combustible waste is incinerated into ash, while non-combustible soil and the like are stored in a disposal site without being incinerated. The incineration ash and soil that are generated by the decontamination process can also be categorized in terms of the leachability associated with the difference in their properties in adsorbing cesium. In particular, cesium tends to leach out of the fly ash produced by incineration.

(2) Thresholds for storage and reuse

The acceptance criteria for the respective destination originally assigned for this estimate are presented as follows.

(i) Acceptance threshold for interim storage facilities: Over 100,000 Bq/kg

The lower limit was set by assigning the value specified in the MOE's workflow for the waste (e.g., soil and incineration ash) produced by the decontamination conducted in Fukushima Prefecture. Currently, the feasibility has yet to be verified with regard to the proper treatment and disposal of waste by reducing its concentration of between 30,000 and 100,000 Bq/kg to below 30,000 Bq/kg. For this reason, after volume reduction was conducted for the target waste, the rate of acceptance at controlled disposal sites was lowered (the decontamination rate requirement was lowered from 80% down to 70%) and the rate of acceptance at interim storage facilities was increased.

(ii) Acceptance threshold for soil and other waste at controlled disposal sites: 30,000 Bq/kg or less

The upper limit is set to 30,000 Bq/kg. A guide level of 8,000 Bq/kg is provided for the lower limit to ensure that the annual exposure of workers to waste is limited to no more than 1 mSv under normal conditions. However, the specified waste and other waste materials as well as the soil produced during the decontamination process shall be accepted even if their concentration levels are below 8,000 Bq/kg (according to the MOE's workflow).

(iii) Restricted reuse: 3,000 Bq/kg or less

A threshold of 3,000 Bq/kg was assigned on the basis that it is below 8,000 Bq/kg but a few dozen times higher than the clearance level [7)].

IV. Setting Unit Costs

1. Unit Costs for Decontamination

The unit costs for decontamination were set in accordance with the MOE's guidelines for decontamination projects [9)]. Reference was also made to actual records from the JAEA's decontamination demonstration to assign unit costs for pruning, the removal of fallen leaves, and so on. A similar unit cost as that used for controlled disposal sites was assigned for the acceptance of waste at temporary storage yards. In addition, a factor of 1.7 was assigned to areas with an annual dose rate of 20 mSv or more as decontamination takes more time than normal work due to the need to prepare protection against radiation.

2. Unit Costs for Treatment

The unit costs were adopted from published sources (see **Table 2**).

(1) Incineration and volume reduction

The unit costs for incineration and volume reduction were assigned with reference to projects such as the decontamination demonstration conducted by the JAEA.

(2) Packaging, transport, and emplacement

The treatment workflow was divided into two types: the first type is incineration followed by transport before temporary storage while the other is incineration followed by transport after temporary storage. The unit costs were assigned with reference to the calculation of civil engineering costs by local governments.

(3) Sorting according to the measured concentration and monitoring

Waste must be sorted according to the measured radioactivity concentration in each treatment process. In this estimate, the sorting costs were included in the cost of storage.

Similarly, the costs involved in monitoring the waste disposal sites once they have started operating were also included in the cost of storage.

Table 2 All expense items for decontamination, treatment, and storage—Case 1 (see Note (3) regarding Case 2)

No.	Category	Item	Amount [× 10,000 m^3]	Unit cost [× 10,000 yen/m^3]	Addition rate for other related expenses	Total [trillion yen]
1	Decontamination	Decontamination subtotal (including temporary storage yards)	See Table 1			3.896–4.516
2	Treatment	Incineration	882.3	5	50%	0.662
		Volume reduction, etc. (sorting, etc.)	250	2	50%	0.075
		Alternatives for volume reduction, etc. (chemical treatment, etc.)	As above	7.5	As above	(0.281)
		Incineration followed by transport before temporary storage (up to a distance of 10 km)	2,995	0.24	--	0.072
		Incineration followed by transport after temporary storage (distance of 100 km)	2,201	0.31	--	0.068
		Treatment subtotal				0.877–1.083
3	Storage	Temporary storage yards	Included in decontamination			--
		Controlled disposal sites/removed soil, etc.	1,725	3.2	--	0.552
		Controlled disposal sites/incineration ash	144.8	As above	--	0.046
		Interim storage facilities/removed soil, etc.	325	10.0–18.0	--	0.325–0.585
		Interim storage facilities/incineration ash	13.1	As above	--	0.013–0.024
		Restricted reuse	20	3.2	--	0.006
		Storage subtotal				0.942–1.213
4	Other	Monitoring, etc.	Included in storage			--
	Total		--	--	--	5.715–6.812

Note: (1) The cost associated with the “Monitoring, etc.” item in the table was included as a cost for storage.
(2) The “Addition rate for other related expenses” item in the table was set to 50% based on the fact that most expenses are concentrated in decontamination target areas (treatment facilities) (see Note (2) in Table 1).
(3) Case 2: A unit cost of 500,000–800,000 yen/m^3 was assigned to interim storage facilities. Subtotal for storage: 2.295–3.309 trillion yen. Total: 7.068–8.908 trillion yen.

3. Unit Costs for Storage

The unit costs involved in storage were adopted from published sources, as presented in Table 2.

(1) Setting unit costs for storage

Since no specific approaches have been established for the storage of waste with two different types of properties (i.e., leachable and non-leachable), and also bearing in mind their radioactive nature, the same higher unit cost was assigned for both types of waste.

[i] Temporary storage yards: The same unit cost for accepting waste as that in controlled disposal sites.

[ii] Controlled disposal sites: The highest market price was applied to the unit cost for accepting waste [10].

[iii] Interim storage facilities: Two cases were examined, with one using the market price for shielded disposal sites (disposal sites for hazardous materials and other industrial waste) and the other using the unit price for the storage of radioactive waste. See Section (2) below for details.

[iv] Restricted reuse: Restricted reuse involves costs associated with producing recycled products. In practice, these costs vary significantly according to the intended purpose. However, a high unit cost runs contrary to the purpose of reuse. Consequently, this estimate applied the same unit cost because waste is accepted at controlled disposal sites, which can be regarded as a target level for producing recycled products.

[v] Final disposal after storage at interim storage facilities: Not considered in this estimate.

(2) Alternative unit costs proposed for the acceptance of waste at interim storage facilities

The following cases were considered in the setting of unit costs involving the use of interim storage facilities.

- Case 1: A level comparable to that of shielded disposal sites
- Case 2: A level comparable to that for the storage of radioactive waste (a sort of shallow trench disposal site)

Note: Shallow trench storage is an institutional practice involving the shallow burial of chemically stable waste (e.g., concrete and metals) from nuclear power stations with extremely low levels of radioactivity.

V. Estimate Results

The estimate costs were within the range of 5.7 to 6.8 trillion yen in Case 1 and 7.1 to 8.9 trillion yen in Case 2 (Tables 1 and 2). This calculation did not include the costs involved in conducting the final disposal after storage at interim storage facilities.

No.	Item	Case 1	Case 2
1	Decontamination (including temporary storage yards)	3.90–4.51	3.90–4.51
2	Treatment (packaging, transport, emplacement, incineration, and volume reduction)	0.88–1.08	0.88–1.08
3	Storage (controlled, interim storage, and reuse)	0.94–1.21	2.30–3.31
	Total	5.72–6.81	7.07–8.91

VI. Future Tasks

This estimate of the total environmental remediation costs was conducted using basic scenarios and an additional original scenario. It was produced based on the workflow, amount, and unit costs specified by the MOE. Going forward, greater precision should be pursued in accordance with the types and properties of the respective waste targets.

Concerning the waste amounts, this estimate utilized basic waste data from the MOE after ensuring that there were no significant discrepancies with other major databases. Further precision with respect to the amounts involved should be pursued in line with the actual state of contamination.

The performance of each decontamination method has been demonstrated in the field tests conducted in FY2011 by the JAEA and so forth. Nonetheless, their technical reliability must be enhanced to ensure effective and efficient work at the site.

In this estimate, most unit costs were based on the MOE guidelines for decontamination projects. The remaining unit costs were compensated for based on experience gained from the decontamination demonstration conducted by the JAEA. Going forward, a wider range of empirical unit costs should be adopted. In particular, unit costs associated with storage may be reduced by assigning the appropriate disposal sites for waste according to the levels of leachability and other such properties.

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