

【Manual】

Strategy of separation and treatment of disaster waste ~Focusing on the Great East Japan Earthquake 2011~

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Outline

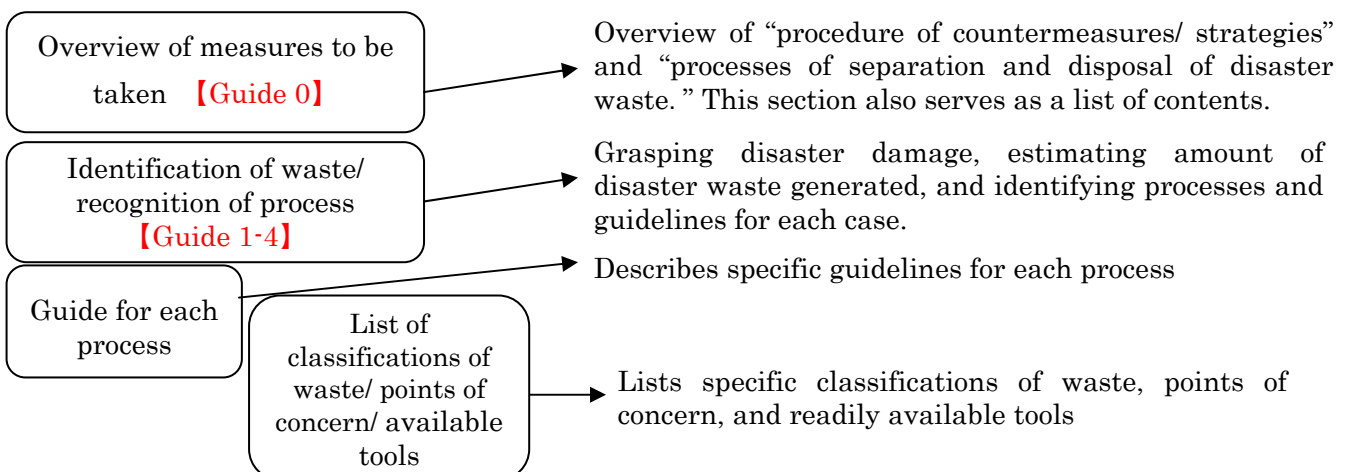
■ Purpose

One of the important aspects of securing lifelines after a disaster is how we respond to disaster waste issues. Countermeasures that should be taken vary with each case: according to the place where a disaster occurred, and the type and scale of the disaster. This manual is based on the approaches taken by disaster areas such as Sendai City to deal with waste issues generated by the Great East Japan Earthquake in March, 2011. The purpose of the manual is to support smooth recovery and reconstruction of disaster areas by sharing this information as guidelines on how to tackle disaster waste issues together with the aim of preparing for possible future disasters.

This manual has been compiled based on the Disaster Waste Management Guidelines provided by the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), and aims to give objective information, providing guidelines that are easy to follow, so that disaster areas can carry out smooth removal of collapsed houses and other waste, and can take actions to deal with waste generated by earthquake and tsunami, in line with notices and guidelines issued by the government (e.g.: Guidelines for Removal of Collapsed Houses etc. / Guidelines for Measures to Treat Earthquake Waste / Guidelines for Measures to Treat Flood Damage Waste). Records of experiences and results at other disaster areas will be added to this manual accordingly.

※ The scope of this manual, for the time being, does not include how to negotiate with the national government concerning cost burden for managing disaster waste. This does not, however, mean that this manual denies the need for information to be provided on financial issues. This manual also does not refer to preventive measures that should be taken in advance of disasters.

■ Contents are divided into sections as a **【Guide】** for easy reading.



■ **Targeted readers of this manual :**

This manual is intended to provide useful information mainly for officials who create guidelines or spearhead on-site waste disposal, and for support staff.

■ **Targeted waste :**

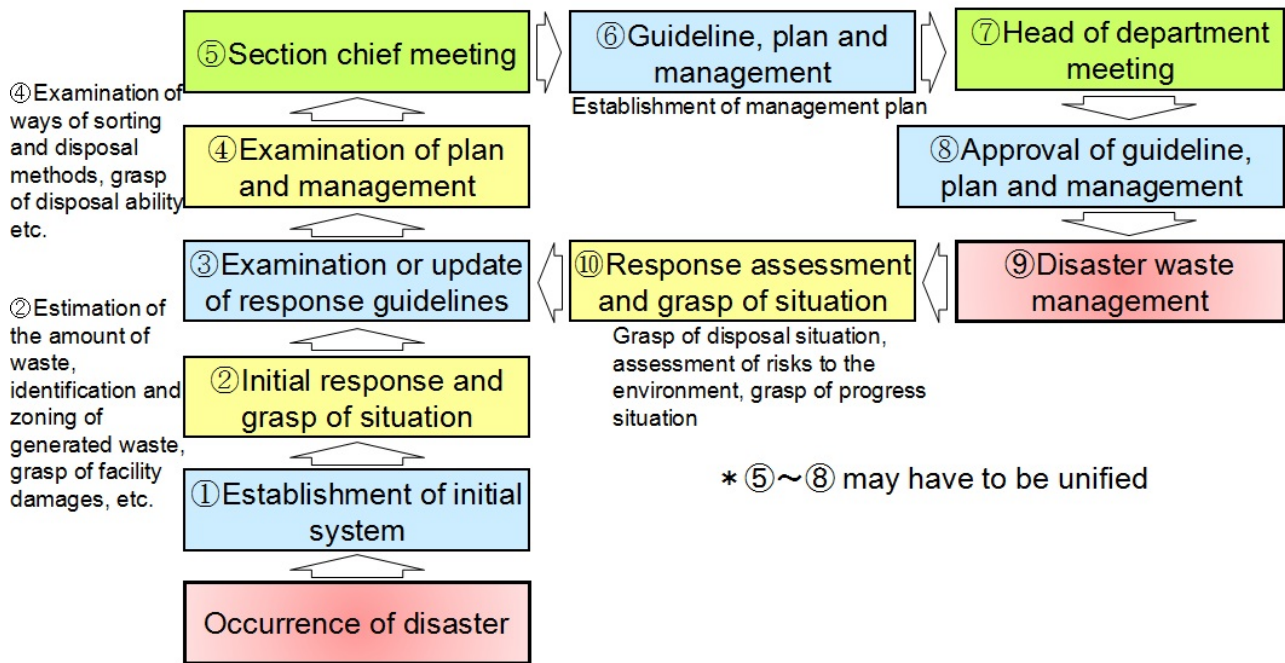
The manual at this phase focuses on how we are tackling waste issues generated by the Great East Japan Earthquake. The three main targeted kinds of waste are as follows, as shown in **【Table1-1: Categories of disaster waste】** .

- ◇ Waste from evacuation shelters
- ◇ Earthquake waste, which is waste resulting from the earthquake (Sometimes called “Yama-gomi” in Japanese – “yama” means “mountain”)
- ◇ Tsunami waste, which is waste resulting from and affected by the tsunami (Sometimes called “Umi-gomi” in Japanese – “umi” means “sea”)

The above categories of waste are particularly classified to describe waste issues generated by the Great East Japan Earthquake; they are different from those for “wastes produced in daily life” or “debris” designated in the Guidelines for Measures to Treat Earthquake Waste, or those for “bulky waste,” “human waste,” and “others : driftwood” designated in the Guidelines for Measures to Treat Flood Damage Waste. Radioactive contaminated waste (including contaminated general waste) generated by the accidents at Fukushima nuclear power plant is not treated in this manual.

【Guide 0】 Flow of measures and process

【Fig. 0】 indicates a flowchart of management implemented after the occurrence of the disaster. 【Table 0】 shows the main contents of management.



【Fig. 0】 A flowchart of disaster waste management (PDCA cycle)

【Table 0】 Time flow of substantial contents of management and concrete strategies and tools for reference

Flow of management	Concrete strategies and tools for reference
① Establishment of initial system	
● Role sharing after the designation of responsible person (including recess in case of activities without sleep or rest)	
● Collection of basic disaster information, lifeline information and network information (compile concise data/use whiteboards for efficient sharing of information)	
② Initial response and grasp of situation	
● Identification of category and zoning for disaster waste	【Guide 1】
● Estimation of quantity generated	【Guide 2】
● Grasp of situation of existing disposal facility damages	
③ Examination or update of response guidelines	

<p>● Examination of response guidelines according to waste categories, recovery and reconstruction phases</p>	<p>【Guide 3】 Phase of recovery or reconstruction and waste management 【Guide 4】 Flow for disaster waste separation and disposal</p>
<p>④ Examination of plan and management</p>	
<p>● Planning of separation and disposal strategy</p>	<p>【Guide 5】 Planning of separation and disposal strategy</p>
<p>● Removal of collapsed houses, selection and operation of temporary storage sites (primary and secondary waste storage sites)</p>	<p>【Guide 6-1】 Removal of collapsed houses etc. (Government guidelines) 【Guide 6-2】 Selection and operation of temporary storage sites 【Guide 6-3】 Selection and operation of storage sites (Primary and secondary waste storage sites)</p>
<p>● Examination of waste sorting methods</p>	<p>【Guide 7-1】 Examples of types of waste: Waste management in evacuation shelters 【Guide 7-2】 Examples of separation ~ garbage from emergency accommodation facilities, household disaster waste, tsunami-soaked wastes, at early recovery phase 【Guide 7-3】 Examples of separation ~ tsunami debris and earthquake rubble at initial recovery phase 【Guide 7-4】 Removal and separation of waste from collapsed houses 【Guide 7-5】 Countermeasure against airborne dust using dust protective masks</p>
<p>● Examination of disposal methods for individual items</p>	<p>【Guide 8-1】 Mixed wastes containing combustibles 【Guide 8-2】 Desalination of wood waste soaked in seawater 【Guide 8-3】 Wood waste (reuse, recycle) 【Guide 8-4】 Tsunami sediment 【Guide 8-5】 Marine industrial waste 【Guide 8-6】 Concrete and asphalt 【Guide 8-7】 Tires 【Guide 8-8】 Specified electrical home appliances under the Recycling Law 【Guide 8-9】 Other WEEE (Waste Electrical and Electronic Equipment) 【Guide 8-10】 Automobiles 【Guide 8-11】 Motorcycles</p>

	【Guide 8-12】 Boats and ships 【Guide 8-13】 Asbestos 【Guide 8-14】 Hazardous/dangerous articles 【Guide 8-15】 Personal valuables
●Ways to inform residents	【Quick Reference for Handling Disaster waste】 Cautions for workers and volunteers
●Detailed information	【Reference information about dismantling of damaged automobiles (for businesses)】
<u>Japanese version only</u> ●Confirmation of governmental guidelines	【Reference】 National guidelines for waste management following the Great East Japan Earthquake

Step⑤～⑩are based on ①～④. Update (repetition) based on ⑩ is also important.

【Guide 1】 Identification of category and sorting for disaster waste

“What kind of waste” generated from “what kind of place”?



Important for deciding how to “collect,” “sort,” “dispose of” waste in each area.

■ Identification of generated waste categories

Since the types and amount of waste depends on the scale of the earthquake or tsunami, it is necessary to divide them into several categories for the identification of the management guidelines (reference manual).

Here, we are going to organize them as shown in **【Table 1-1】** based on the cases used in management after the 3.11 earthquake. This manual sheds light on “evacuation waste,” “earthquake waste (mountain waste)” and “tsunami waste (sea waste)”. Medical waste should be appropriately sorted and disposed of but if a route cannot be secured, it is necessary to swiftly examine the management plan. Corpses are not included in the disaster waste we are dealing with here. We will deal with public toilets and human waste in the “evacuation waste” category.




■ Zoning




It is necessary to understand what types of waste (category) have been generated from which area. Here, we will identify and organize disaster situation and waste as indicated in **【Table 1-2】** in each area based on photographs, observation, seismic intensity distribution, inundated area and tsunami height distribution.

[Table 1-2] Examples of zoning and scheduling for disaster waste based on the damage situation

Situations in disaster area	Disaster waste	Emptying time scale (hr)			
		10 ²	10 ³	10 ⁴	10 ⁵
A number of collapsed houses due to earthquake motion	Earthquake waste (earthquake rubble, household effects waste), evacuation waste				
Not many houses collapsed, but citizens evacuate to shelters	Earthquake waste (household effects waste), evacuation waste				
Normal garbage collection system is not working	Evacuation waste				
In urban area, damage caused only by inundation	Tsunami waste (tsunami-soaked waste), water damage waste (water damage soaked waste), automobiles, evacuation waste				
Some houses collapsed or flowed out due to tsunami etc	Tsunami/water damage waste (tsunami/water damage collapsed waste, automobiles, vessels, vegetation)				
In urban area, much tsunami sediment is deposited due to tsunami etc	Tsunami waste (tsunami sediment, tsunami collapsed waste, tsunami-soaked waste, automobiles, vegetation)				
In harbor area, collapse damage caused by tsunami etc	Tsunami waste (automobiles, vessels, marine products, large-sized items, vegetation, tsunami sediment/collapsed waste)				
In farmland, damage caused by tsunami etc	Tsunami waste (tsunami sediment, automobiles, vegetation, vessels, tsunami collapsed waste)				
Damage caused by fire spread	Burned embers of earthquake waste, tsunami waste, water damage waste				

[Table 1-1] Waste category and zoning in case of earthquake or tsunami
(using examples of the 3.11 earthquake)

CATEGORY	SUMMARY	IMAGE	TYPE OF WASTE
Evacuation waste	General waste generated from evacuation shelter emitted and managed in a non-ordinary way due to the difficulty in securing lifelines (excluding collapsed houses, household effects)		Combustibles, kitchen waste, incombustibles, plastic packages, cans, glass bottles, plastic bottles, harmful waste, human waste, medical waste (including dry items)
	Medical waste generated from medical institutions, nursing homes, evacuation shelters		Needles, items and gloves contaminated with blood
Earthquake waste (so called mountain waste)	Waste such as household effects destroyed, damaged due to earthquake (excluding damaged houses)	 <p>Carried-in waste storage site (Sendai-shi niperia 3/30) Photograph by academy task team</p>	Electrical appliances, furniture (including dry items)
	Collapsed houses due to earthquake (may include household effects etc) * including those which were damaged due to fire after the earthquake	 <p>Not the main waste in Sendai but was in the Hanshin earthquake (Kobe)</p>	Collapsed houses, home appliances, furniture, large-sized garbage, tatami mat, mattress, garden trees, harmful waste (asbestos, PCB etc) (including dry items)

Automobiles	Automobiles		
Tsunami waste (so called sea waste)	Tsunami-soaked waste	<p>Waste soaked with sea water in areas damaged but not devastated by tsunami (mainly household effects)</p>  <p>Tracks of flooding(in Tagajyou-shi 3/28) photograph by academy task team</p>	<p>[Items soaked with sea water] electrical appliances, furniture, large-sized garbage, tatami mat, mattress, garden trees</p>
	Tsunami collapsed waste	<p>Collapsed houses and drenched with sea water due to tsunami (may include household effects etc)</p>  <p>Collapsed houses mingled (Sendai-shi Wakabayashi-ku 3/26) Photograph by academy task team</p>	<p>[Items soaked with sea water] collapsed houses, electrical appliances, furniture, large-sized waste, tatami mat, mattress, garden trees, harmful waste (asbestos, PCB etc)</p>
	Tsunami sediment	<p>Sediment accumulated on land due to tsunami (may include sludge)</p>  <p>Rice farm covered with sediment (Sendai-shi Wakabayashi-ku 3/26) / top left corner: zooming parched sediment Ishinomaki 3/31 Photograph by academy task team</p>	<p>Properties differ facilities in the area ⇒Should be coped with individually in each area</p>

<p>Marine products</p> <p>Automobiles, vessels</p> <p>Large-sized items</p> <p>Concrete</p> <p>Vegetation</p> <p>Others</p>	Marine products, processed marine products transformed into waste due to disaster (some mixed with tsunami sediment)	<p>Marine industrial waste (Iwate prefecture) / top left corner: waste mixed with sludge starting to decay (Ishinomaki 3/31) Photograph by academy task team</p>		
	Automobiles, vessels		Automobiles, motorbikes, vessels etc	
	Large-sized items	Large/special type of waste generated from factories and structures		Tanks, telegraph poles, forage, fertilizers which require individual management
	Concrete	Concrete		Concrete, asphalt, demolished tiles
	Vegetation	Scattered and accumulated coastal pine trees and garden trees	<p>Accumulated trunks, branches and leaves of coastal pine trees (Sendai-shi Miyagino-ku 3/26) Photograph by academy task team</p>	Raw (unseasoned) wood etc
	Others	May have to pay attention to in the near future		

*As for collapsed house waste, we mostly refer to them as damaged house materials. It may be necessary to change managements according to the level of demolition.

[notes] We do not include corpses in the disaster waste indicated above. We will look into public toilets and human waste in the evacuation waste chapter.

【Guide 2】 Estimation of quantity generated

“What types of” waste “in what amount”?



This is important for deciding how to “collect”, “sort” and “manage” waste on a certain scale or in

Estimation of the amount of disaster waste can be implemented by taking the following steps. Since the way of estimation illustrated below is for establishing the structure and the system of disaster waste management in the emergency phase, it should be revised according to achievements etc in the disaster management cycle.

(1) Amass information on disaster. In municipalities, the fire departments are informed of the damages caused by the disaster (Article 53 of Disaster Countermeasures Basic Act)

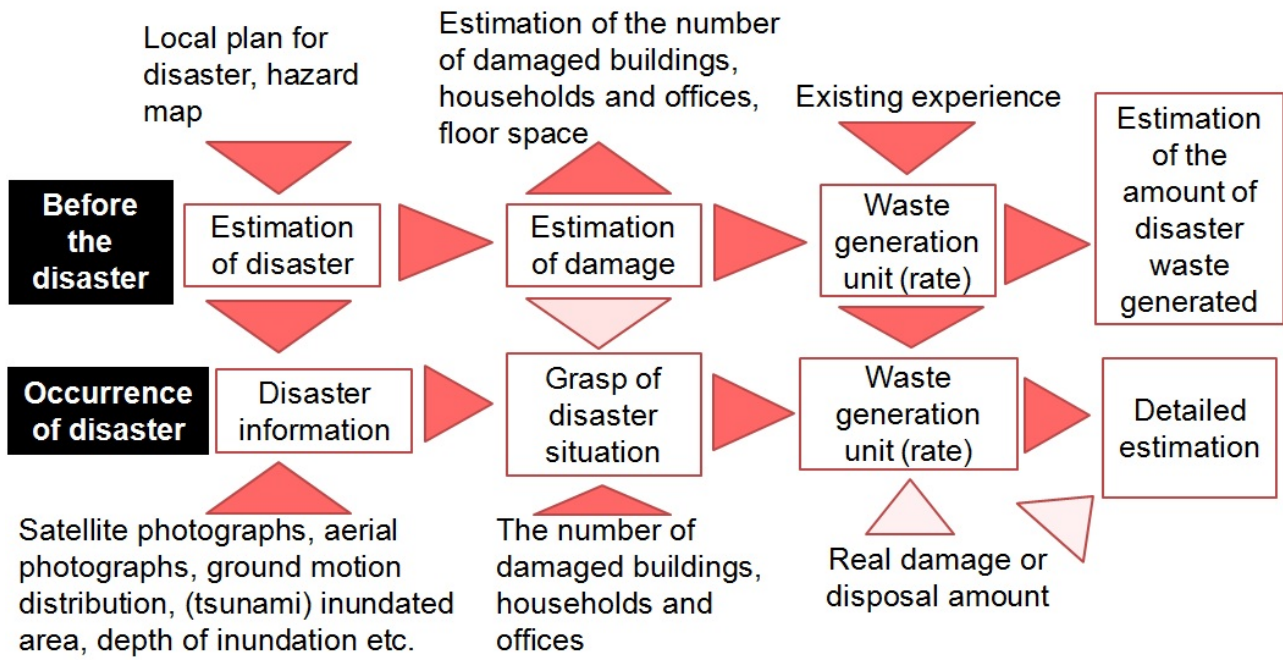
In the emergency phase, if the disaster management headquarters are collecting information, the environmental departments are not necessarily responsible for the work.

(2) Estimate the damage of houses, workplaces based on the disaster information. If possible, it will be better to estimate the damage by classifying it into several groups (fully collapsed, heavily collapsed, half collapsed, partially collapsed, inundation above the floor level, inundation below the floor level). As for flood damage or tsunami disaster, estimation is carried out by measuring the depth of inundation. As for information on the depth of inundation, since it is difficult to gain that information in the emergency phase, it is possible to make an estimation of the number of buildings or households in the inundated area using various statistics.

(3) Estimation of the amount of disaster waste can be calculated by multiplying waste generation consumption rate with the number of estimated damaged buildings and households.

Example of calculation:

$(100 \text{ fully collapsed households} \times 113 \text{ tons per household}) + (1000 \text{ inundated households above floor level} \times 4.6 \text{ tons per household}) + (10000 \text{ inundated households below floor level} \times 0.62 \text{ tons per household}) = 22,100 \text{ tons}$



[Fig. 2] Summary of the estimation flow of the amount of disaster waste

【Guide 3】 Phase of recovery or reconstruction and waste management

How recovery and reconstruction will proceed in the present time and in the future?



How to manage “what kind of waste” on “what kind of schedule”?

Management (scheduling) based on the understanding of recovery, reconstruction of all disaster managements (situation of disaster areas) is required. As for waste disposal, management indicated in the right column of **【Table 3】** , **【Table 1-2】** can be thought of.

In particular, swift response in the early recovery (relief) phase is required. Although in some area, the disaster management phase may be heavily delayed depending on the local government or the size of the disaster, it is important to share precedents and know-hows in order to advance the recovery and reconstruction as swiftly as possible.

【Table 3】 Waste management standards in disaster management (disaster area) phases

Disaster management (disaster area) phases			Waste management
Emergency Phase	Occurrence of disaster (prioritize lifesaving) ★Transportation security is basically implemented in this phase.	10 ² hours (approximately 3 days = 72 hours)	① Establishment of initial system ② Initial management and grasp of situation ● Mainly "evacuation waste", "earthquake waste (household effects)", "tsunami waste (tsunami flooding)" ③~⑧ Examination of management guidelines ~ approval ⑨ "Evacuation waste" commence disaster management
Early Recovery (Relief) Phase	Implement until recovery of victims and distribution of goods (lifeline recovery)	10 ³ hours (approximately 1 month)	● "Earthquake waste(collapsed)", "tsunami waste(collapsed)" management ③~⑧ Examination of management guidelines~approval ⑨ Disaster management →removal of large amount of waste from the city area
Recovery Phase	Implement until recovery of social stock (removal of evacuation shelter)	10 ⁴ hours (approximately 1 year)	Waste disposal (reuse, recycle)
Reconstruction Phase	Implement until recovery of industry	10 ⁵ hours (approximately 10 years)	

*It is highly likely that the time standard for these phases differs from area to area.

★Although "establishment of temporary toilet"etc is an issue of the emergency phase, it is not included in this manual.

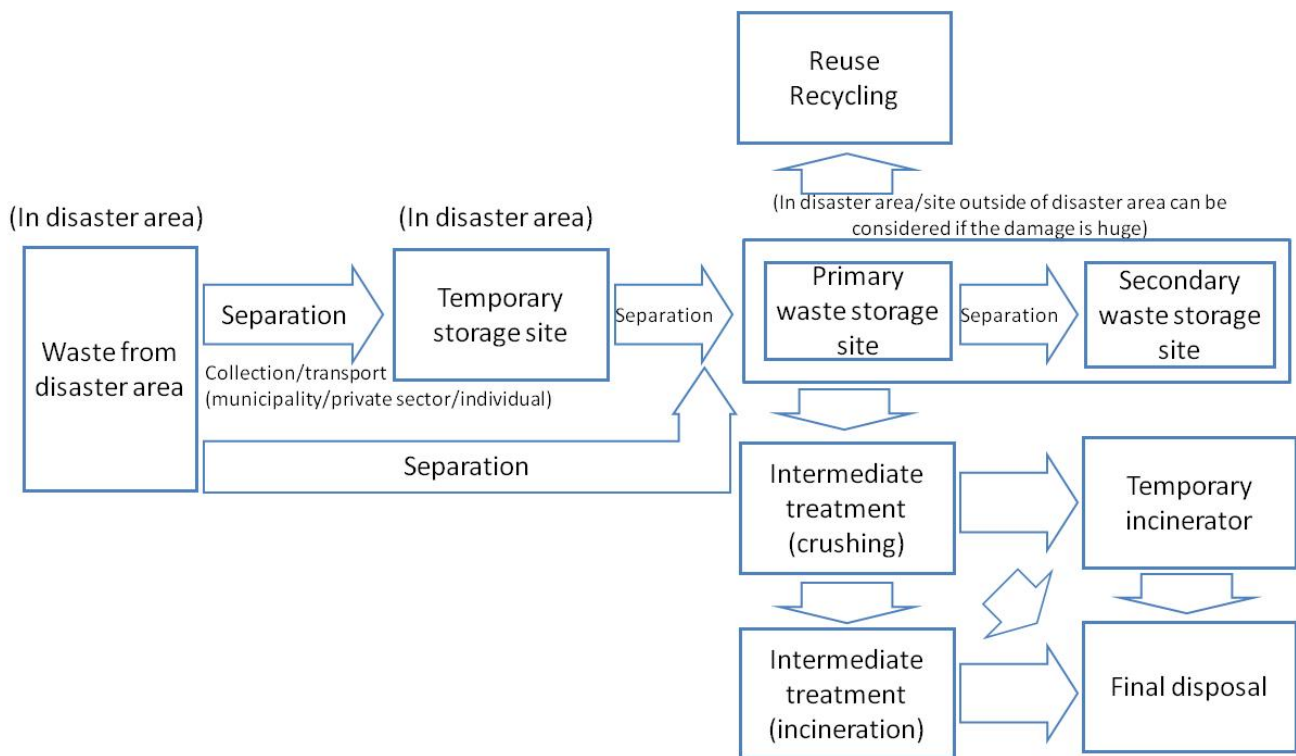
【Guide 4】 Outline of the processes of separation and disposal of disaster waste

Common understanding for the processes of separation and disposal of disaster waste



How to place temporary storage sites and transport and recycle/dispose of disaster waste

Methods of separation and disposal for disaster waste vary with each category and type of waste, and according to region (some processes may be unnecessary, or impossible to utilize) ; however, it is necessary to keep the overall processes of disaster waste in mind when planning separation/disposal strategies. Common understanding of the processes as well as technical terms among related parties is vital, to ensure smooth communications. The following is an outline of the processes for separation and disposal of disaster waste.



【Fig. 4】 Outline of the processes for separation and disposal of disaster waste

■ Glossary

Temporary waste storage site: A place where disaster waste is temporarily stored in disaster areas to secure space/living environment, and to enable smooth reconstruction. The photograph on the right shows an example of a temporary waste storage site set up in an open space beside houses (following heavy rain damage in Kagoshima Pref. in 2006)



Primary waste storage site: A place where waste is kept/sorted for a certain period of time before disposal (including reuse/recycling). The photograph on the right shows an example of a primary storage site at a playground in a city in Kagoshima Pref. in 2006.



Secondary waste storage site: A secondary waste storage site needs to be set up in case that waste is not sufficiently separated if space for separation of waste at the first (primary) storage site is insufficient. Guidelines on setting up/running it will be the same as for the primary storage site. Depending on the types or various statuses of waste, or areas where wastes are being kept, there are some cases in which only the same treatment as that provided at the primary storage site is sufficient. In some cases, it may be possible to set up only one primary storage site.

Separation: Appropriate separation for waste is desirable, taking into consideration later disposal including reuse/recycling with each priority and hazard characteristics of wastes when keeping or disposing of them.

Reuse: Waste like “debris” and “gravel & pebbles and timber not soaked with salt water” should be separated at primary/secondary storage sites and used appropriately for reconstruction.

Recycling: Waste like “debris,” “timber,” “metals,” “electric home appliances,” “automobiles” and others collected and separated at primary/secondary storage sites should be properly managed and used as recyclable resources for reconstruction.

Intermediate Treatment (Crushing & Shredding) : This procedure is applied after waste is collected and separated at primary/secondary storage sites to improve efficiency of transportation or incineration disposal.

Intermediate Treatment (Incineration): This is a procedure before final disposal allowing stabilization and reduction of the volume of disaster waste. In some cases, temporary incinerators are set up in primary/secondary waste storage sites.

Temporary Incinerator: This will be installed to enable sufficient processing/treatment of waste in the case that treatment is difficult using only existing incinerators, or when accepting large amounts of disaster waste from other regions.

Final disposal: Landfill incinerated ashes that are stabilized by intermediate treatments. In the case that handling only with the existing landfill facilities is difficult, soil analysis must be made rapidly in order to find and set up new landfill areas. The sites should be taken care of by each municipality.

Tiles and Pebbles : Concrete / asphalt rubble

Disaster debris (Debris) : Waste from collapsed buildings and from demolition/ mixture of household goods and rubble

★Difference between previous cases and the case of the Great East Japan Earthquake, especially in relation to “temporary waste storage sites” and “primary/secondary waste storage sites”):

Compared to previous cases, the volume and type of disaster waste resulting from the Great East Japan Earthquake, especially due to the tsunami, is extremely huge and serious. This manual compiles data and provides guidelines for “temporary storage sites” and “primary/secondary waste storage sites”. This treatment is done because of the necessity of providing broad area-wide waste treatment. “Temporary storage sites” should be set up close by houses, where waste from inside the houses can be put for a short period in the early stage of recovery of individual daily lives. As “primary /secondary waste storage sites” are intended to be places for separation of waste and intermediate treatment, considering future processing including reuse/recycling, locations outside of the disaster areas can be considered. **In past cases, “temporary storage sites” were designated as “tentative storage sites,” and “primary/secondary waste storage sites” were described as “temporary storage sites”.**

【Guide 5】 Planning of separation & treatment strategy

- Especially in the case of the Great East Japan Earthquake, disposal of tsunami waste is expected to be difficult, and waste management plans and order of priority are expected to be different in each municipality. After looking through individual items described in this manual concerning methods of treatment (or reuse/recycling), each municipality should draw up a separation and treatment strategy according to the following criteria.
- **Criteria:** prioritization of reuse and recycling, environmental protection, consideration for recovery and reconstruction, capacity of separation and treatment facilities, cost, etc.
- The main considerations in separation and disposal strategy are the quantity of waste to be treated, separation and disposal process, zoning of waste collection and treatment, selection of storage sites and transportation methods, organization for disposal, scheduling, etc.

■ Key points

· Especially in the case of the Great East Japan Earthquake, disposal of tsunami waste is expected to be difficult, and the disposal plan and the order of priority are expected to be different in each municipality. After looking through the individual items described in this manual concerning possible methods of disposal (reuse recycling), each municipality should draw up a separation and treatment strategy according to the following criteria.

■ Criteria for planning strategy

(1) Prioritization of reuse and recycling: reuse and recycling should be conducted as much as possible, while urgency of disposing of disaster waste and its quantities are considered. Separation and treatment process will be determined after conditions of receiving materials for reuse and recycling and required separation are taken into account. Emergent receiving conditions and transportation route might be decided by the industry or administration in addition to conventional ones. Refer to **【Fig. 5-2】** for an example of separation and treatment processes of wastes including reuse and recycling.

(2) Environmental protection: It is important to minimize impacts on human health or the environment and to prevent danger, while considering speed of disposal. Fundamentally, it is necessary to check the state of hazardous substances and products, which entail careful handling in non-emergency situations, prevent any exposure of residents and workers to such materials, and treat them properly during all stages of separation and treatment processes. If the entire disposal process is likely to take a long time, priorities of removing waste should be set and storage sites should be selected cautiously because hygiene problems may occur where waste exists, in the living environment and at temporary storage sites, etc. Environmental monitoring should be carried out basically.

(3) Consideration for recovery and reconstruction: Disposal of waste can support recovery and reconstruction of disaster areas, and it is preferable to treat and dispose of disaster waste in such ways. For example, job creation by hiring local citizens for separation and disposal of waste, reorganization of regional economies and companies, and provision of resources (reuse and recycling materials) that will be utilized in reconstruction work.

(4) Capacity of separation and disposal facilities: It is necessary to confirm the separation and treatment capacity in municipalities in the disaster areas (or outside the areas if affected municipalities do not have sufficient capacity), and examine the operational conditions of those facilities. Gaining cooperation from industry and various aid/support organizations is also important.

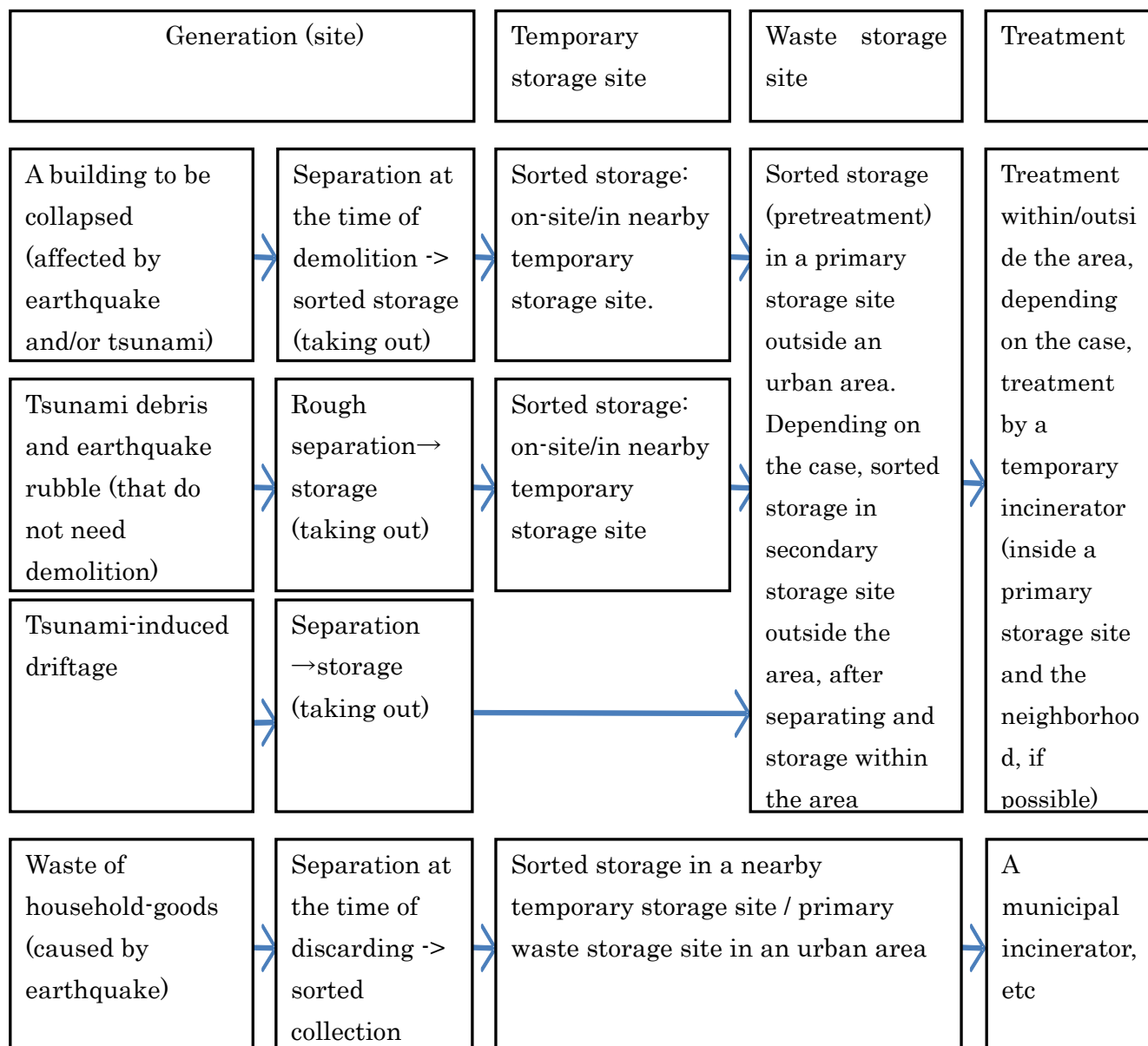
(5) Cost: It is essential to reduce total cost ensuring that disposal is carried out at a suitable price while considering reuse, recycling and environmental protection. It is necessary to examine costs, using normal unit prices of disposal or those in other disaster areas as benchmarks.

■ The main points of separation and disposal strategy

- (1) Quantity of waste to be treated : The amount of waste by generation source and type of waste should be estimated roughly, and the planned amount of waste to be disposed of has to be determined as early as possible. This amount may change as disposal proceeds. Sooner or later, it is necessary to measure the amount of waste as accurately as possible. For example, consider installing a weighing station or truck scale to measure the weight of vehicles in primary waste storage sites etc., and establish a record-keeping system.
- (2) Separation and disposal process: A detailed flow-chart should be prepared, showing all stages of processes from waste generation to separation and disposal, clarifying what and how strictly materials in waste should be separated. An example of such a flow-chart is the one in which the diagrams **[Fig. 5-1, 5-2]** are arranged in a way that local conditions etc. are incorporated. It shows flows of waste by waste type together with the amount (1). Materials shown at the left in **[Fig. 5-2]** , which are relatively easy to separate at the site, should be separated as early as possible in the flow (closest to source). Once wastes become mixed, separation is more difficult, and the possibility of becoming mixed with sediment or destroyed by mixed loading during transportation also increases.
- (3) Zoning of waste collection and treatment: Based on identified waste flows in (2), zoning of waste collection and treatment should be made. That is, it clarifies what types of waste are generated, where they are to be collected, and in which treatment facility they are to be treated in accordance with the amount of wastes (in some cases, including wastes collected from more than one municipality). Then waste storage sites and transportation methods are selected in detail.
- (4) Organization for disposal : It is necessary to clarify organizations responsible for disposal of specific items/areas, as well as for the entire process. Especially when a prefectural or regional government takes over the leadership of subordinate municipalities, an organization should be formed appointing an appropriate person to lead the working group and frontline managers for districts and types of waste to the member of the group, for effective disaster waste management and time-line management, although the governor of the prefecture concerned or inter-municipal organization is formally responsible.
- (5) Schedule: Clarify the schedule of waste disposal, such as removal of disaster waste from an urban area (transportation from temporary storage sites to primary waste storage sites) and collection of waste relating

significantly to citizens' life, in a way expediting the process of recovery and reconstruction of disaster areas. However, the schedule might be delayed due to various unexpected occurrences. This should be clearly stated in advance.

(6) Environmental monitoring: Monitor the environment if necessary such as measuring air quality when demolishing and removing collapsed buildings (before, during and after) and soil at waste storage sites (before and after use). This should be done for environmental protection and the later use of waste storage sites after their closure and restoration.



* In actual practice, the amount of generated waste, the number and location of storage sites/treatment facilities and transportation methods, etc. should be recorded.

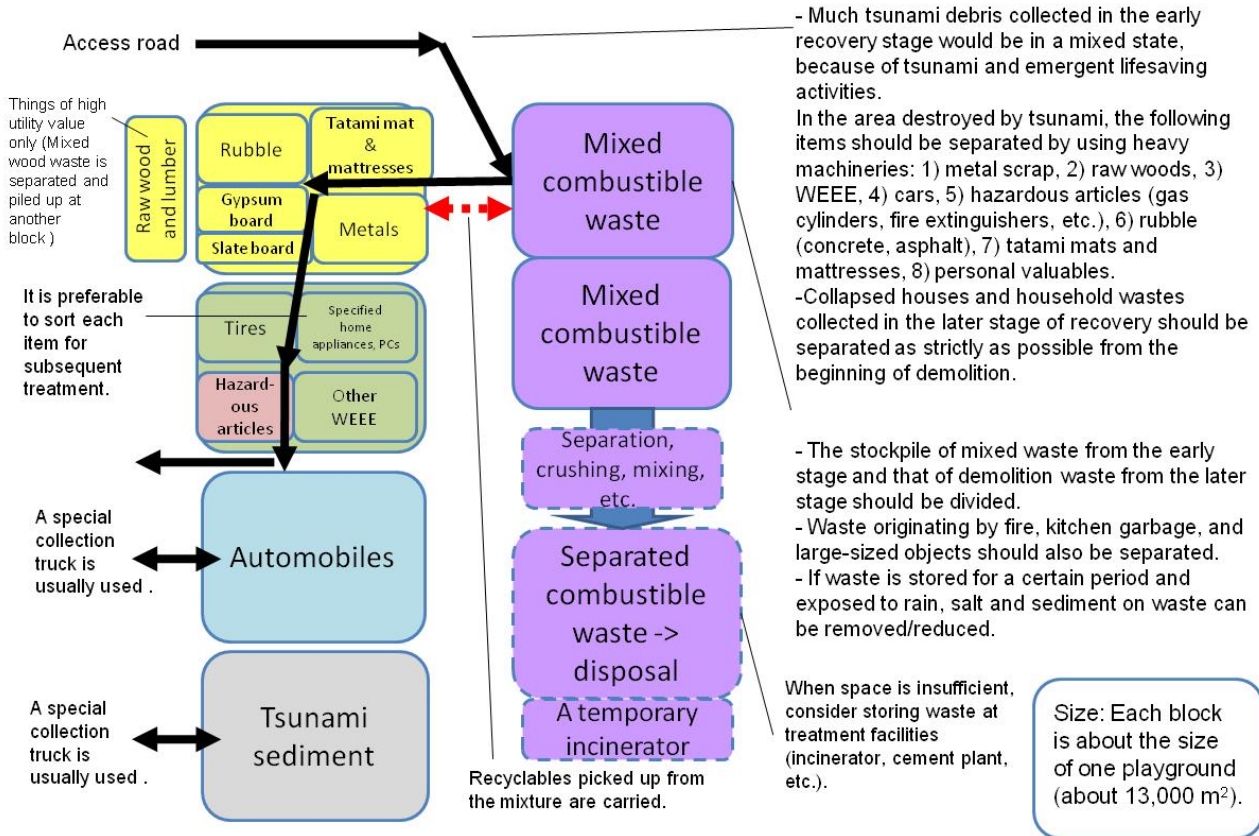
* It is important to set and inform of items and criteria for sorting, etc.

* Although land transportation (e.g. truck) is generally used, marine transportation may be available depending on type of waste and location.

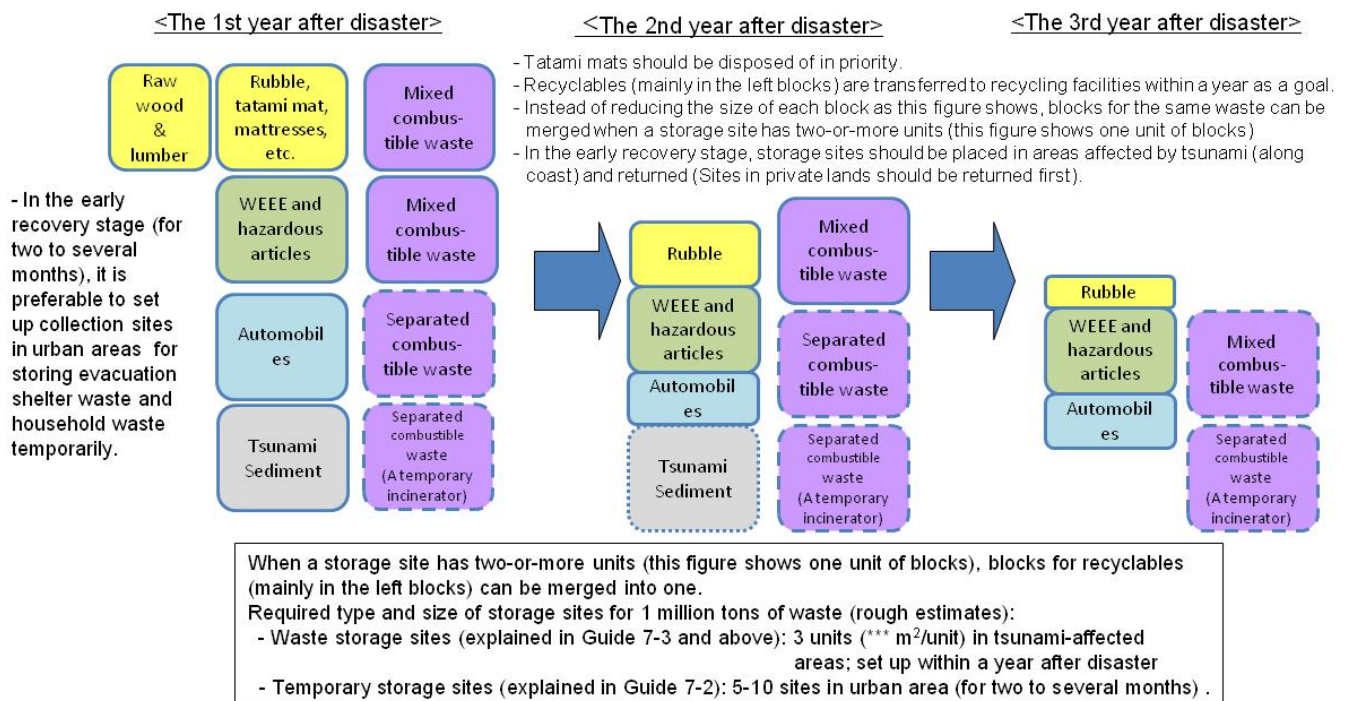
* Needless to say, appropriate contractors with legal licenses and capability should be selected for transportation and treatment of waste in compliance with relevant laws and regulations.

[Fig. 5-1-1] Flow-chart of separation and treatment of waste (overall view)

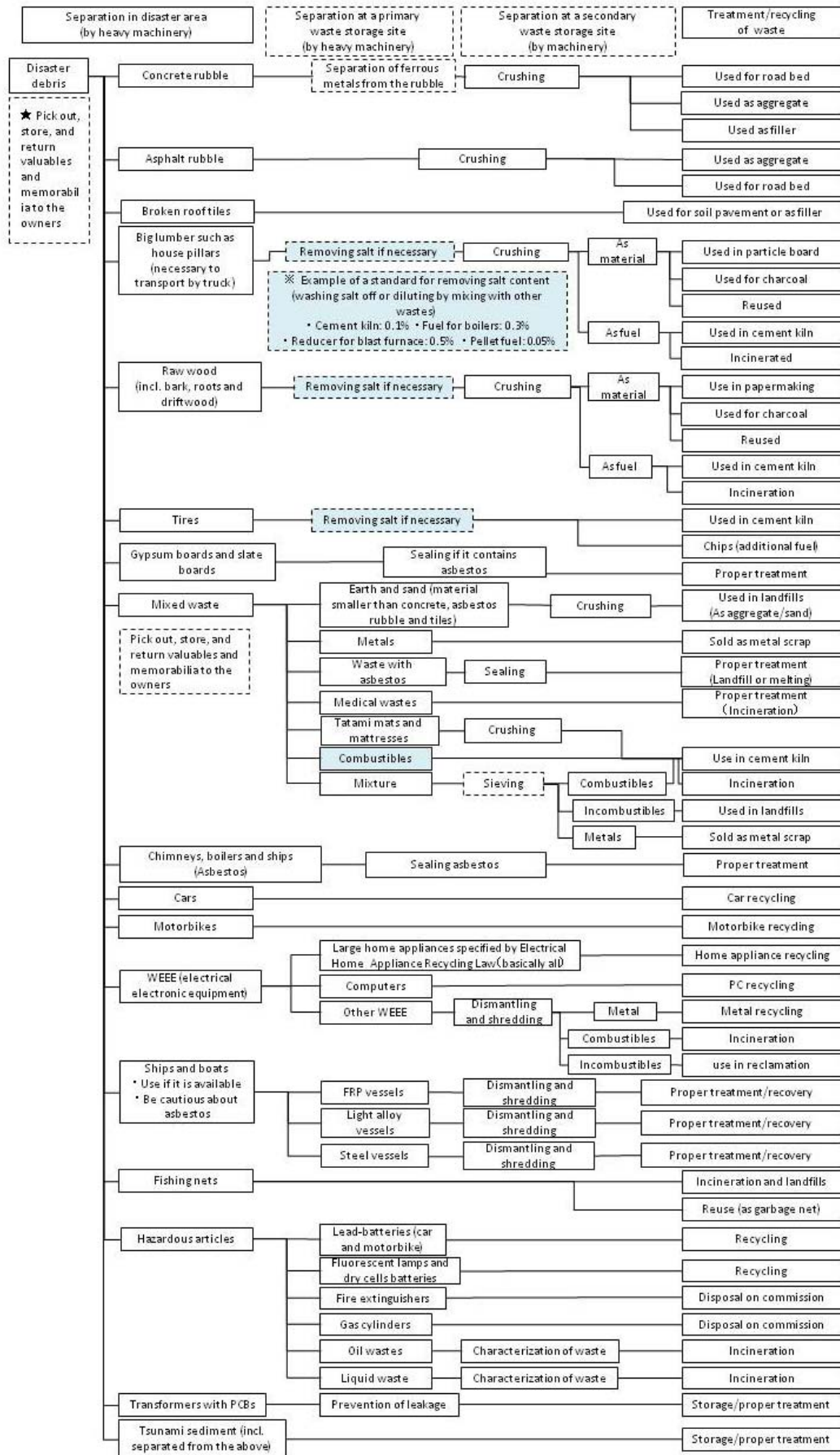
◆ An example of block plan of a large waste storage site



◆ An example of operation of a large waste storage site by time



【Fig. 5-1-2】 Diagram of separation and treatment



[Fig. 5-2] Example of separation and treatment processes for various types of wastes including reuse recycling

【Guide 6-1】 Removal of collapsed houses etc. (government guidelines)

The “Guidelines for removal of collapsed houses etc. resulting from the Great East Japan Earthquake” were established especially to deal with difficulty of treating disaster waste.

Main points of the guidelines are as follows:

- Provide information in advance about the schedule for removing waste / debris and the location of targeted removal areas
- Record damage to buildings, automobiles, and ships/boats by taking photographs and by other methods
- Return valuables and items of sentimental value such as ancestral tablets and albums to

■ Key points

The main three points in the “Guidelines for removal of collapsed houses etc. resulting from the Great East Japan Earthquake” will be introduced in this section: for more information, see [【Ref.】](#) Guidelines issued by the government.

* Some parts are explained as plain and summarized descriptions; that is, not all of the following text corresponds exactly to the original. For details of know-how concerning collapsed houses, see [【Guide 7-4】](#) .

1. Provide information in advance about the schedule for removing waste / debris and the location of targeted removal areas

Try to contact landowners wherever possible to obtain their approval before entering private properties to remove waste, and request their presence at the site. Removal, however, can be carried out even if owners cannot be contacted. It is desirable that the schedule for waste/debris removal and the location of targeted removal areas should be provided in advance.

2. Keep records of damage to buildings, automobiles, ships and boats by taking photographs and by other methods before removal

- Buildings/ houses: It is desirable to obtain owners’ approval before removing debris of collapsed houses/buildings or buildings that were swept away from their original locations. However, removal can be carried out even if the owners cannot be contacted. In the case of buildings that partially retain their original state and remain standing at their original locations, the basic procedure should be to confirm the owners’ approvals before removal. If it is impossible to contact the owners or where there is potential danger of collapse, these houses/buildings may be dismantled and removed according to the assessment by experts, such as land and building inspectors, that they are of no further value. Keeping clear records is desirable in such cases.
- Automobiles: Move them to temporary storage sites and try to contact their owners, returning them to the owner if possible. As for automobiles that appear unuseable, keep them at temporary storage sites and try to find their owners, returning them to their owners if possible. Others should be disposed

according to the End-of-Life Vehicle (ELV) Recycling Act (Law). For other cases, a guideline will be provided later. Keep records of the status in all cases in advance.

- Motor cycles/scooters: Dispose of them according to the instructions for automobiles
- Ships/boats: Collect and keep them at temporary storage sites and try to contact their owners, and return them to the owner if requested to do so. As for ships/boats that seem to be unuseable, remove/keep them at temporary storage sites and try to find their owners, and return them to the owner if possible. As for ships/boats that seem to be difficult to remove, consult with their owners. For other cases, a guideline will be provided later. Keep records of the status in all cases before removal or disposal.

3. Return valuables and items of sentimental value such as mortuary tablets and albums to their owners

- Precious metals, valuables and safes (movable properties other than automobiles/ships) should be temporary stored; try to find the owners. Return those valuables to the owners if they ask for them. Proper disposal should be carried out according to the Lost Goods Act in the case that owners cannot be identified.
- Valuables such as ancestral tablets, albums, and other belongings that would appear to have intrinsic personal value for individuals should not be disposed of.
- Items other than those above can be removed and disposed of.

Notice: Your vehicle damaged by tsunami will be removed/ stored

We express our deepest sympathy to everyone affected by the Great East Japan Earthquake on 11, March, 2011.

As a step toward reconstruction, we are commencing to remove disaster waste, including damaged vehicles, from the city. We hereby inform vehicle owners that, on your behalf, the mayor of the city will remove, store, and recycle your vehicles after confirming/recording ownership.

Removal of damaged vehicles will start from ●●, 2011.

Registration number : ●●—●●

Please contact the following address in the case that you intend to pick up your automobile yourself, or if you do not want it to be removed from this site.

Contact Address : ●●City●● TEL : ●●●●●●●●

[Fig. 6-1] Example of a notice to owners, to be attached to automobiles, etc.

【Guide 6-2】 Selection and operation of temporary storage sites

■ Key points

- Temporary storage sites should be set up and operated promptly from the viewpoint of enabling damaged houses to be cleaned up, even if the victims have been evacuated, according to the situation of the disaster area.
- When selecting sites and setting up temporary storage sites, it is necessary to locate them in available parks and vacant lots in a disaster area. Moreover, it is necessary to position them keeping in mind the necessity of allowing access from temporary storage sites to primary/secondary waste storage sites.
- Access must be provided for garbage and dump trucks to allow transportation from the temporary storage site to primary/secondary waste storage sites.
- Since disaster waste is transported by residents and volunteers, the responsible administration has to provide notification about separation rules of waste beforehand. This can be done through the use of an administrative wireless network, distribution of pamphlets, information stickers in evacuation shelters, advising heads of residents' associations, and notification to volunteer centers etc., as the initial reaction to a disaster.
- “Temporary storage sites” can also be called “on-site temporary storage sites.”

■ Selection of location and setting up of temporary storage sites

- (1) Temporary storage sites should be established at sites as close to victims' residences as possible, such as at parks and vacant lots in disaster areas.
- (2) Access must be provided for garbage trucks (4-ton type) and dump trucks (10-ton type).

*As a rule, it is preferable that tsunami debris is accumulated in the primary waste storage sites which have been set up. However, we consider maintaining temporary storage sites that are separate from the primary waste storage sites in disaster areas and access to them.

■ Separation in temporary storage sites

- (1) Reducing the victims' burden should be considered as much as possible in the separation of waste in the temporary storage sites. On the other hand, when proper processing is considered, it is necessary to think about separation as the starting point of the disaster waste treatment in addition to the separation in the primary and secondary waste storage sites. As a rule, combustible waste, non-combustible waste (debris), specified Electrical Home Appliances under the Recycling Law, non-large appliances (PC, etc.), tatami mats, tires, carpets, hazardous and dangerous articles (gas cylinders, heating oil, and fluorescent lamps, etc.) are sorted. It is preferable to load each type into different trucks when transported. **【Fig. 6-2】** Reference image
- (2) The **【Quick Reference for Handling Disaster Waste】** can be distributed and shared since it is drawn up by victims and volunteers.

Waste generated from shopping areas, etc. The removal of the waste by volunteers has begun, too. (4/3 Ishinomaki City)



■ Operation of temporary storage sites (Including volunteers' support)

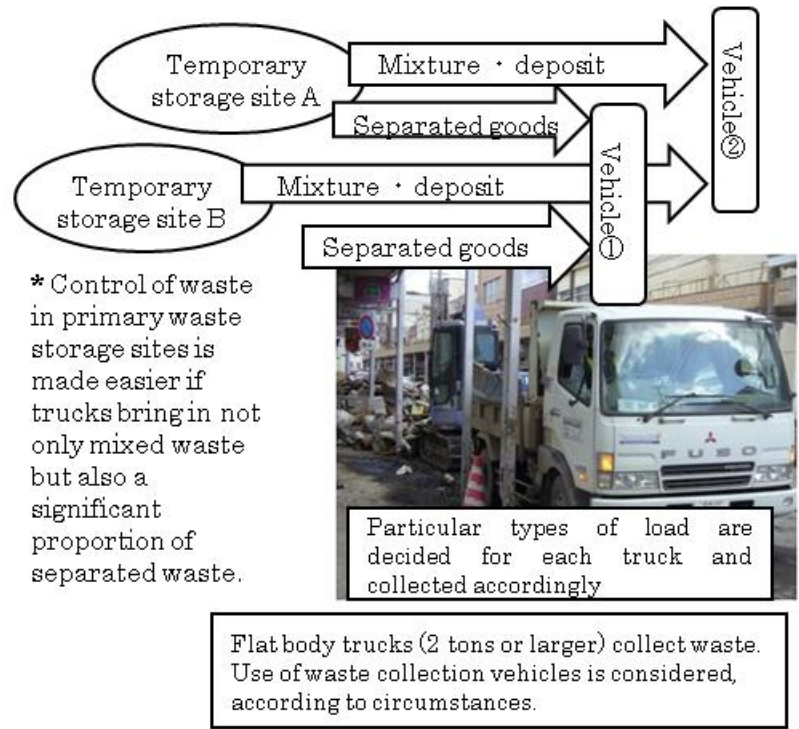
- (1) It is necessary to make arrangements considering separation in the primary waste storage sites and transportation to them. Moreover, it is preferable to assess the amount and state of separation every day, and to estimate the amount of processing and the cost afterwards. When direct weighing of the waste is not possible, loading waste to vehicles could be recorded by digital camera for record-keeping on loading or carrying, to estimate garbage weight visually from the image.
- (2) The extent of separation depends on the strength, understanding, and the leadership of the victims and volunteers who work on each area. So it is advisable to nominate a leader in each area, and to separate within the possible range. Specifically, the following procedures are taken into consideration.
 - The volunteers' mobilization (where, how many, when) is adjusted in cooperation with volunteer centers. Moreover, we consult with them about arrangements for safety equipment and work tools such as buckets, hoses, shovels, wiping cloths, and cutters.
 - Workers must wear masks, shoes with a strong sole (if possible, safety shoes are best, for prevention of penetration of sharp objects), protective clothing with minimum exposure, helmets, and safety glasses for work safety. Also, volunteers work in groups from the viewpoint of secondary accident prevention.
 - It is preferable that volunteers acquire a common understanding through lectures about separation before they begin to work.
 - Removal of household disaster waste, such as tatami mats, becomes easier if cutters are used. For example, tatami floor mats can be cut into thirds or even smaller pieces for easier handling.
- (3) If the setting up of temporary storage sites is delayed, or local notification is not maintained, citizens might begin to carry out open burning. It is necessary to call for "prohibition of open burning" due to negative impacts on the environment and human health that may result from burning of waste.



Hazardous articles are kept together.



Note that kerosene may remain in stoves.



【Fig. 6-2】 Reference : Example of separation in temporary storage sites and transportation to primary waste storage sites

【Guide 6-3】 Selection and operation of storage sites (Primary and secondary waste storage sites)

■ Key points

- The setting up and operation of the primary and secondary waste storage sites (hereafter, jointly called “storage sites”) should be promptly started in accordance with selection of the method of treatment (including commissioned treatment and recycling). It is assumed that it will take about one year to collect all targeted disaster waste in parallel with treatment, and about 3 years to fully complete treatment.
- In some cases, depending on location and state of waste, only primary storage sites are established. When separation in the primary storage sites is insufficient, a secondary storage site is needed. When it is not possible to set up both in the same municipality, the waste should be transported to a secondary storage site in another city.
- Concerning the selection and setting up of storage sites, it is necessary to examine availability of permission from the landowner, use of abandoned disaster-affected land, accessibility and workability of heavy equipment and vehicles, and securing the availability of the minimum amount of water required for fire prevention and extinguishing (if not available, consider the use of on-site sprinkler equipment, etc.). Also, plenty of available space is required for storage of the waste.
- Concerning design of the storage site, it is necessary to apply appropriate separation matched to treatment according to the characteristics of the waste and period of expected storage.
- In storage sites, a simple version of operational management executed at waste landfills has to be carried out. Where possible, measures should be taken to eliminate environmental pollution risk by waste water treatment, water interception, and prevention of waste particles scattering. In the case of toxic wastes, those measures are essential. An adequate measurement of the state of the site (background-state) is important for monitoring.

■ Selection and setting up of storage sites

- (1) Land use and use of abandoned disaster-affected land: It is preferable to set up storage sites using urban areas or farmland that has been flooded, unused publicly-owned land, abandoned land, parks, parking lots, or landfills. Site selection can be carried out referring to “listings of current land use” investigated and kept by municipal and prefectural authorities based on Article 6 of the City Planning Law. Confer on this with the relevant department of city planning if possible.
- *If transportation by sea to a waste treatment facility/disposal site is possible, a primary storage site near the shipping port (wharf where large vessels can moor) should be set up.
 - *If the water supply system is unavailable, groundwater wells might be used. Basically, storage sites should not be set up near them (precisely, this depends on the types of waste). The location of underground streams may need to be checked.
 - *When playgrounds and seaside resorts are used as storage sites, it is often necessary to remove broken glass from the ground after the use of the sites.
 - *From disaster waste directly affected by tsunami, salts will leach out and affect the environment when rain falls. It is necessary to take measures against the leaching by the installation of blue tarpaulins or selecting appropriate places for storage sites where there is no problem even if salts elute (for instance, land in a coastal zone or land formerly used as landfill).

*It is advisable to show in advance preventive measures against pollution and monitoring of pollution level after remediation of contaminated lands to land owners and residents, especially in the case that a privately-owned area is used as a storage site.

*A disposal site of ash from a thermal power plant and its coal yard could be used as a storage site. When cooperation is feasible, the use of those sites should be examined. (Wastewater treatment in case that disaster waste contains organic matter, and a legal procedure to accept municipal solid waste are necessary)

(2) Access roads to a storage site: Prepare access roads (about 12 m or more in width) from disaster area to the storage site, paved with concrete/asphalt/gravel through which large-sized vehicles can pass. The roadbed may need to be stabilized.

*If the separation of debris (stone and concrete rubble) is possible, the rubble can be used as a base material for the roadbed of a temporary access road in flooded areas. When rice fields, dry fields, etc. are used for an access road, it would be better to place blue tarpaulins on the ground before rubble is put in place, for the sake of remediation and protection of soil in the field. Moreover, it is necessary to keep records of the location of the temporary road in case it is turned into a regular road.

(3) The ground of a storage site: It must be flat and large enough (in past cases, sites of about 2 ha or larger were usually used). There must be plenty of space and ground strength that can support 10-ton dump trucks. Especially, when disaster waste is temporarily placed on the soil (including farmland), "iron plates" used as a matt for a temporary road etc., should be used in order to ensure the workability of construction machinery with water sprinkling. Hydraulic and mechanically stabilized slag (HMS) for road can be used as a roadbed. When blue tarpaulins are laid out in a storage site where disaster waste containing oil, salinity, or hazardous substances may be disposed of, waterproof sealing must be done at joints. When the blue tarpaulins are installed under water, the blue tarpaulins must be covered with soil, etc. in order to prevent lifting.

(4) Preparation of water for fire prevention and control: The minimum amount of water must be prepared for fire prevention, extinguishing, and dust control. If water is unavailable, prepare on-site sprinkler equipment instead.

* Separation rules and allocation of storage sites will be described later.

■ Separation rule and design (equipment) of storage site

(1) In order to determine separation rules for waste, consider its treatment method, the hazards of the waste, and expected period of the storage. If storage sites are each set as exclusively for combustible waste, non-combustible waste, and hazardous articles, then management and treatment become easier.

(2) Although separation may be limited, depending on the amount generated and the type of waste, targets are enumerated in **【Guide 7】** .

(3) In consideration of the owners' feelings, "PCs and small home appliance products" and "Photographs, albums, and ancestral tablets" should be carried out so that memories and personal information are preserved. In the case of PCs and mobile phones, if manufacturers (industry lobby) cooperate, information can be extracted according to owners' demands.

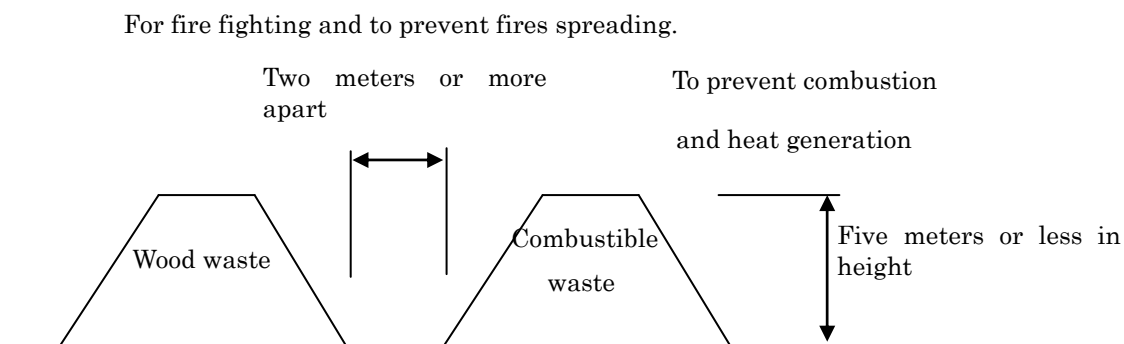
(4) To process large amounts of wood waste and raw wood, a wood crusher and temporary incinerator (**Refer to 【Guide 8-1】**) may be needed for volume reduction. A concrete crusher can be used to process large amounts of debris. Prepare them in cooperation with the timber industry, fishing industry, and/or local

general contractors (with priority). When assistance is given by other municipalities, waste collection vehicles with crushing function should be requested as a priority.

- (5) When there is concern about dirty water being generated by disaster waste, underground seepage must be prevented by using blue tarpaulins, etc. Outside leakage is also to be prevented by installation of drainage trenches, storage ponds, and tanks, etc. around the storage site. (In some cases, dirty water should be collected and treated).
- (6) Waste to be carried in and out must be measured and recorded on a daily basis by using a truck scale (suitable for weighing vehicles including trucks) in order to estimate the amount of waste to be treated and its cost afterwards. When measurement by a truck scale is difficult because of power failure and/or equipment shortage, the amount of waste in temporary storage sites can be estimated by recording the number of vehicles, areas and height of waste deposited. Recording vehicle loads with digital camera enables estimation of the weight of waste from the image.

■ Operation of storage sites (mainly environmental risk measures)

- (1) It is necessary to take measures against noise, air and dust pollution (by using a net to prevent scattering of waste, especially plastic waste, and by water sprinkling), and offensive odors (by scattering of slaked lime, disinfectant, and deodorant). Where shredders and temporary incinerators are used, measures against noise, vibration, and dust are essential. To block sound from storage sites, suitable materials may be chosen from disaster wastes to create a simple enclosure.
- (2) Environmental monitoring should be executed when possible. When evaluating the environmental impact of a temporary storage site, take soil samples from about ten points before waste is placed on it.
- (3) Especially, slaked lime should be sprinkled on wood waste soaked by seawater (wood and collapsed house, etc.). Refer to **【Guide 8-2】** for details.
- (4) To prevent combustion and heat generation, wood waste and combustible waste must not be piled up more than five meters in height. See **【Fig. 6-3-1】**. Since secondary lead-acid batteries (in cars and motorcycles), tires, and stoves (possibly still containing kerosene) might cause a fire, such items must be removed from waste piles. Attention must also be paid to avoid crushing them with heavy machinery. To facilitate fire-fighting and to prevent spreading of fire in such cases, the piles should be located two or more meters apart. Prepare fire extinguishers if possible. (Fire extinguishers discarded as garbage should be collected for reuse.)



【Fig. 6-3-1】 Configuration of waste piles for prevention of combustion and heat generation

- (5) Infiltration of hazardous waste and oil contained in home appliances into groundwater must be prevented by the use of blue tarpaulins. In this case, contaminated water is to be collected by a drainage facility and a temporary storage facility (storage ponds, tanks, etc.) and treated by proper processing.
- (6) Attention is required to ensure the separation and management of PCB and asbestos. Refer to governmental guidelines for details. To provide relevant information on-site, the **【Quick Reference for Handling Disaster waste】** can be used.
- (7) Refer to **【Guide 8】** for responses and notifications regarding other individual wastes.
- (8) It is important to keep in mind that the amount of waste at an urban storage site tends to increase more than expected. Preventive measures for discarding undesigned wastes should be taken as well.
- (9) The workers must wear masks and dustproof safety glasses to safeguard against possible asbestos particles, in addition to appropriate clothing to ensure hygiene and safety. Though it is preferable to wear safety boots due to the threat of nails that could cause tetanus, a thick sock liner can be used in boots when safety boots are unavailable.



Tatami floor mats, etc. are laid down to protect tires of vehicles and workers' feet against glass shards.



Unused fire extinguishers found in debris should be collected for re-use in emergencies.



A waste collection vehicle sent by Kyoto City to assist Sendai City was used in place of a shredder that had broken down.



Flat-tray trucks used for rubble (10-ton type is required).

【Fig. 6-3-2】 Reference: Example of devices in operation (as described in **【Guides 7-2, 7-3】**)

【Guide 7-1】 Examples of types of waste: Waste Management in evacuation shelters

■ Key points

- Evacuation shelters are established immediately after the occurrence of a disaster. Schools and community centers are usually utilized to be evacuation shelters, where victims, i.e. those suffering significantly from the disaster reside temporarily. .
- The situation in each evacuation shelter largely depends on the post-disaster circumstances in the disaster area, the degree of functionality of the local government, on-site conditions, etc. Moreover, the situation and requirements of the evacuation shelter also shift from the immediate response right after the disaster to the time when considering recovery from the disaster. Therefore, it is also necessary to seek the best practice in each evacuation shelter at each different phase of recovery.
- It is also important to collect and analyze information and experiences to obtain lessons learned from past post-disaster responses and ideas for improvement of waste management strategies for both normal states and possible states of disasters in the future. Evacuation shelters in a disaster area accumulate valuable experience-based lessons which should be examined and compiled in order to better prepare for possible disasters in the future, (including the expected functions and quantity of emergency relief supplies, the appropriate supply of support materials, the handling of surplus goods, the increase of waste caused by disposable goods, etc.), drawn directly from experience in large-scale evacuation shelters after an unprecedented catastrophic disaster.

■ Waste from evacuation shelters immediately after the victims' arrival

(1) Evacuation shelters are established immediately after a disaster, in facilities like elementary schools or junior high schools and other facilities designated to be safety evacuation shelters. In other words, as soon as such shelters are set up following a disaster, waste is immediately generated through daily activities of the victims after they move into these evacuation shelters. Though there are some differences in disaster areas concerning how fast and how much support materials



are delivered, each evacuation shelter receives support materials consisting mainly of water and food supplies from the victims' first arrival. Wastes generated during the period include corrugated cardboard, plastic bags and packaging waste, food waste and human excreta, etc. In addition to water and food, blankets and blue tarpaulins, etc. are also delivered.

(2) Immediately following a disaster, the needs for water, food and toilet facilities are particularly high in evacuation shelters. The following waste will be generated. To ensure sanitary conditions, it is advisable to begin waste sorting using corrugated cardboard, garbage bags and labeling supplies (pens, packing adhesive tapes and paper), etc. even though it may be coarse.

- Water: paper cups or plastic cups (in the case of supply by water wagons), empty bottles (in the case of PET bottles)
- Food: corrugated cardboard cartons, plastic packaging waste, cans (boxes for rice balls, bread, crackers, etc.)
- Toilet*: Portable toilets (When obtainable; sealed management is required to minimize infection or

offensive odors even for urine hardened by polymer, for which sanitary storage seems possible).

* Many existing toilets may be unusable due to suspension of water supply and power failure, etc. In the case of combined septic tanks, toilet use becomes possible when water and electricity are restored. In the other cases, sewage disposal is dependent on operability of the sewage disposal plant; however, flushing itself is possible if water and electricity are restored. In emergency settings flushing forcibly, making emergency toilets, and digging holes for toilet use (composting toilets), covering waste with newspaper might be acceptable. Refer to **[Guide 8-17]** for further details.

* Since it is unlikely that temporary toilets are installed at the time of victims' first arrival, it is necessary to send emergency toilets together with drinks and toilet paper when sending support materials. Regarding portable toilets, 800-cc toilets (not as commonly available) are better than the normal 500-cc toilets due to their greater capacity. It would be necessary to improve hermetic sealing for storage of excrement for a certain period of time.

■ Evacuation shelter waste during the period of early recovery

(1) The volume of relief goods received will increase quickly after three days. Not only food but also clothing and daily necessities will begin to arrive. Discharge of corrugated cardboard increases, and waste from daily life also starts to increase. **[Table 7-2-2]** shows how waste sorting can be conducted with consideration of waste types. This is an essential aspect of evacuation shelter management.

(2) When collection of household waste by the local government is resumed, collection of evacuation shelter waste is usually performed as well. In some cases, all may be collected as waste because it is unfeasible to separate recyclables from waste. If possible, waste containing recyclables should be stored at the evacuation shelter until the usual MSW collection is resumed by the local government.



[Fig. 7-1] The situation of a evacuation shelter in Sendai city (newspapers are also separated)

■ 3Rs of evacuation shelter waste (including house evacuation)

(1) Recycling: When collection of waste generated at evacuation shelters is difficult for a disaster-affected local government, it may be possible to use the return route of transportation carrying in support materials or to ask volunteer personnel to take waste away, especially stable recyclables. In particular corrugated cardboard would accumulate in large quantities. Although it will be collected appropriately if paper recyclers resume operations, such take-back would be worth considering.



(2) Reduce and reuse:

The following actions should be considered to counter the tendency of increased waste generation, due to wide use of disposable products for hygienic reasons and convenience, etc.

- Cling film use for tableware: Since it is often impossible to waste tableware, many disposable containers will be used. A good practice observed was that tableware was wrapped with cling film and only the cling film was discarded after meals for reuse of tableware (for individual use only).
- Composting of food waste: Examples were also observed of collection of food waste for recycling by neighboring farmers or dairy farmers.
- Installation of washing machines: if clothing is used and thrown away since washing is impossible, this may result in a large quantity of waste when supply of support materials increases. Installation of washing machines should be considered in the case that evacuation is prolonged.

(3) House evacuation

- Household waste: Household waste collection is generally based on the normal means of MSW collection in both cases of house evacuation and evacuation shelters. Normal waste collection would be resumed with reduced frequency immediately after a disaster in places without tsunami damage. Recyclables would be kept at private houses, which causes stress to citizens. Citizens' cooperation is necessary for a certain period (approximately one month).

- Tsunami-soaked waste:

Household goods inundated by tsunami are discharged as “tsunami-soaked waste” (**[Guide 7-2, 7-3]**). Since this waste contains mud etc., it may be difficult for residents to discard by themselves. Moreover, even if discarded with a help of volunteers, it may be left on the street in front of houses especially when it cannot be stored in a nearby temporary storage site, etc. This can cause obstructions to traffic where roads are made narrower by the accumulated waste.

【Guide 7-2】 Examples of separation ~ garbage from emergency accommodation facilities, household disaster waste, tsunami-soaked waste, at early recovery phase

- At early recovery phase, attention should be paid to “garbage from emergency accommodation facilities (evacuation waste),” “household disaster waste,” and “tsunami-soaked waste.” Generally speaking, the goals include the deployment of collection sites in urban areas and restart of collection services of household waste, etc.
- Separation should be carried out as much as possible in order to maintain hygiene, avoid risks from hazardous waste, and promote reuse and recycling.
- Every effort should be made to follow ministerial guidelines. Such guidelines include those about automobile, ships, asbestos, and PCB-containing electrical equipment such as transformers, and Specified Electrical Home Appliance under Recycling law.

■ Wastes of most concern at early recovery phase

At the early recovery phase, it is necessary to deal with “garbage from emergency accommodation (evacuation waste),” “household disaster waste,” and “tsunami-soaked waste.” (See **【Table 1-1】**). In some areas, recovery may be delayed due to the extent of damage, etc. It is important for even such areas to share information about areas where recovery is proceeding and their know-how in order to promote progress in recovery and reconstruction.

■ Guides for separation and examples

- **【Table 7-2-2】** shows examples of wastes that require proper handling and consideration, among evacuation waste, household disaster waste, and tsunami-soaked waste. At the early recovery phase, first priority should be given to deploying collection sites for these wastes and to restarting collection services for household waste, etc. As the generation of waste tends to be elevated in this phase, we should aim to control the amount of waste generation and collection according to an order of priority.
- Waste treatment cannot be carried out within the jurisdiction of a municipality in some cases. When setting separation rules, it is necessary to take into account the possibility of treating the collected waste in another municipality.
- The guides here are based on the concept that collection and treatment of wastes are to be delayed as much as possible without causing waste/sanitary issues. The reason is due to the facts that capacity of collection sites and intermediate treatment facilities tend to be insufficient and it is difficult to obtain fuel for collection in some cases.
- Basically, most actions to deal with huge amounts of collapsed housing/building debris will be made in the recovery phase. Even in the emergency phase, a certain amount of debris may have to be collected. Refer to **【Guide 7-3】** for this case.

【Table 7-2-1】 Reference: Examples of early actions in the case of East Japan Earthquake Disaster (Sendai city) (compiled by the task force)

Date	Action for waste management	Items of separation and collection
March 13	Decision on deploying one primary waste storage site (to bring in) for each ward (district).	
March 15	Restart of waste collection, limited to household waste only Deployed five primary waste storage sites in the city (Ima-izumi, Seikaen Park, Nishi-Nakada Park, Tsurugadani Central Park, Shogen Park)	Regular collection: Household waste (combustibles) Primary waste storage: three separation categories (burnables, unburnables, and electronics). Workers sorted them further.
March 23	Establishment of a primary waste storage site at Hinode-cho Park baseball ground (The one in Tsurugadani Central Park was closed). When a site becomes full, a new site will replace it, using them in turn.	
March 27	Establishment of a primary waste storage site at Nipperia.	Six separation categories (combustibles, Glass/ceramic waste, debris, WEEE, metal scrap, furniture)
March 28	Restart of funeral hall for pets	
March 29 - April 4	Collection of cans, glass and PET bottles, and batteries (one time only)	
April 25	Restart of collection of plastic packaging waste (Limited collection for a while)	
May 10	All to be closed (according to plan at that time)	



Entrance: Directing vehicles according to congestion inside.

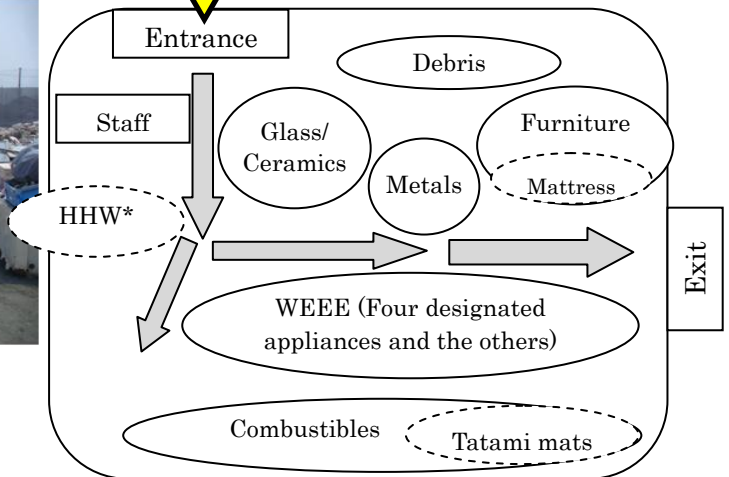


Entrance: Checking categories of waste and giving instructions on disposal.

* It is preferable to sort HHW although this site apparently did not insist on this.



"Debris" was sorted behind "glass/ceramics".



Among "WEEE", designated appliances (TV, refrigerators, washing machines, air conditioners) were stockpiled together.



"Metals" are mainly metal scraps; motorbikes and bicycles were stockpiled adjacently.



"Combustibles" contained some wood, tatami mats, and carpets.



"Furniture" was sorted although the sign says "sofa". (At some sites, mattresses were separated)

【Fig. 7-2】 Reference: A good example of separation at a primary waste storage site for early recovery phase, Nipperia playground, Sendai city; Workers direct and instruct how to sort and unload waste in drive-through style (Similar to deposit sites of municipalities in Western countries).

[Table 7-2-2] Wastes requiring proper handling and consideration at early recovery stage
(Evacuation waste, household disaster waste, and tsunami-soaked waste)

	Early recovery (emergency) phase		Recovery phase
	Collection sites (to bring in)	At restart of collection	Until return to normal
Combustible waste			
Food waste	Received as “combustibles” (until collection is started)	Collected with limited frequency as “combustibles”	Collected with limited frequency as “combustibles”
Diapers and sanitary goods			
Highly degradable waste			
Packaging waste	Requested to be stored on-site; only collected if necessary		
Others (non-degradable)			
Incombustible waste			
WEEE*	Received as “WEEE”		Requested to be stored on-site
Broken glass and ceramics*	Received as “glass/ceramics”		Requested to be stored on-site
Other WEEE			
Motorbikes/bicycles*	Received as “motorbikes/bicycles”		
Furniture*	Received as “furniture”		
Tires*	Received as “tires”		
Metals*	Received as “metals”		
Others			
Recyclables			
Paper			
Plastic packages			
Cans and glass/PET bottles			Collected with limited frequency
Hazardous waste and medical waste			
Batteries			Collected with limited frequency
Lamps	Sorted collection with labeling/wrapping for broken items		Collected with limited frequency
Healthcare (Medical) waste (household)	Sorted collection with labeling/wrapping		
Fire extinguishers, stoves (kerosene), etc.	Sorted collection with caution for accidents		
Other hazardous waste*	Sorted collection with labeling/wrapping		
Others	Requested to be stored on-site; only collected if necessary		
Debris (Large amount of collection will be conducted at the next recovery phase.)			
Debris and tatami mats/carpets	Sorted according to condition (tatami mats, combustibles, etc.)	Requested to be stored on-site; only collected if necessary	
Asbestos-containing materials	Sorted collection with labeling/wrapping – : ministerial guidelines, etc.		
PCB-containing WEEE	Sorted collection with labeling/wrapping – : ministerial guidelines, etc.		

[Color of cells] Red: First priority, Yellow: higher priority, blue: low priority

* Only for waste causing hindrance to recovery

Debris that may contain asbestos (**[Guide 8-13]**) shall be sorted and not crushed/shredded.

【Guide 7-3】 Examples of separation ~Tsunami debris and earthquake rubble at initial recovery phase

- Tsunami debris and Earthquake rubble will be the main focus at the initial recovery phase
- Designate temporary storage sites within a disaster area), and then aim to locate waste storage sites (primary and secondary) in or outside the disaster area.
- Sort debris much as possible, from the viewpoints of hygiene, hazardousness, and reuse/recyclability
- Follow ministerial guidelines regarding; automobiles, boats and ships, asbestos, PCB-containing electrical equipment such as transformers and items subject to the Electrical Home Appliance Recycling Act.

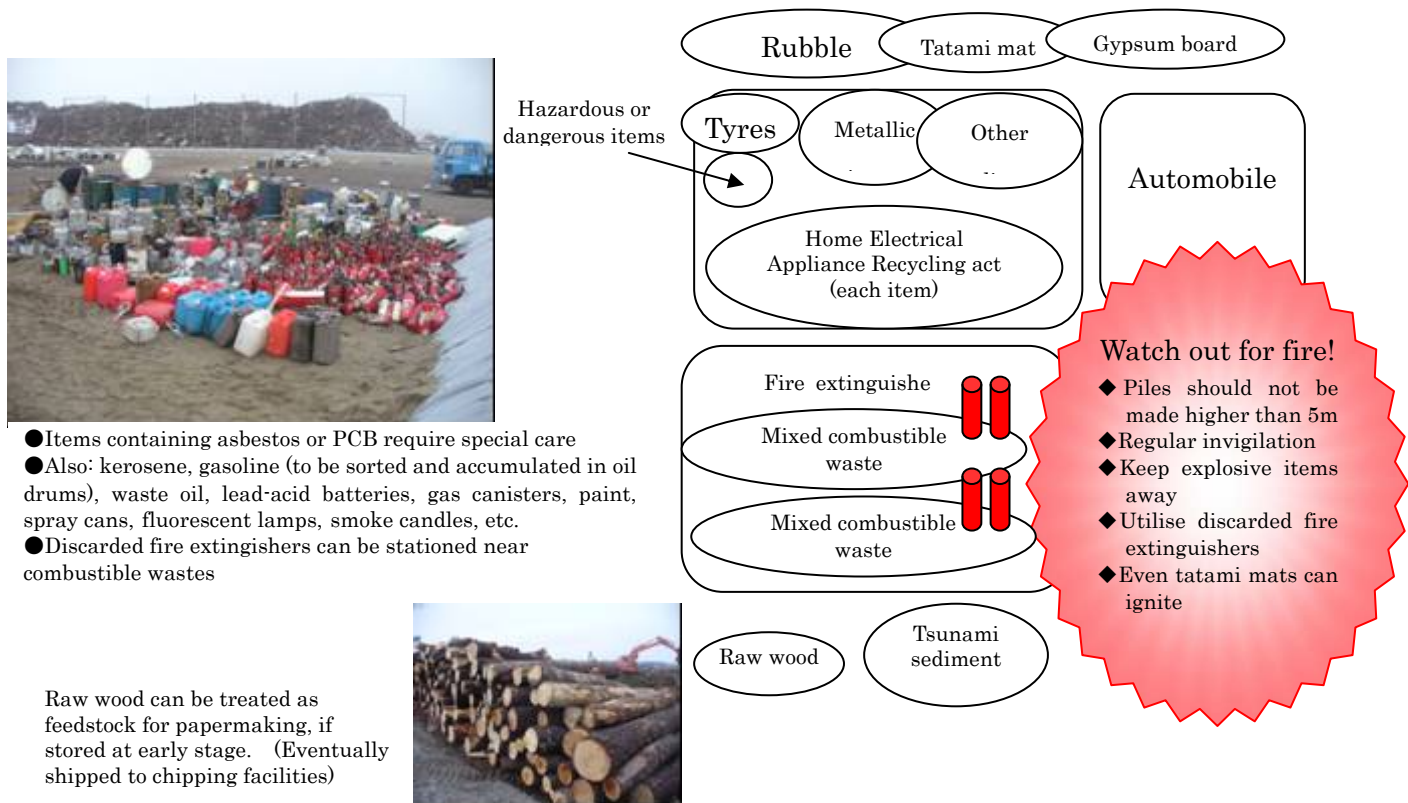
■ Main waste subject to recycling/disposal at the initial recovery phase

In the initial recovery phase, it will be necessary to deal with “tsunami waste (collapsed house by tsunami)” and “earthquake waste” (collapsed house by earthquake) **【Table 1-1】**. To speed up the recovery and reconstruction process, it is important to share the experience and know-how gained in previous cases of recovery, although some areas may experience delayed progress, depending on the local authority and severity of damage. Policies made in the initial recovery phase will greatly affect the later stages of recovery and reconstruction.

■ The basic ideas for and examples of separation

【Table 7-3】 shows an example of separation categories in the initial recovery phase. “Tsunami debris” and “earthquake rubble” in the initial recovery phase are the main waste that should be considered. This table was compiled from the viewpoint of running (primary) waste storage sites. In the initial recovery phase, temporary storage sites will be designated as well as the collection sites. See **【Fig. 5-1】** for chronological development, **【Fig. 5-2】** regarding final separation and disposal, and **【Guide 8】** regarding treatment of specific items.

- Some items may be impossible to treat locally. Separation should take into account the situation outside the local area.



[Fig.7-3] Example of separation at primary waste storage sites for tsunami debris (Sendai City)

[Table 7-3] Wastes that need to be sorted at the initial recovery phase

Waste category	Notes on separation and accumulation of waste	Ideas on waste storage sites and time-span to deal with items	Guidance for disposal
Timber soaked with salt water (demolished houses etc)	<ul style="list-style-type: none"> • Removal of salinity is desirable • To be incinerated (possibly recycled) 	<ul style="list-style-type: none"> • Ideally where it is convenient to remove salinity • Mid- to long term disposal 	● 8-2
Large raw wood	<ul style="list-style-type: none"> • Potentially recyclable 	<ul style="list-style-type: none"> • Short- to mid term disposal 	● 8-3
Timber	<ul style="list-style-type: none"> • Potentially recyclable 	<ul style="list-style-type: none"> • Mid- to long term disposal 	● 8-3
Putrescibles	<ul style="list-style-type: none"> • Detrimental to surrounding environment. May contaminate groundwater • To be incinerated 	<ul style="list-style-type: none"> • Choose a location away from a disaster area • Incinerate within short term 	● 8-1
Mixed combustibles (wood and paper waste, plastics, furniture)	<ul style="list-style-type: none"> • Risk of ignition • In principle to be incinerated (or crushed) (batch with little contamination may be recycled) 	<ul style="list-style-type: none"> • Similar treatment as salt water doused timber may be necessary • Safe area even if it catches fire • Incinerate in mid-term ★ May be useful to classify by the content of extraneous items in the batch 	● 8-1 ● 8-2
Tatami mats and mattresses	<ul style="list-style-type: none"> • Shred and incinerate preferably after removal of salinity and drying 	<ul style="list-style-type: none"> • Treat similarly as salt water doused timber • Dry as much as possible before intermediate treatment 	● 8-1 ● 8-2
Tsunami sediment	<ul style="list-style-type: none"> • Depends on the 	<ul style="list-style-type: none"> • Mid-term landfill * Apply slaked lime if necessary 	● 8-4

(Items covered with the sediment)	characteristics of tsunami sediments		
Concrete debris	<ul style="list-style-type: none"> • Heavy / Environmentally inert • Can be utilised as roadbed material ★ Watch out for asbestos 	<ul style="list-style-type: none"> • Can be accumulated near a disaster area • Mid-term disposal (reuse if possible) 	<ul style="list-style-type: none"> ● 8-6 ● 8-13
Tyres	<ul style="list-style-type: none"> • Recyclable as fuel 	<ul style="list-style-type: none"> • Relatively easy to handle (risk of fire) 	<ul style="list-style-type: none"> ● 8-7
Gypsum board and slate board	<ul style="list-style-type: none"> • In some cases recyclable ★ Watch out for asbestos 	<ul style="list-style-type: none"> • Mid- to long term disposal 	
Item subject to the Electrical Home Appliances Recycling Law, automobiles, boats and ships, and motorcycles	<ul style="list-style-type: none"> • Risk of ignition and explosion • Potentially recyclable 	<ul style="list-style-type: none"> • Avoid piling up the items • Cover ground with blue tarpaulins (items may leak oil) • Recycle in mid-term 	<ul style="list-style-type: none"> ● 8-8 ● 8-10 ● 8-11 ● 8-12
Personal computers and small electronic equipment	<ul style="list-style-type: none"> • Owners may seek to recover memory media • Potentially recyclable 	<ul style="list-style-type: none"> • Sheltered area is desirable • Need to provide access for owners 	<ul style="list-style-type: none"> ● 8-9
Other household appliances	<ul style="list-style-type: none"> • Risk of ignition (check and remove leftover fuel from oil heaters) • In principle to be crushed and incinerated 	<ul style="list-style-type: none"> • Avoid piling up the items • Cover ground with blue tarpaulins (items may leak oil) • Mid-term disposal 	<ul style="list-style-type: none"> ● 8-9
Hazardous waste, (Fire extinguishers, asbestos, PCB, etc.)	<ul style="list-style-type: none"> • Separation, packing, labelling may be necessary (Ministerial guidelines) 	<ul style="list-style-type: none"> • Cover ground with blue tarpaulins • Items that could be scattered should be stored in oil drums • Sheltered area is desirable 	<ul style="list-style-type: none"> ● 8-13 ● 8-14 Ministerial guidelines
Personal valuables (photos, mortuary tablets, etc.)	<ul style="list-style-type: none"> • Owners may come searching for them 	<ul style="list-style-type: none"> • Sheltered area is desirable • Need to provide access for owners 	<ul style="list-style-type: none"> ● 8-15

【Guide 7-4】 Removal and separation of waste from collapsed buildings

- Removal of collapsed house by tsunami is carried out in groups divided according to district and date, under the instruction and consideration of municipal staff.
- 1) Waste metals, 2) raw wood, 3) home appliances, 4) automobiles, 5) hazardous articles (gas cylinders and fire extinguishers, etc.), 6) rubble (concrete and asphalt), 7) tatami floor mats, mattresses, and 8) valuables and items of sentimental value are sorted as much as possible.

■ Key points

- In this Guide, “collapsed houses by tsunami” refers to waste of house/building structures collapsed and household goods washed away by tsunami, not including houses/buildings affected by tsunami required to be demolished for waste disposal.
- The owners’ approval should be obtained as much as possible. The clean-up schedule and district is to be informed beforehand, according to the governmental guidelines and **【Guide 6-1】**. For documentation, photographs must to be taken before and after the cleanup.
- After setting work policy (including commissioned company’s work, separation, and coordination with municipal staff), the clean-up site, the schedule, the carrying-in route, and the group composition (the number of workers from the municipality and commissioned company and the necessary quantity of heavy machinery), commission a company which will undertake operations. Arrangements should be made so that the commissioned company is instructed according to the directions of the municipal staff. Since the movement of large vehicles is expected to increase, it is necessary to design access road appropriately in a clean-up work area and to the primary waste storage site.
- Especially, since many inquiries and direct contact with residents are expected, it is preferable that related information should be shared with the persons concerned, and Q&A should be prepared.
- It is assumed that these collapsed building wastes have already been searched for missing persons, mixing various materials. However, it is preferable to sort them on-site, if possible, and transport them to a primary waste storage site. Specifically, 1) waste metal, 2) raw wood, 3) home appliances, 4) automobiles, 5) hazardous articles (gas cylinders and fire extinguishers, etc.), 6) rubble (concrete and asphalt), 7) tatami floor mats, mattresses, and 8) items of personal valuables etc. should be sorted as much as possible.

■ Notes

- Ensure the safety of workers and all persons concerned, and confirm information sources (distribution of radios) when a tsunami warning is officially announced and provide information on evacuation sites in advance.
- Water sprinkling is necessary to prevent dust and asbestos from spreading. In addition, workers and observers must wear protective equipment such as dust masks and safety glasses.



Separation and removal are carried out more efficiently by heavy machinery and hand work.



Items of personal valuables are stored for safe-keeping.



A fire extinguisher is provided in a work area.

【Fig. 7-4】 Reference: View of cleanup that commenced on April 22, 2011 in Sendai City (scheduled duration is approx four months)

【Guide 7-5】 Countermeasures against airborne dust using dust masks

■ Key points

- It is important that workers and volunteers wear an appropriate dust mask to prevent and reduce exposure of dust from disaster wastes such as collapsed houses by tsunami and tsunami sediments. The Ministry of Health, Labor and Welfare (MHLW) issued a Notification Concerning Prevention of Occupational Injuries in Disaster Recovery Works, which describes preventive measures against dust-associated risk.
- An ideal countermeasure is to wear an all-round dust mask and prevent exposure to all hazardous substances that might exist, because it is difficult to specify what kind of compounds may be contained in airborne dust. Actual state of chemical contamination of dust resulting from the Great East Japan Earthquake is unclear as the tsunami collapsed and washed away many buildings and houses probably containing hazardous articles. It is also important to apply more suitable countermeasures against dust based on results of air quality monitoring.

■ The significance of a dust mask

- A dust mask is a respiratory protective device that prevents inhalation of airborne dust containing substances hazardous to human health.
- At sites where poisonous gases such as volatile organic solvent and carbon monoxide exist, a gas mask must be worn. It prevents exposure not only to poisonous gas but also to airborne dust.
- Countermeasures against airborne dust through use of a dust mask, but not a gas mask, are described in this chapter. If you need information about gas masks, please contact the Japan Safety Appliances Association (<http://www.jsaa.or.jp>; in Japanese).

■ Types of dust masks

- Several types of dust masks are available. It is important for workers and volunteers to select an appropriate dust mask from MHLV-certified products. Be sure to check the certification label attached (See Figure). Masks for pollen are less effective in blocking airborne dust from debris.
- Disposable and replaceable types are identified by the letters “D” and “R”. Masks labeled “S” and “L” are those used for solid and liquid particles, respectively. If oil particles (oil-mist) exist in the work environment, you should use an “L” type mask. If no oil particles are present, you can use an “L” or “S” type mask.
- Dust masks are categorized into three types, based on particle trapping efficiency (*): Class 1 is over 80%, Class 2 is over 95%, and Class 3 is over 99.9% (**【Table7-5-1】** **【Table7-5-2】**). Select appropriately, according to potential hazardous substances in dust particles. (*Sodium chloride (particle size: 0.06 to 0.1 μm) and dioctyl phthalate (particle size: 0.15 to 0.25 μm) are used for measuring the trapping efficiency of solid and liquid particles, respectively.)

**Be sure to use products with
national certification!!**

The following labels are displayed on certified products.

Example of label
displayed on
replacement-type
dust masks (Class
RL2 Heisei 20
certified)



国(平20)検
第TM〇〇号
DR「直」RL2

Translated from a leaflet by the Japan Safety Appliances Association and Japan Respirator Manufacturers Association.

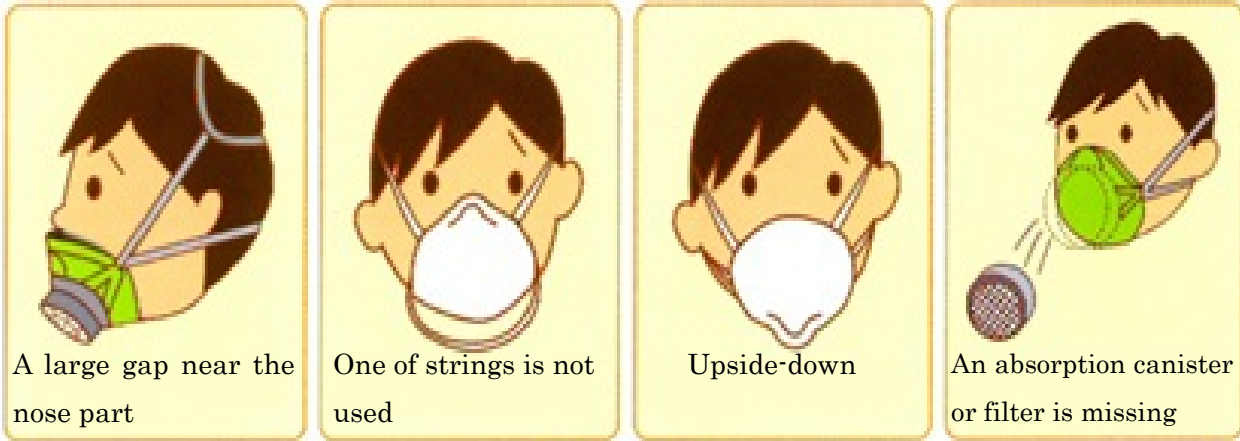
■ Putting on a dust mask

- Select a suitably-sized mask and confirm that it fits properly. MHLW has issued a notification to carry out a fitting test before selection and use of a mask. For details of the Notification, access the website of the Japan Industrial Safety and Health Association, Advanced Information Center of Safety and Health (<http://www.jaish.gr.jp/anzen/hor/hombun/hor1-46/hor1-46-4-1-0.htm>; in Japanese).
- When you put on a mask, make sure that the straps hold the mask tightly against your face. If you feel any air leakage, confirm mask fit by: (i) Adjusting the position of the mask; (ii) Adjusting the length of strap; (iii) Checking the connection status of parts such as an air release valve.
- Air leakage caused by poor fit of a mask significantly reduces the particle trapping efficiency even when an appropriate mask is selected. The following figure shows cases of inappropriate use of a mask.

Wear your mask properly



Avoid these cases



Fit your mask to your face firmly.

Make sure that your mask fits your face properly.

【Fig. 7-5】 Examples of inappropriate use of dust masks

Note: Translated from a leaflet by the Japan Safety Appliances Association and Japan Respirator Manufacturers Association.

【Table 7-5-1】 Labels of dust masks with different trapping efficiencies

Trapping efficiency	Replaceable type		Disposable type	
	For oil mist	For solid particles only	For oil mist	For solid particles only
Class 3: more than 99.9%	RL3	RS3	DL3	DS3
Class 2: more than 95%	RL2	RS2	DL2	DS2
Class 1: more than 80%	RL1	RS1	DL1	DS1

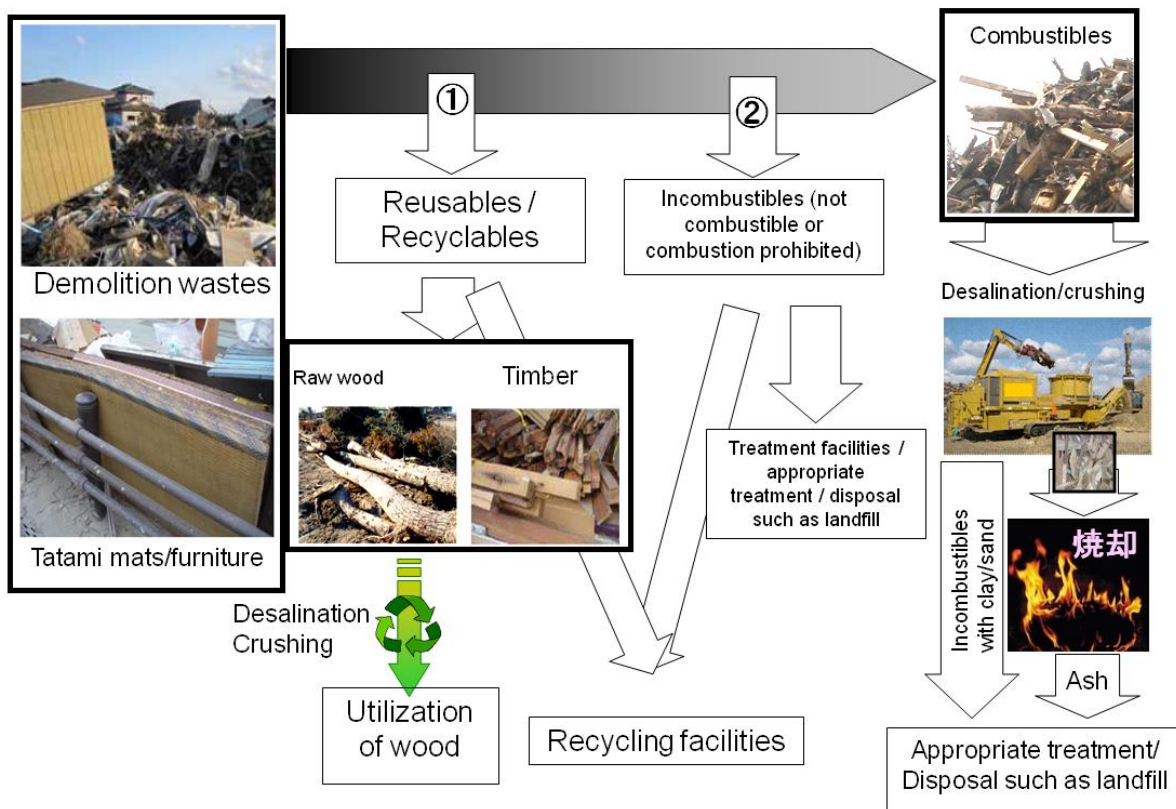
Note: Illustrations are quoted from a leaflet by the Japan Safety Appliances Association and Japan Respirator Manufacturers Association.

【Table 7-5-2】 Appropriate dust masks to be used, according to types of particles and work

Types of works	Types of particles	
	Oil-mist (liquid particles)	Solid particles
<ul style="list-style-type: none"> - Works incurring possible exposure to dioxins or radioactive substances - Or any work similar to the above 	RL3	RS3 RL3
<ul style="list-style-type: none"> - Work where specified particle matters* are present *Asbestos, cadmium, chromium acid, bichromium acid, and their compounds (Legal management level for working environment is lower than 0.1 mg/m³) - Work in which metallic fumes are generated, such as welding and cutting of metal - Or any work similar to the above 	DL2 DL3 RL2 RL3	RS2 RS3 DS2 DS3 RL2 RL3
<ul style="list-style-type: none"> - Work involving dust particles other than those listed above 	L type	Any types

【Guide 8-1】 Mixed wastes containing combustibles

- Mixed wastes are, after removal of reusable/recyclable and incombustible wastes, to be incinerated with appropriate combustion conditions and flue gas treatment.
- Those wastes can be utilized for cement production, boilers and blast-furnaces. However chlorine (due mainly to seawater) and foreign matters in the wastes may limit such utilization.
- In the case of long-term storage of wastes, due care must be taken to avoid ignition and fire.
- Open-burning is prohibited in principle for public health and environmental protection.



【Fig. 8-1-1】 Basic treatment flowchart for combustibles

■ General points

- At first, remove 1) Reusables/recyclables and 2) Incombustibles from large-sized housing timber, mixed wastes containing combustibles, tatami mats and furniture. These combustible wastes are to be reduced in volume and stabilized by incineration, and then ashes generated are to be disposed of in a landfill site.
- To reduce the formation of hazardous substances such as dioxins in the process of incineration, high temperature (over 800 degree Celcius) and adequate exhaust gas treatment are desirable, and pretreatments of waste such as washing salinity (see 【Guide 8-2】) and mud away from wastes are preferable.
- Incineration facilities should be equipped with a good combustion control system and exhaust gas

treatment. First of all, availability of the existing facilities should be examined. In the case that capacity of the facilities in disaster area or neighboring areas is not sufficient, installation of a temporary incinerator is examined.

- Wastes can be used in cement plants, boilers and blast-furnaces. However, chlorine and foreign matters in the wastes may limit such utilization. In the case of the utilization in cement production, chlorine concentration should be below 0.1%. Details are described in **【Guide 8-3】**. It is important to take these factors such as treatment capacities into consideration, when creating a disaster waste management plan.
- For storage of waste containing combustibles, due care must be taken to avoid ignition and fire.
- Open-burning is prohibited in principle by law, for public health and environmental protection.

■ Separation/Removal

(1) Mixed waste would contain many kinds of incombustibles such as nails, clay-wall and exterior-wall boards other than seawater and mud. Separation as specified below should be carried out as much as possible to reduce low-grade combustible wastes.

- Sort reusables/recyclables (see **【Fig. 5-2】**) from mixed waste at the early stage.
- Use different blocks in a storage site according to the level of dirt and content of foreign matters.
- Separate and remove incombustibles from mixed waste.

(2) Incombustibles that tend to be contained in mixed waste containing combustibles are clay/sand, concrete rubble, tiles, gypsum boards, glass wool, glass, metals, wires, and WEEE. Separate/remove them from mixed waste by hand sorting with heavy machinery. In some cases separation by sieving might be necessary depending on the treatment conditions (explained later).

(3) Objects that should be separated and removed prior to incineration are PVC (see **【Fig.8-1-2】**) and explosives.

■ Storage/Pretreatment

(1) Salinity removal: Salinity should be removed as much as possible from timber, etc. soaked in seawater (see **【Guide 8-2】**)

(2) Crushing/Separation

- Size of furniture, tatami mats and mattresses should preferably be reduced by crushers or cutters. Size reduction is beneficial since wastes can be fed easily into an incinerator and transportation efficiency will be improved by increasing loading density. Incombustibles and foreign matters should be removed sufficiently before size reduction.
- For crushing and cutting, existing or temporary large-scale facilities can be used. Hydraulic excavators (mini-size jumbos/backhoes: see Pictures) or mobile crushers (e.g., chippers, tab grinders) may also be used in the case of treating small amounts of wastes.
- Incombustibles which cannot be removed by simple separation such as adhered clay/sand, deposits and metal particles on waste are to be separated by dry/wet gravity separation (e.g., by immersing in a pool), magnetic separation or sieve separation (e.g., trommels). Removed incombustibles are disposed of at authorized sites. Since they often contain a small amount of combustibles and organics, they should preferably be disposed of at controlled landfill sites.

(3) Avoidance of ignition and fire: Measures specified in " **【Guide 6-3】** Selection and operation of storage

sites (mainly for environmental risks)" are important. In particular, if tatami mats are stacked together, there will be risks of the growth of molds and fungi and possible ignition. For this reason, tatami mats should be treated at the earlier stage and special attention is required during storage — mixing with other wastes is one solution.

- (4) Priority order of treatment: Problematic wastes causing odor and sanitary issues should be treated first of all.

■ Incineration/Combustion (including energy recovery facilities)

- (1) Some waste, depending on the characteristics of wastes, can be used at cement production plants. However, chlorine and foreign matters in the wastes may limit such utilization. When waste is used for cement production, for instance, chlorine concentration should be below 0.1%. More details are provided in **【Guide 8-3】**.
- (2) Incineration should be implemented at high temperatures (above 800 degree Celsius) with adequate exhaust gas treatment. It is preferable that incinerators are equipped with a heat recovery system, but other factors such as the capacity of facilities, transportation methods, and urgency of treatment may be more important in disaster waste management.
- (3) The use of existing municipal solid waste incinerators in the municipality should be considered in the first priority. There also are several alternatives:
 - Industrial incinerators for fishery waste can be used depending on the type of wastes.
 - Installations of temporary incinerators or the use of existing incinerators located outside the municipality should be considered when the amount of wastes exceeds available capacity of the incinerators in the municipality due to damage, etc.
- (4) Temporary incinerator
 - Temporary incinerators must be equipped with exhaust gas treatment and the combustion temperature must be controlled properly (above 800 degree Celsius). Two types of available temporary incinerators use are shown in **【Table 8-1】**. These were selected from the viewpoint of short installation time, i.e. taking only a few months to construct (strictly speaking, depending on capacity). There is no significant difference in the installation cost between the two if the capacities are about the same.
 - It would be effective to utilize different types of temporary incinerators jointly for increasing efficiency of waste treatment in a disaster area. For instance, rotary-kiln type and stoker-type furnaces (including fixed-bed type) are installed in the early recovery stage to treat wastes suitable for each type and/or waste which needs urgent treatment. This would reduce the amount of wastes piled up at waste storage sites. Remaining wastes are then transported to an existing incinerator or a newly built stoker-type incinerator equipped with a heat recovery system for proper treatment.
 - Even in the case of treatment by temporary incinerators, exhaust gas treatment for the removal of dust and HCl is necessary to prevent environmental pollution caused by exhaust gas from the stack.
 - Cooling equipment should be installed to reduce exhaust gas temperature to 200 degree Celsius before entering a dust collector. The gas temperature should be measured and recorded. In addition, use of a continuous measurement and recording system for gas temperatures in the combustion chamber is desirable.
 - Temporary incinerators are usually built outdoors, and heat recovery by such incinerators is difficult. However, consideration of hear recovery should be encouraged. A melting furnace is another alternative but

may not be practical due to its long installation period (1 to 2 years) and difficulty in fuel or electricity acquisition.

- Disaster waste is more likely to contain various kinds of waste as compared to ordinary municipal solid waste, and thereby it dirties and damages the furnace and its stokers more. It is therefore important to select an incinerator that can be maintained and cleaned easily.

(5) Incinerators outside the disaster area

In the case that disaster waste is treated by municipal solid waste incinerators outside of the disaster area, types of waste to be treated should be selected cautiously and mixing ratio of disaster wastes and ordinary waste should be determined so as not to disturb waste treatment of the municipality. In the case of incinerating mixed wastes from collapsed houses by tsunami, it is desirable to accept only sorted waste and/or incinerate them after mixing and diluting with other waste. This would avoid the following problems: unstable combustion due to unstable calorific value of waste, increased clinkers and ash, difficulty in discharging ash, and subsequent insufficient treatment of exhaust gas.

(6) Control of wastes to be incinerated:

As in the case of ordinary incineration, calorific values of waste to be incinerated should be adjusted at an optimal condition by mixing plastics and wet waste.

【Table 8-1】 Types of temporary incinerators and their features

Type	Features
Rotary-kiln type	<ul style="list-style-type: none"> - Suitable for incinerating wastes with high calorific values (e.g., plastic waste) and wastes which tend to show fluidity in the course of combustion. Because combustion air is supplied to the surface of waste, carbonized materials and clinkers may be generated depending on the extent of mixing waste. Due care should be taken when burning wood waste or wet papers in order to minimize generation of such materials. - When inlets of burners and combustion air are placed at the front side of the kiln together with a waste feed, the size of the waste feed has to be small. Crusher is necessary. - Operation is relatively easy. Depending on the extent of mixing waste and the supply of combustion air, gas flows, temperatures and exhaust gas properties may fluctuate occasionally and therefore should be monitored with caution. - The diameter of the kiln should be larger than 2m for removal of clinkers, and appropriate capacity of a furnace is considered to be 100 ton/d. Note that the volume of exhaust gas from the stack becomes larger when employing water-sprays for cooling of combustion gas.
Stoker-type (including fixed bed type)	<ul style="list-style-type: none"> - Stoker-type furnaces, owing to efficient supply of combustion air and high performance of mixing wastes, have been employed to ensure stable treatment of various wastes ranging from relatively high calorific value to those with high ash content resulting in low calorific values. To reduce the formation of clinkers, this furnace is suitable for incinerating wastes with smaller residue content. - Fixed bed furnaces' mixing performance is not necessarily high. The size of wastes should be reduced to 150mm or smaller by a crusher as pretreatment and

distributed onto the grates (stoker). Auxiliary fuel burning equipment is necessary to cope with fluctuation of properties of waste.

- Be aware that waste might become stuck between the stokers or grates and that the grates might be abraded, damaged or fall down.
- Stoker-type furnaces can feed large-sized waste (*). However, the use of crushers is encouraged to reduce the size of waste because the waste feed of the furnace is designed so that it is sealed with waste.
- For continuous operation of fixed-bed type furnaces, it must be equipped with a sealing device at the waste feed and automatic discharge device to remove ash from the grates.
- When heat is not recovered from an incineration process of a disaster waste, water-spray cooling of combustion gas is to be employed. In this case, the volume of exhaust gas becomes larger. Installation of two-or-more small stoker-type furnaces (e.g., <50 ton/d/unit) can be an option.

* Appropriate size of waste: Maximum size of waste to be fed to furnaces varies according to feeding methods and sealing equipment of the furnace.

■ Caution: Open burning (forbidden in principle)

(1) According to the Waste Management and Public Cleansing Act, open-burning is forbidden for the following reasons:

- Increase of respiratory diseases and deterioration of eyesight caused by fumes and dust.
- Virtual impossibility of control of generation, distribution, and pollution of hazardous chemical substances such as dioxins.
- Increased risks associated with a runaway fire.

【Reference】 Waste Management and Public Cleansing Act, Article 16 (Prohibition of Incineration)

Article 16-2 No one shall incinerate waste except the following methods.

- 1) Incineration of waste, which is conducted in accordance with the municipal solid waste disposal standards, the specially controlled municipal solid waste disposal standards, the industrial waste disposal standards and the industrial waste requiring special treatment standards.
- 2) Incineration of waste, which is conducted in accordance with the other acts or disposal method based on these acts.
- 3) Incineration of waste, which has no other way to be incinerated for the reason of the public good or social custom, or which only has a slight impact to the living environment of the surrounding area as specified by the Cabinet Order.

(2) Meanwhile, the Ordinance for Enforcement of Waste Management and Public Cleansing Act (Article 14) also refers to exceptions. Among them, the following two cases could specifically be applied to the case of recovery and reconstruction from the Great East-Japan Earthquake.

- Incineration of garbage commonly practiced in daily life on a small scale such as small open fire.
- In the case that local or neighboring “incineration facilities” have stopped operating due to the

damages caused by earthquake/tsunami, while wastes need to be incinerated locally and urgently in order to prevent serious public health problems such as an expansion of infectious diseases.

【Reference】 Ordinance for Enforcement of Waste Management and Public Cleansing Act, Article 14 (Incineration of waste exempt from the prohibition of incineration)

Article 14: Incineration of waste specified by Article 16-2-3 of the Cabinet Order is as follows:

1. Incineration of waste necessary to control the facility by the national/local governments.
2. Incineration of waste necessary for prevention of, emergency actions against, and recovery from earthquake, wind and flood damage, fire, freeze and frost damage, and other disasters.
3. Incineration of waste necessary to conduct social customs or religious ceremonies.
4. Incineration of wastes inevitable in agriculture, forestry or fishery.
5. Incineration of garbage commonly practiced in daily life on a small scale such as small open fire.


(3) However, even when open-burning is carried out as an exception in accordance with (2), the following measures should be taken without fail.

- Measures against spread of fire
- Removal of PVC and timber treated by CCA to avoid generation of toxic substances. (see **【Fig. 8-1-2, 8-1-3】**); Both materials would contribute to generation of toxic substances such as dioxins.

◆ Widely used products containing PVC:
Wallpaper, sash, vinyl film (mostly agricultural)/sheets and water pipes (mostly grey)

◆ Distinguishing method
Use of handy-type analyzers using infrared rays, or the method as described on the right.

◆ Simple method to distinguish PVC in plastics



- ① Heat a piece of copper wire
- ② Scrub and take a part of sample by the heated copper wire
- ③ Ignite the copper wire with sample. If the sample contains chlorine compounds, a green flame will be produced.

*If PVC is sorted from other waste, it can be recycled.

【Fig. 8-1-2】 Methods to distinguish chlorine compounds such as PVC (The figure is cited from <http://homepage3.nifty.com/asanoyayoi/>)

◆ Judgment on appearance

1) Cut or scrape wood to clean the surface or show the cross-section.

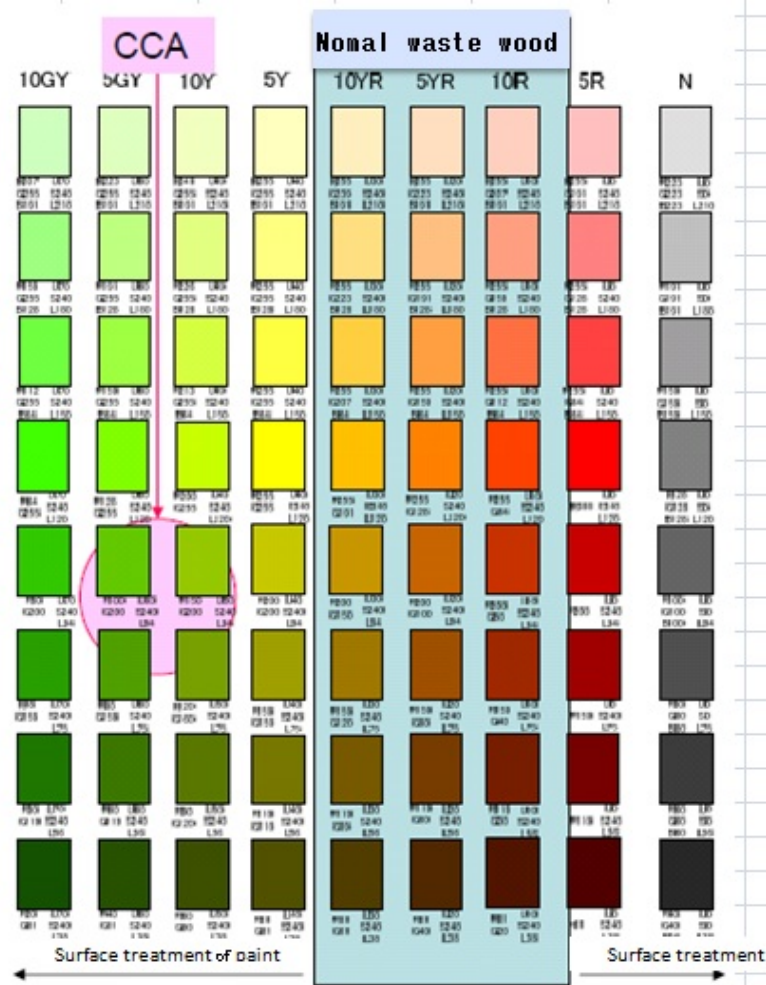
2) Assess the surface by color. CCA treated wood has greenish color (refer to color samples). Wood not treated by CCA (but containing Cu) sometimes exhibits a similar color.

◆ CCA: Wood-preservatives

containing a fair amount of heavy metals (chromium, copper and arsenic)

are often used for treatment of columns in houses. The chemicals penetrate to the depth of 10mm from the surface by pressurized injection.

◆ Distinguishing method: Reagent or handy-type analyzer using near-infrared rays, or by the method described on the right.



[Fig. 8-1-3] A method to distinguish CCA treated woods by appearance

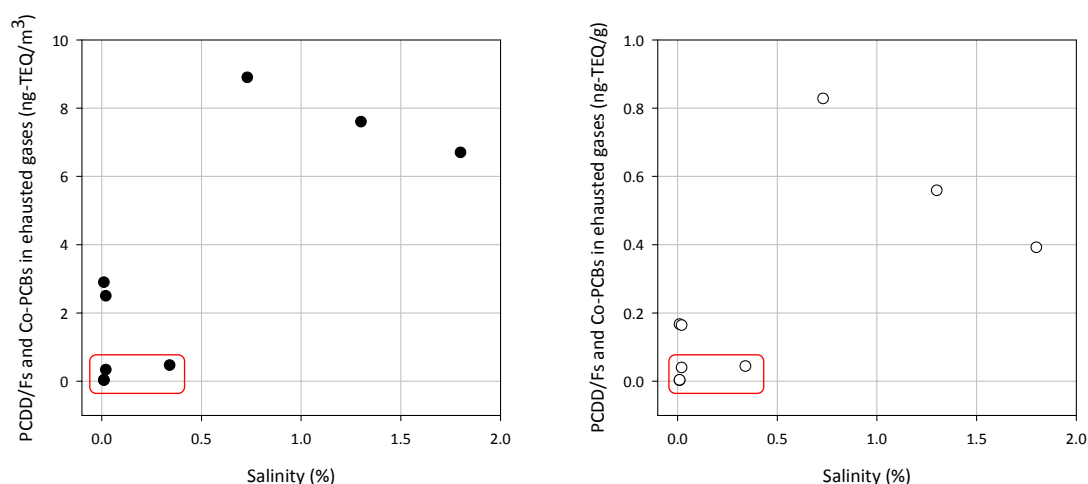
【Guide 8-2】 Desalination of wood waste soaked in seawater

- The Great East Japan Earthquake generated tsunami waste such as wood waste soaked in seawater.
- Basically, wood waste containing salinity should be incinerated at high temperature for subsequent exhaust gas treatment after desalination by exposure to rainfall.



■ Key points

- Tsunami waste treatment following the Great East Japan Earthquake is essential. Waste wood soaked in seawater should be treated very carefully.
- Waste wood containing salinity should be incinerated in an incineration plant with exhaust gas treatment at a temperature above 800 degree Celsius for reduced generation of toxic substances such as dioxins from the treatment. Ideally, salinity and adhered tsunami sediment of wood waste should be reduced during storage.
- Although correlation between salinity and generation of dioxins is still unclear, it has been reported that, due to exposure to seawater, dioxins emissions from incinerators doubled (The report identified salinity in municipal waste as the cause of the generation of dioxins).



【Fig. 8-2】 Correlation between salinity and generation of dioxins at incineration.

Combustion time of wood with various levels of salinity was about one or two hours. Exhaust gases were collected at the outlet of the combustion chamber and analyzed by gas chromatography/mass spectrometry (GC/MS). Plots circled in red were gases incinerated in the combustion chamber at temperatures above 800°C. The others were treated at temperatures ranging from 549 to 618°C.

Note: Salinities of less than 0.01% were plotted as 0.01% in Figure 8-2.

(Produced from data in Yasuhara et al. Environ Sci Technol. 2003, 1563-1567.)

- Wood waste and drift waste from which salinity is removed to a certain extent, as well as wood waste from collapsed houses generated inland may be re-used . Refer to **【Guide 8-3】** for further information.

■ Treatment in storage sites

- Wood waste soaked in seawater should be exposed to rain to reduce salinity. Exposure to river or agricultural water is more effective.
 - Salinity from seawater soaked into wood up to one centimeter from the surface. According to a report, it is possible to reduce salinities from 2-3% to 1% by exposing to 80 millimeters of cumulative rainfall. In the case of the Great East Japan Earthquake, salinity would be removed from wood waste at the time of the rainy season.
 - Be sure to store wood waste with particular attention to spontaneous ignition and fire until the end of desalination. Limit the height and area of piles of wood to less than 5 meters and 200 square meters, respectively. Separate wood piles at intervals of 2 meters.
 - Incinerate wood waste promptly after desalination and/or sprinkle slaked lime on wood waste in order to prevent generation of molds and fungus which tend to grow as salinity decreases and the temperature increases.
- * When removing salinity from wood waste without using a blue tarpaulin on the ground, note that leached salinity would accumulate in surrounding soil. Therefore, when selecting collection sites, it is important to consider the expected use of the land after the closure of the site. If possible, it is advisable to place collection sites of waste wood near the coast and/or alongside rivers.

■ Incineration at municipal solid waste incinerators, etc.

- Incineration should be implemented at high temperatures (above 800 degree Celsius) with adequate exhaust gas treatment. If wood waste containing soil and tsunami sediment is incinerated, the furnace may be physically damaged by incombustible solids called clinkers.
- Incinerating wood waste together with plastics, which have high calorific value, will increase combustion temperature and contribute to reducing the formation of dioxins.
- Please refer to **【Guide 8-1】** for detailed information about incineration.

■ Notes

Proper combustion conditions for wood waste from collapsed houses should be examined by combustion experiments, etc. prior to incineration because wood might have been treated by CCA or contain tsunami sediment. Combustion of these contaminants may cause physical damage to incinerators and/or environmental pollution.

【Guide 8-3】 Wood waste (reuse, recycling)

● Large raw wood, timber from sawmills and relatively clean wood waste mainly from demolished houses could be reused or recycled. An appropriate separation strategy should be implemented by taking into account the quantity of waste that can be accepted, and other conditions.



● These wood wastes should be sorted and stored suitably so as not to be mixed with other wastes.

● Raw wood can be used as a raw material for paper manufacturing. Relatively clean wood waste from demolished houses can be used as various raw materials after being chipped.



■ Key points

- Large raw wood, timber from sawmills and relatively clean wood waste mainly from demolished houses could be reused or recycled. An appropriate separation strategy should be implemented by taking into account the quantity of waste that can be accepted, and other limitations.
- Raw wood can be used as a raw material for paper manufacturing, and relatively clean wood waste from demolished houses can be used in various raw materials after being chipped. These wood wastes should be sorted and stored so as not to be mixed with other wastes. Chipping should be done shortly before processing of wastes to avoid decomposition and fire.

■ Options of reuse and recycling and their requirements

- Possible available methods of reuse and recycling of wood waste and their requirements are summarized in **【Table 8-3-1】** based on existing reuse/recycling methods.
- Raw wood can be used as a raw material for paper manufacturing, wood wastes mixed with other waste can be used as a raw material for cement manufacturing, and relatively clean wood waste from demolished houses can be used as various raw materials after being chipped. Recycling as litter and compost is not considered in this section due primarily to concerns about degradation of the quality of materials.
- Among methods of energy recovery from wood waste, direct combustion is the most common practice. To improve energy efficiency gained, research and demonstration studies have been carried out for gasification, biodiesel fuel and methane or ethanol fermentation.
- Each reuse/recycling facility has a different criterion to receive and process wood wastes and a different treatment capacity. Selection of a facility should be made carefully after operating and treatment conditions at the time (including qualities of the wastes accepted) are investigated and the conditions of wood waste to be recycled are



considered. With the aim of contributing to recovery from a disaster and development of local industries, priority should be placed on local use of recycled wood within the area.

■ Crushing/Separation

- Wood waste can be recycled after chipping, according to the following three scenarios, depending on where chipping is carried out.


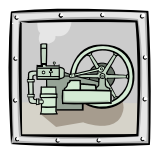

- (1) Wood waste is chipped at a primary/secondary waste storage site by crushers temporarily installed for the recovery and then to be transported to a recycling site
- (2) Wood waste is chipped at an utilization site
- (3) Wood waste is chipped at an existing facility and transported to a utilization site.


The selection from (1) to (3) should be made after drawing up a flowchart of the treatment up to the utilization site. In the case of (1), chipping at a collection site, transportation efficiency will improve, but long-term storage should be avoided in order to prevent possible fermentation.

- Prior to chipping, it is important to remove large foreign matters by preferably hand-sorting and removing clay/sand to a possible extent. Impurities such as clay/sand also should be removed after crushing, by employing a separation method (e.g. trommel) and washing equipment.

- In addition to existing chipping facilities (e.g. those for chip production), mobile crushers can be used such as chippers, large crushers for wood, and tab grinders.

【Table 8-3-1】 Examples of reuse/recycling of wood waste and requirements (can vary by facility)

Reuse/recycling		Limit of salinity concentration (example)*	Possibility of recycling /other conditions
Paper manufacturing	Used as a raw material for paper manufacturing or fuel substitute	—	<ul style="list-style-type: none"> • Raw wood (lumber) is optimum • Rotten wood and wood with clay/sand must be avoided. • Relatively large capacity
Cement production	Used as a raw material or a fuel for cement production 	0.1%	<ul style="list-style-type: none"> • Wood with clay/sand is acceptable (needs to be taken into account in the total treatment plan) • Relatively large capacity
Boiler	Used as a fuel in the form of wood chips for boilers installed in paper mills and heated swimming pools.	0.4%	<ul style="list-style-type: none"> • Rotten wood and wood with clay/sand must be avoided.
Pellet stove	Foreign matters may damage the furnace. 	0.05%	<ul style="list-style-type: none"> • Rotten wood and wood with soil/sand must be avoided.
Planting and mulching materials	Used as a ground-covering material to prevent scattering of the surface and growth of weeds and to maintain heat and humidity of the soil thereby promoting plant 	1%	<ul style="list-style-type: none"> • Wood with clay/sand is acceptable.

	growth.		
Particle board	Used as a material for production of particle board, which is made by blending wood chips with glue.	—	<ul style="list-style-type: none"> • Timber from damaged houses with less dirt/stain is suitable. • Rotten wood and wood with soil/sand must be avoided.
Others	Use of wood waste from damaged houses as a building material for public facilities (e.g. toilet facilities), wood frameworks for supports of tree roots and concrete structures <div style="text-align: center;">  </div>	—	<ul style="list-style-type: none"> • Size is important. • Rotten wood is not acceptable. • Applicable in recovery and reconstruction periods.

* Goal for desalination. The concentration for cement production and fuel is chlorine concentration.

■Reference: Required quality and use of recycled woodchips

• Effective use and required quality of recycled woodchips presented by the NPO Japan Wood Resource Recycle Association are shown in **【Table 8-3-2~8-3-4】**. Typical required characteristics are still under examination but indicated in “quality standard for recycled wood chips”.

• Woodchips are categorized as either “shaved chips,” or “crushed chips,” according to processing method. Effective use of each, and their relevant quality standards, are shown in **【Table 8-3-2】** and **【Table 8-3-3】**, respectively.

• Quality for each standard prepared by the association mentioned above is shown in **【Table 8-3-4】**. The standards for salinity also have been summarized in the proposal for coastal driftwood recycle systems (partially cited in **【Table 8-3-1】**).

• Information about whether wood waste comes from fallen wood (raw wood) or construction materials is important in some cases, and therefore the information should be obtained for better operation.

【Table 8-3-2】 Standard use of recycled wood chips

			Classification of chips				
			A	B	C	D	E
Typical use	Material recycling	MDF	○				
		Ethanol	○				
		Paper	○				
		Paper (cardboard)	○	○			
		Charcoal	○	○			
		Compost	△※4	△※4			△※4
		Mulching	○	○			
		Hardboard/Insulation board	○	○			
	Particle board	○	○	○			
Energy recovery	Fuel	○	○	○	○	△	
	Material/fuel for cement	○	○	○	○	○	

	(fuel)	Blast-furnace reducing agent	○	○	○	○
	Others *3	Wood mat for livestock (litter)				
		Material for moisture control				
		Cultivation soil				

*3 Quality

classification is necessary according to the purpose of use. Special attention should be paid in the case of using byproducts of C-D chips.

*4 When used as compost materials, lumbered wood /wood after

root removal are preferable as they are less likely to contain foreign matters or preservatives.

◆Chip A-D : less than 50mm in size
◆Chip E : less than 5mm in size
◆Judgment of CCA: refer to **【Fig. 8-1-3】**

【Table 8-3-3】 Quality standards for recycled woodchips

Chip category	Raw material of chips	Remarks
Chip A (incl. cut chips)	Wood with large cross-section such as pillars, beams and trunks or virgin wood	Foreign matters such as preservatives, ply boards, painted wood, metals, plastics and clay/sand or bark are not contained.
Chip B (incl. cut chips)	Similar to those for Chip A and virgin wood including wood for pallet/ packaging and dismantled wood	Foreign matters such as preservatives, ply boards, painted wood, metals, plastics and clay/sand are not contained.
Chip C	Similar to those for Chip B	Similar to those for chip B and ply boards. Foreign matters such as preservatives, painted wood, metals, plastics and clay/sand are not contained.
Chip D	Similar to those for Chip C and fiber boards, wood with paint/glue (incl. wood-framed and papered doors (Japanese “fusuma and tatami mat”) or branches and wood after root removal	Foreign matters such as CCA wood, metals, plastics and clay/sand are not contained basically.
Chip E	By-product of chip production	Hazardous materials and metals are not contained.

◆Chip A-D: less than 50mm in size, ◆Chip E: less than 5mm in size, ◆Judgment of CCA: refer to **【Fig. 8-1-3】**

【Table 8-3-4】 Required test items

Classification	Test item	Standard to be applied	Name of standard	Standard value
Common	Size	JIS Z 8801-1	Sieves for the test-No.1 Metal-made net sieves	Less than 50mm
	Total water content *5	JIS Z 7302 3	Refuse derived fuel (RDF): the test-No.3 for water content	Less than 25 %
For energy recovery only	Calorific value	JIS M 8814	Coals and cokes- Measurement method of higher calorific values by bomb calorific meter and calculation procedure of lower calorific values	Higher than 3,000kcal/kg
	Ash content	JIS Z 7302 4	Refuse derived fuel (RDF): the test No.4 for ash content	Less than 2.0%
	Chlorine content	Sewage test method 2.4.20.1		Less than 0.1%

*5: Applied especially to particle boards among other board groups

Although the main component of tsunami sediment is seabed soil and sand, various materials were engulfed by the tsunami in coastal, harbor, and urban zones. The properties and composition of the debris and tsunami sediment are therefore not uniform, and might be hazardous to human health and human living environments.

- Removal and treatment of tsunami sediment must be carried out with particularly careful attention.
- While carrying out disposal of existing tsunami sediment, the taskforce intend to continue to disseminate relevant information in order to promote effective processing of tsunami sediment based on the knowledge obtained to date.

Composition and properties of tsunami sediment

- Tsunami sediment is fundamentally seabed soil and sand that has been carried onshore by the tsunami, subsequently remaining there. However, depending on the circumstances of land use in the disaster area, various other objects and materials (wreckage) might have become mixed into it. Thereby, its composition and properties tend to be diverse.
- Composition and properties of tsunami sediment differ according to the circumstances of land use and type of seabed soil/sand that the tsunami has deposited onto coastal lands. “Circumstances of land use” in this context mean, for instance, a circumstance that the coast is natural and that no structures had been constructed there, or a harbor with a high density of residences and buildings of business enterprises. The difference in the circumstances results in variety in the composition and properties of tsunami sediment. In addition, the characteristics of the aquatic environment of the coastal lands influence them greatly. From open waters, sediment will be composed of mainly sand and gravel. In contrast, from closed waters or the mouth of a river, the sediment might be extremely muddy, containing much organic matter.
- Whether or not sediment includes wreckage is an important index in planning removal work. Inclusion of wreckage of homes or household articles from collapsed houses and buildings can be judged by visual inspection.
- Organic matter is an important index of decaying matter and oil content. Discarded decaying organic matter does degrade, usually emitting offensive odors and inviting the growth of pathogens. In addition, oil might contain toxic substances that adversely affect people’s health. Here, we defined “includes organic matter” as ignition loss of greater than about 5% and called attention to decaying organic matter and petroleum products on this basis. This was referred from a standard shown in the individual treatment standards at a landfill site designed for inert industrial waste, which is determined by the Waste Management and Public Cleaning Act enforcement order, Article 6, Paragraph 1, Item 3. However, in measuring ignition loss, it is necessary to separate organic matter that had been included originally in the carefully measured soil. For quick assessment, visual judgment, measurement of temperature, and confirmation of offensive odors are useful as well.
- Although chemical analysis is to be conducted, a preliminary assessment can be made according to the land use circumstances of a disaster area. If a facility regulated as promoting the accumulation or discharge of specified chemical substances to the environment exists or existed in the area, then it has been asked to submit a Pollutant Release and Transfer Register (PRTR) report to the national

government. Thereby, one might easily evaluate the possible discharge of toxic chemicals from that facility. To find institutions that have provided PRTR reports, visit the following website of the Ministry of Environment:

<http://www.env.go.jp/chemi/prtr/kaiji/index.html>

- The circumstances of land use prior to the disaster suggest the properties of tsunami sediment. We can perform a tentative zoning that reflects the risk existing in tsunami sediment, considering the circumstances of land use and characteristics of facilities before the disaster. Zoning conducted in this manner and making use of its information would promote proper assessment, removal, and disposal of tsunami sediment.

Basic flow of removal and treatment tsunami sediment

Removal and treatment of tsunami sediment must follow the procedure presented in Fig. 1, depending on its composition and properties.

- (1) Zoning with characteristics of areas (area division)
- (2) Classification into categories by visual inspection and spot screening
- (3) Intermediate treatment and utilization of tsunami sediment by category

- (1) Zoning with characteristics of areas (area division)

Zoning divides tsunami affected area into three areas: Area I (non-polluted areas), Area II (possibly polluted areas), and Area III (polluted areas). Divisions are designated in accordance with local characteristics and on-site reviews. Local land use and distribution of facilities may also be taken into consideration.

Area I: Clean sand gravel without inclusion of wreckage or toxic materials, according to local characteristics and onsite study.

Area II: Possible inclusion of wreckage, organic matter, toxic chemicals, or hazardous articles, according to local characteristics and onsite study.

Area III: Definite inclusion of harmful chemicals and dangerous materials, according to local characteristics and onsite study. Institutions might have filed PRTR reports since the occurrence of the tsunami.

- (2) Classification into categories by visual inspection and spot screening

Area I: Check by visual inspection to determine whether the tsunami sediment contains wreckage. Determine whether it is contaminated by oil spilled from vehicles and whether it contains muddy slime with organic matter from floodwaters. If free of all the above pollutants and confirmed as clean sand gravel, it is classified as Category A. When it includes wreckage and/or other materials, it is classified as Category B or C after spot screening.

Area II: Sediments in Area II are classified as Category B or C after spot screening.

Area III: Sediments in Area III are classified as Category D or E at the collection site.

- (3) Intermediate treatment and utilization of sediment by category

Area I:

Sediment from Area I might not contain anything harmful to human health. If visual inspection identifies it as clean sand gravel it can be used as it stands (Category A). Confirmation by analyses is fundamentally unnecessary. However, if the appearance of deposition is questionable, analysis shall be requested. Although

sediment of Area I is usually transported to the collection site and stored there, it can be transferred directly to the place it is used. Alternatively, it can remain at the site of deposition. In addition, ocean dumping might be a solution in some cases. However, in this option, several aspects need to be considered. Firstly, the circumstances of the site of deposition and pressing need of excavation and removal of sediment. Secondly, formation of consensus among related persons and organizations on ocean dumping. Thirdly, compliance with the Act for the Prevention of Marine Pollution and Maritime Disasters and other regulations relating to maritime disasters (“Marine Pollution Prevention Act,” hereinafter).

Area II:

Tsunami sediment in Area II might contain wreckage, organic matter, toxic chemicals and hazardous articles. Carry out field screening by simplified measurement to verify whether the sediment contains toxic substances and hazardous materials. If the sediment does not contain toxic organic substances, glass wool and harmful substances and includes only the inert industrial waste such as concrete debris and plastic waste, it can be processed at facilities for that type of waste which have submitted reports to the national government in compliance with the Waste Management and Public Cleaning Act enforcement order, Article 15, Paragraph 2, Item 5 (Category B). Chemical analysis of Category B sediment may be carried out as necessary according to the method of utilization.

When close attention is necessary for handling sediment, it shall be transported to a collection site and stored there after proper separation. If high concentrations of organic matter are probable and incineration disposal seems applicable, the sediment can be burned at an energy recovery plant (Category C). Alternatively, if chemical analysis of sediment suggests the necessity of detoxification processing, it must be sent to a detoxification facility and then utilized appropriately after processing (Category D). Finally, sediment that does not meet landfilling standards should be purified and processed by thermal treatment (Category E). In addition, some marine products for which ocean dumping was permitted were actually dumped into the ocean as an urgent measure because they could have caused severe sanitary and environmental problems due to decay if left uncontrolled. In such cases, necessary measures must be taken to comply with the Marine Pollution Prevention Act.

Area III:

From results of examining local characteristics and field confirmation, sediment in Area III was found to be more likely to include toxic substances and hazardous materials. Sediment in the area shall be sent to a collection site for separation and chemical analysis. If detoxification processing is necessary (Category E), then it is to be treated at an appropriate processing facility. The remainder (Category D) shall be properly utilized depending on its properties and quantities.

Preventive measures against work-related accidents and environmental pollution while processing tsunami sediment

(1) Preventive measures against work-related accidents while processing tsunami sediment

Tsunami sediment may contain toxic substances and disease-causing bacteria and agents such as oil, acids and alkali, pharmaceuticals and pesticides, asbestos, and other hazardous materials. Therefore, it is necessary to provide protection for the health of workers as listed below:

- 1) Use appropriate dust masks and protective goggles to reduce exposure to dust when handling sediment.

- 2) Wear gloves that are suitable for the work, with nylon glove liners in them as needed.
- 3) Work clothes must be dust-proof, such as nylon ones.
- 4) Wear safety shoes to prevent injury from stepping on nails, for example.
- 5) Prepare portable gas detection equipment, monitoring oxygen concentrations, hydrogen sulfide, and other substances, depending on the circumstances.
- 6) Water sprinkling on sediment to reduce dust scattering.
- 7) Furnish working areas with disinfection equipment, shower facilities and washing water faucets in preparation for injuries. Blow off dust with an air shower, for example, after work and change into clean clothes before leaving the work area.
- 8) Make daily checks of protective equipment and keep it clean. Put used disposable matter in designated places and dispose of it properly.
- 9) Appoint sanitation supervisors in each working area and assign them to supervise the hygiene and health of workers.

Wearing of dust-masks is to be rigidly enforced as a preventive measure against work-related accidents of workers. Appropriate masks must be worn, depending on the sediment properties.

In addition, wreckage might be mixed into tsunami sediment. It must be separated before removing sediment. If heavy machinery cannot be used for separation, then wreckage must be separated manually. In this case, suitable measures should be taken to ensure workplace safety against injury by nails and collapse of wreckage.

(2) Measures to protect the environment during sediment processing

Dust, offensive odors, and noise might occur during removal work of tsunami sediment or at the collection sites. It is extremely important to keep open diverse channels of communication with the local community concerning sediment-related work. Inform local residents of the scheduled work and report on work progress via bulletin boards. In addition, continue water sprinkling on sediment and install fences around work areas.

To protect the environment, take the following measures:

- 1) Water sprinkling and deodorant appropriately to prevent dust scattering and spreading of offensive odors.
- 2) When strong winds blow toward residential areas, consider working procedures and prevent scattering of dust by installing fences.
- 3) Install a water flushing apparatus to remove mud from construction and transporting vehicles at the site entrance.
- 4) It is extremely important to maintain diverse channels of communication with the local community about sediment-related work. Inform local residents of the scheduled work and report on work progress via bulletin boards.

Sediment removal

Sediment including organic matter that has been discarded for a long time is likely to decay and emit bad odors. Muddy materials might produce dust.

If rapid removal of these sediments is difficult, take emergency measures by spraying slaked lime over

sediments or mixing it with the sediment.

As an emergency measure, sprinkle soil improvement agents that are appropriate to the sediment and agitate it, sterilize it, absorb offensive odors, and prevent dust spreading.

Remarks: easy procurement, early delivery, easy work tasks at the site, development and duration of effects (test by preliminary experiment), and cost. Taking into account the importance of all these items, sprinkle the agent and agitate the sediment manually or with heavy machinery. Agents that may be used include slaked lime, zeolite, cement-based improver, and steel slag. Perform a preliminary examination and determine the best mixing ratio of these agents to achieve the target.

When muddy sediment includes much organic matter, high alkalization of the sediment generates ammonia, which might remain for a prolonged period. It should be confirmed through a preliminary examination.

When mixing a soil improvement agent with sediment, take the following precautions:

- 1) Wear a dust-mask and protective glasses when working.
- 2) Perform a preliminary examination and confirm how the materials mix. Monitor generation of ammonia.
- 3) For rapid disinfection, sprinkle sufficient slaked lime on the surface of the sediment. Because dust might occur at that time, give careful consideration to neighboring work areas, residences, and the wind direction.
- 4) Sprinkle zeolite or deodorant to prevent outbreaks of offensive odors.
- 5) Mix agents well with sediment to ensure easy removal later.
 - Work while watering, if dust has been produced by drying.
 - If the date of removal is not scheduled definitely, take care not to harden sediment too much.
 - Although treated sediment takes from several days to one week to solidify sufficiently, it may be removed sooner if planned correctly.
 - Mixing ratios of water and an agent should be determined by experts after mixing trials.
 - Work characteristics are largely dependent on the availability of heavy machinery. Take full account of machinery availability when planning operations.

Use the following directions as reference for planning work procedures in the field:

- 1) Remove mixed wreckage manually. When heavy machinery such as a power shovel or backhoe is available, the use of skeleton pail with a retiform bottom is effective.
- 2) In a field where heavy machinery is available, sprinkling an agent packed in a flexible container by backhoe and mixing using that machinery is beneficial (Fig. 2). Mixing by cultivator is also effective.
- 3) In a field where heavy machinery is not available, sprinkling agents in 20 kg packages manually will be sufficient. Although mixing by cultivator is effective, it can be done manually when a cultivator is unavailable.

Methods of excavation and removal of tsunami sediment shall be determined depending on the size of the deposited area, its thickness, the circumstances of land use, and the composition and properties of the sediment. Tsunami sediment is usually only a thin layer, which makes the use of heavy machinery difficult. Account for this fact when planning the procedures and duration of work. The basic workflow of excavation and removal proceeds as follows:

- 1) Separation and removal of large items manually or with heavy machinery
- 2) Excavating, scraping, and collection manually or with heavy machinery
- 3) Loading onto transportation vehicles using heavy machinery

In urban areas and small areas, use large sandbags (packed in flexible container and others) and buckets for earth and sand to reduce dust scattering. Collect these by Unic crane car and transport them to a collection site.

Muddy sediment from submerged land and farmland can be scraped from damp ground by a bulldozer and then collected by a small caterpillar-tracked carrier).

Because of the varied composition and properties of tsunami sediment, appropriate selection of a collection site tailored to those characteristics is desirable.

In addition, those characteristics might change from those found in preliminary examination, during the course of removal work. Staff assigned to examine and verify the characteristics of sediment should remain at the site where removal work is conducted. Keep a manual and material to examine the sediment characteristics there. In addition, keep in contact with local authorities managing waste disposal in preparation for collecting sediment of unknown properties.

Depending on the sorting conducted at the work site, monitor the mass of sediment at each collection site and for each item of waste using truck scales.

Collection and transportation

Selecting appropriate methods of collecting and transporting sediment based on its properties is important from the standpoint of preventing scattering, outflow, and exposure to the atmosphere.

- 1) Wreckage and other items separated at a removal site might contain harmful agents and hazardous substances such as pharmaceuticals or oil waste used by business entities. Muddy matter of high water content might also be found. Therefore, transportation materials and equipment must be selected while taking these characteristics of sediment into account. Durable bags made of nonwoven cloth and containers that are resistant to breakage might be worth consideration for some properties of sediment.
- 2) Sediment that has been discarded for a long time might smell bad and release dust. Therefore, these offensive odors and dust must be suppressed during loading and unloading of such sediments. In addition, during loading and transportation work, ensure the safety of workers and neighboring people with reference to “Summary of preventive measures against public disasters in construction work” (Construction Ministry, Department of Construction Economy, Number 1, January 12, 1993). It goes without saying that observance of traffic regulations is necessary.
- 3) When full-scale removal work of a huge amount of tsunami sediment is carried out to finish processing in a short time, numerous transportation vehicles will operate. Observe measures to prevent noise and vibration in addition to preserving traffic safety. Regarding routes of transportation, detour to avoid residential areas, shopping streets, schools, and narrow roads. Regarding timing of transportation work, strive to avoid crowded times in streets and commuting times to schools and kindergarten. While planning these matters, consult with local authorities.

At collection sites, store carried-in tsunami sediment as separated by onsite screening, taking steps not to

cause impairment of neighboring environments and to execute provisional storage properly.

Separated sediments shall be kept at each specified place and must not be mixed. Put marks indicating boundaries of each specified place and prevent incorrect unloading by allocating attendants and displaying posters to guide vehicles.

Dust might be blown away by wind and rain falling on sediments will produce muddy water or even wash away the sediment itself. Take measures to prevent such environmental issues including the release of toxic matter into the environment. In addition, prevent decaying substances in sediment from generating offensive odors.

Separation of sediment and storage of separated sediment

A lot of wreckage might have been mixed with tsunami sediment carried in. Wreckage must be separated for the purposes of utilization and disposal of sediment. Separated wreckage and other materials are stored temporarily in each partition of the specified method of processing. They then undergo laboratory analysis to determine the categories of separated sediments. Keep them properly in the designated space for each category, taking care not to affect neighboring environment.

During safekeeping, it is desirable to secure a safekeeping space depending on the acceptance situation of the processing facilities and designated place of utilization.

Management of the working environment at the collection site is carried out to secure a safe work environment. This is of great importance because sediments that are separated and stored might emit dust and offensive odors and spread a variety of chemical substances.

Measures must be taken against scattering of dust and efflux of muddy water and sediment caused by rain. The neighboring environment and quality of water must be monitored to prevent their disturbance by dust.

Intermediate treatment

Intermediate treatment is done to stabilize, detoxify, and adjust the quality of tsunami sediments based on their composition and properties. The output shall be appropriate to their later utilization.

(1) Objective of stabilization

To reduce ignition loss to less than 5%, which is an index of mineralization of organics causing contamination.

(2) Objective of detoxification

To clear prescribed limits of Soil Contamination Countermeasures Act, which are fundamentally intended to eliminate concerns about human health and living environments.

(3) Adjustment of quality

To ensure that output of intermediate treatment shall be appropriate for easy utilization later.

Intermediate treatment of sediment is to be carried out according to categories of separated sediments after separation at the site of deposition and collection site and classification there.

The intermediate treatment described here is intended solely for tsunami sediments, and wreckage resulting from separation. Classification is to be handled separately and appropriately, according to their characteristics.

Examples of intermediate treatment are shown below. They are done at collection sites and other facilities.

(1) Category A

- 1) Provisional keeping or safekeeping, depending on properties such as particle size and color
- 2) Aging for desalination (as needed)
- 3) Adjustment of particle size using a classification device (as needed)

(2) Category B

- 1) Separation of wreckage by visual inspection and human effort
- 2) Desalination
- 3) Adjustment of particle size using a classification device
- 4) Disposal at landfill sites of inert industrial waste

(3) Category C

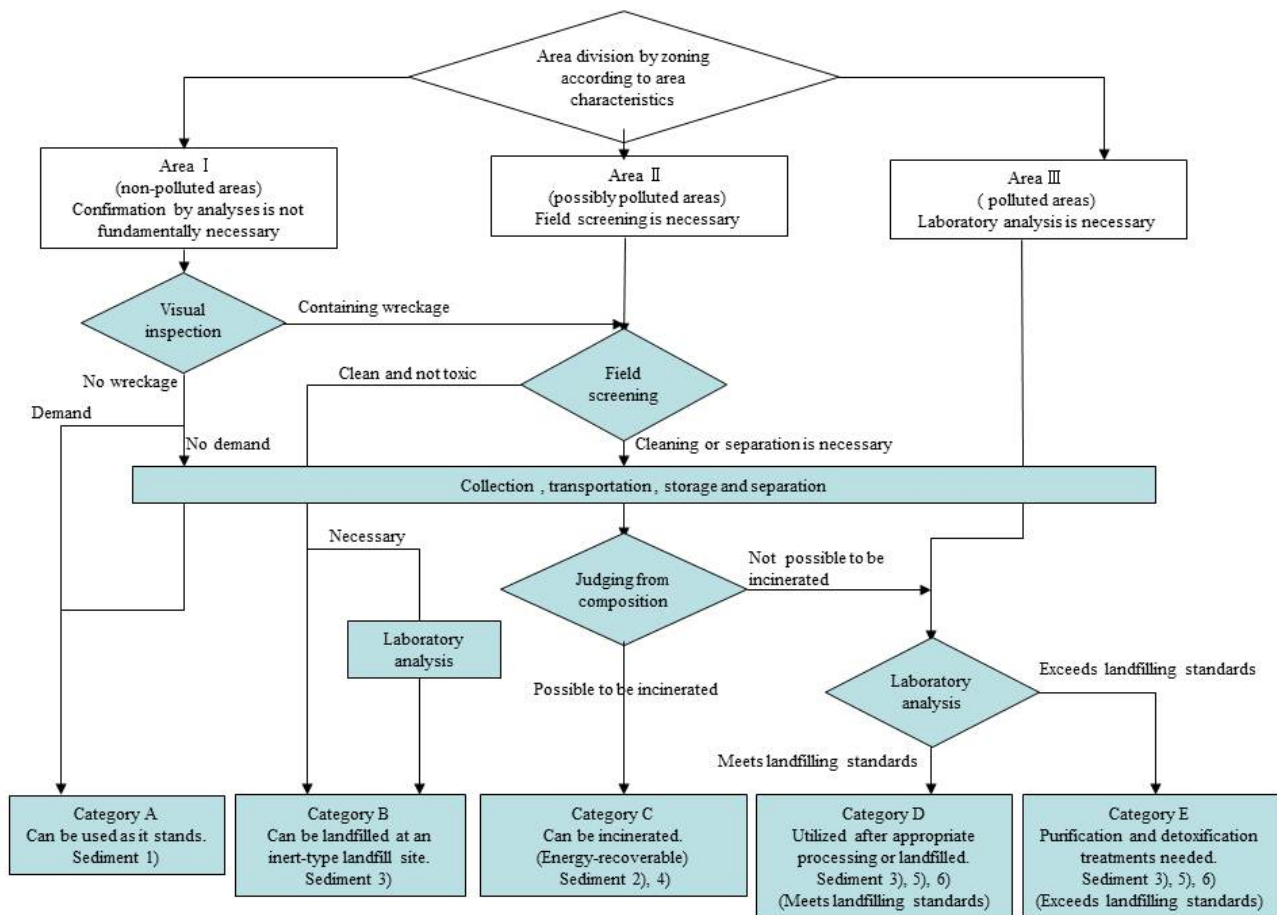
- 1) Energy recovery (high-efficiency power generation at waste incineration plant)
- 2) Simple incineration (including temporary incinerators and industrial waste incinerators)

(4) Category D

- 1) Separation of wreckage by visual inspection, human effort and heavy machinery depending on composition and properties when carried in to the collection site
- 2) Provisional keeping or safekeeping, depending on water content, color, and other characteristics
- 3) Sorting of earth, sand, and foreign substances using screening equipment
- 4) Adjustment of water contents by sun drying, mixing with burnt lime, and other materials
- 5) Curing
- 6) Adjustment of particle size with classification device
- 7) Cleaning and insoluble treatment by washing, heating, and mixing with other agents
- 8) Heat-treatment by incineration, gasification reforming, fusion, burning, conversion to cement raw materials
- 9) Landfill at controlled landfill sites

(5) Category E

- 1) Provisional keeping or safekeeping, depending on water content, color, and other characteristics
- 2) Cleaning and insoluble treatment by washing, heating, and mixing with other agents
- 3) Neutralization
- 4) Dehydration
- 5) Water processing by facilities to treat liquid waste
- 6) Heat-treatment by incineration, gasification reforming, fusion, burning, conversion to cement raw materials
- 7) Physical and chemical treatments



【Fig. 8-4-1】 Selection of removal and treatment methods for tsunami sediment

Composition and properties of tsunami sediment

- 1) Clean sand gravel not containing wreckage.
- 2) Sand gravel containing organic matter, but not containing wreckage.
- 3) Sand gravel containing well-mixed wreckage but not containing organic matter.
- 4) Sand gravel containing organic matter and well-mixed wreckage.
- 5) Sand gravel containing oil and/or chemicals used at coastal businesses.
- 6) Sand gravel containing hazardous substances and/or organic matter which spilled from land, and was dumped as sediment into the ocean.

Note: “includes organic matter” refers to ignition loss greater than about 5%. When a quick judgment is necessary, visual judgment, measurement of temperature and confirmation of offensive odor are useful.

Standards for landfilling are determined by the Waste Management and Public Cleaning Act.



【Fig. 8-4-2】 Image of work with heavy machinery.

【Guide 8-5】 Marine industrial waste

■ Key points

- Marine industrial waste falls into two main categories: fish and wrapped seafood products.
- When implementing disposal and treatment, from the viewpoint of public health, give first priority to disposal of decomposed matter. It is essential to remove marine industrial waste from urban areas as immediately as possible. Alternatively, inhibit spoilage by microorganisms by spreading lime over the spoilage.
- Depending on the degree of urgency, conduct countermeasures such as disposal by night soil treatment plant, incineration, aqueous cleaning with environmental water, and ocean dumping with restriction. However, attention must be paid to related laws and regulations.
- In the case of the Great East Japan Earthquake, authorization for urgent ocean dumping in Miyagi Prefecture, under specific conditions, was issued by the Ministry of the Environment, Japan. For further information please refer to the Ministry's website (http://www.env.go.jp/jishin/attach/an23_44a.pdf; in Japanese).



■ Treatment method

- Prioritized countermeasures against decaying marine industrial wastes are shown in **【Table 8-5】**.
- In the case of the Great East Japan Earthquake, countermeasure **【3】** has already been conducted.
- Countermeasures **【5】** and **【6】** were considered appropriate for urgent treatment because decaying marine industrial waste was generated in large quantities.
- In fact, Miyagi Prefecture applied for special consideration under the Act for the Prevention of Marine Pollution and Maritime Disasters, to carry out urgent ocean dumping. Soil carriers conveyed and disposed of decaying marine industrial waste offshore from Miyagi Prefecture.
- Countermeasure **【7】** should be considered to deal with a large quantity of paper packaging attached to decaying marine industrial waste.
- To prevent marine industrial waste from decaying, Iwate Prefecture planned to create a disposal site in the mountains and dispose of the waste in landfill together with slaked lime after separating fish from debris.

【Table 8-5】 Countermeasures against marine industrial waste

Best	<p>【0】 Incinerate or dump marine industrial waste in a final disposal site</p>
Better	<p>【1】 Decomposed matter: Dispose of marine industrial waste at a night soil treatment plant after crushing it into smaller particles. Do not discharge into sewers because sewerage systems are not usable due to the earthquake.</p> <p>【2】 Debris contaminated by marine industrial waste: Wash marine industrial waste out of debris in the sea or a pond.</p>
Emergency	<p>【3】 Inhibit spoilage by microorganisms by sprinkling slaked lime over spoilage. Absorb excess water from marine industrial waste with water absorbers such as cardboard.</p> <p>【4】 Seal marine industrial waste tightly in drum cans.</p> <p>【5】 Ocean dumping of marine industrial waste: dump marine industrial waste wrapped in fishnet offshore.</p> <p>【6】 Store (or store temporarily) marine industrial waste in a site with clay soil or a downhole with plastic sheet lined surface.</p> <p>【7】 Conduct open burning of marine industrial waste at a site distant from urban areas.</p>

■ Detailed method of ocean dumping

- Dump marine industrial waste wrapped in fish net into the sea after separating it from plastics or paper packaging. Fish net keeps waste from spilling during transportation, yet seawater easily enters fish net in the sea.

A specific example: (1) Prepare receiving space by placing trawling net or drag net on the outer side of breakwater. (2) Crush marine industrial waste into small particles without separation by heavy machinery and dump into the receiving space by machinery. (3) Ship contents to the open sea.

■ As an exception under the Act for Prevention of Marine Pollution and Maritime Disasters, an urgent announcement was made to Miyagi Prefecture:

(1) In Article 10, paragraph (2), item (vii) of the Act for Prevention of Marine Pollution and Maritime Disasters, when urgent ocean dumping of waste is requested by the Minister of Environment and is conducted according to criteria for the dumping sites and methods designated by the Minister of Environment, prohibitions on the ocean dumping of waste may be waived.

(2) In the case of the Great East Japan Earthquake, a notification concerning the authorization of urgent ocean dumping under specific conditions was issued to Miyagi Prefecture by the Ministry of the Environment, Japan on Apr. 7, 2011. The content of this notification are summarized as follows:

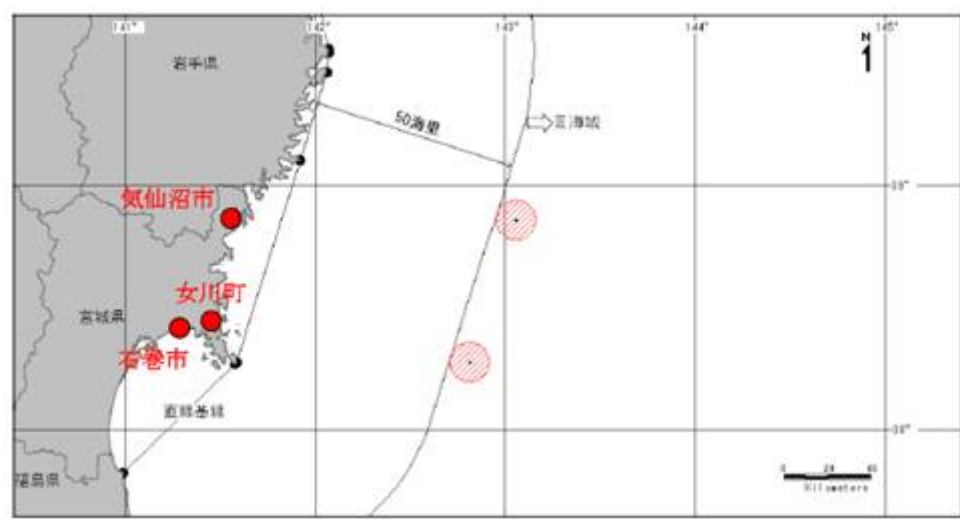
- Due to freezer problems caused by the Great East Japan Earthquake, a huge quantity of deep-frozen fish for seafood products thawed out and decomposed in Miyagi Prefecture. It was difficult to appropriately dispose of about 35,000 tons of this material on land. At that time, Miyagi Prefecture requested permission for ocean dumping.
- In response to this, based on Article 10, paragraph (2), item (vi) of the Act for Prevention of Marine

Pollution and Maritime Disasters, the Ministry of the Environment decided to issue authorization of urgent ocean dumping under specific conditions. Furthermore, the Minister of Environment set the criteria for the dumping sites and methods in this special case.

- Waste covered by this announcement are defined as waste such as crushed animal and plant residues listed in Part 4 and Paragraph 1 of Article 6 of the Order for Waste Management and Public Cleaning Act. Furthermore, they should be waste generated by the Great East Japan Earthquake and in above-mentioned places where waste exists.

- The criteria for the dumping sites and methods for this special case have been set by reference to standards concerning ocean dumping of crushed animal and plant residues based on the Article 10, paragraph (2), item (v) of the Act for Prevention of Marine Pollution and Maritime Disasters (Ministerial Ordinance Concerning the approvals of waste disposal in the sea: the Appended Table 2 of Item (xxviii) of 2005 Ordinance of the Ministry of the Environment).

- In this announcement, the available dumping sites are designated in detailed and extended diagrams: the upper red circle indicates the dumping site for marine industrial waste from Kesenuma city, the other is for wastes from Ishinomaki city and Onagawa town (see **【Figure 8-5】**).



【Figure 8-5】 The available dumping sites

【Guide 8-6】Cement concrete, asphalt concrete

- Recycling of cement concrete rubble and asphalt concrete rubble can be easily carried out if these types of rubble are properly sorted from others.
- Some cement concrete rubble and asphalt concrete rubble can be used for recovery and reconstruction.

■ Key points

- It is highly practical to recycle cement concrete rubble and asphalt concrete rubble if these types of rubble are separated from other types of debris and waste.
- As shown in the flow of **【Fig. 8-6-1】**, these types of rubble can be recycled as construction material after crushing and classification by sieving. Both types can be handled by the same machinery. In general, a processing plant consists of a rubble haulage management facility; sorting equipment for removal of foreign substances such as mud; crushing equipment; sieving equipment used to classify the recycled aggregate by particle size; and a storage facility. The crushing equipment is composed of a primary crusher and a secondary crusher. A jaw crusher or roll crusher is used for the primary crusher. An impact crusher or barmac is used for the secondary crusher.
- From the viewpoint of recycling and using for recovery and reconstruction, it is desirable to utilize the intermediate treatment facilities around disaster areas. If the amount of rubble brought in to a primary waste storage site is large, consider installing the primary crusher at the primary waste storage site. The location and area of the primary waste storage site needs to be considered, as well as the arrangement of the facilities and equipment, in order to ensure the capacity to receive and store a large amount of rubble for its reuse.

■ Cement concrete rubble

(1) Cement concrete rubble is typically reused as roadbed materials (recycled crusher-run stone) or backfilling materials (recycled sand). However, considering the amount of the disaster waste and the increasing demand for construction materials, it is necessary to consider the use of concrete rubble as recycled aggregates for concrete. The methods of the intermediate treatment are shown in **【Table 8-6-1】**.

(2) In the early stage of recovery from the disaster, land-clearing activities and restoration of road networks are important. Therefore, primary target rubble includes cement concrete products for roads, cement concrete paving slabs, and cement concrete substructions. These are called “initial cement concrete rubble.” On the other hand, the cement concrete rubble generated from concrete houses, buildings, and industrial plants, etc. is treated in a later stage of recovery unless there is danger of collapsing. This is called “later cement concrete rubble.”

- Initial cement concrete rubble may contain various types of foreign substances such as salt, dirt, ceramics, gypsum board, and wood, etc. These foreign substances pose little problem when using initial cement concrete rubble for land preparation. However, in the case of utilization for construction materials after crushing and sieve classification, foreign substances degrade the quality of construction products. Therefore, it is necessary to thoroughly separate rubble and to wash with water depending on the situation.

- Later cement concrete rubble might be contaminated with asbestos. Thus, dust generation must be inhibited by water sprinkling and a local dust collector during the crushing process. Additionally, workers must wear full-face dust masks (Category 3). The asbestos-containing materials must be removed from the recycling stream, and be disposed of in landfill. If the recycled aggregates have a possibility of containing non-friable asbestos originating from slate boards etc., the recycled aggregates must not be used for paving materials covering large areas such as car parking lots.

(3) Reuse (applications and standards)

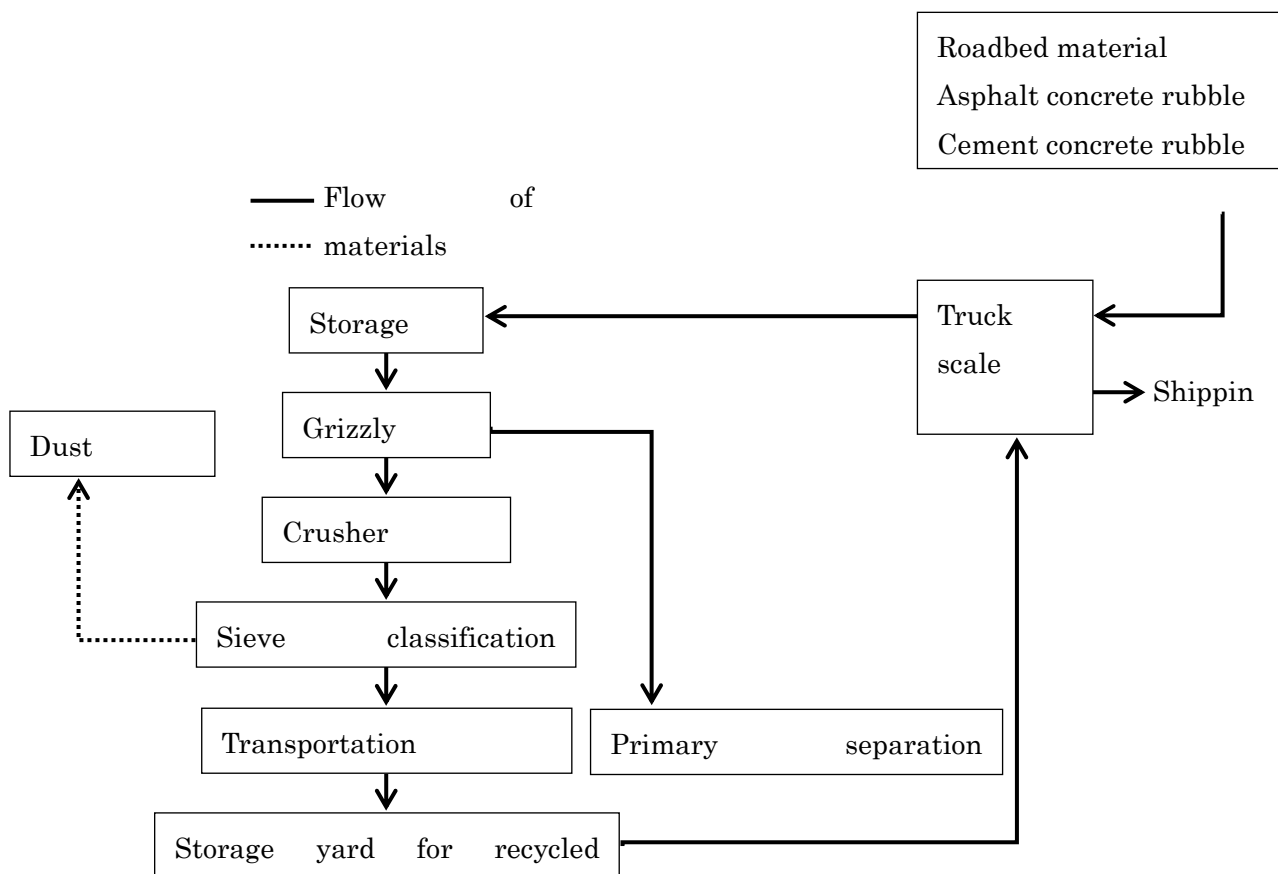
- Roadbed materials: quality targets for recycled aggregate applied to roadbed materials for lower layer paving are shown in **Table 8-6-2**.
- Backfilling materials: demand may increase for backfilling materials for the reconstruction of gas, water and sewer facilities. There is no criterion for such applications of the recycled materials. However, in the case of concern about leaching of hexavalent chromium derived from the cement concrete, it is necessary to confirm the presence of leaching and take countermeasures if found. When considering countermeasures, the technical report “Report of Joint Research Related to the Reduction of Hexavalent Chromium Leaching from Recycled Cement Concrete, Joint Research Report No. 415, 2011.3” (in Japanese) published by Public Works Research Institute may be helpful. If stockpiled, the materials shall be covered with protecting sheets to prevent scattering of fine powder.
- Recycled coarse aggregate M: recycled coarse aggregate of grades M and L can be produced at relatively low cost in existing plants. To produce recycled aggregate grade M, in addition to the primary crusher, the several secondary crusher is required. Moreover, a facility for 20 mm or 25 mm sieve classification is needed. The density and absorption of the recycled coarse aggregate grade M shall be more than 2.3 g/cm³ and less than 5 %, respectively. Use of recycled coarse aggregate grade M has been limited to constructing underground structures by JIS (Japanese Industrial Standards) concerning ready-mixed concrete. However, if used only for producing precast concrete products (concrete secondary products), recycled coarse aggregate grade M is acceptable even in severe usage environments such as Tohoku Region. A draft guideline concerning this issue has been published by Japan Concrete Institute TC071A: the technical committee on the Design and Utilization of Precast Concrete Products. There are also some products registered to NETIS (New Technology Information System) which is consolidated by the Ministry of Land, Infrastructure, Transport and Tourism in Japan. Utilization of precast concrete products can significantly reduce construction schedules. Therefore, aggressive utilization of the recycled coarse aggregate grade M for producing precast concrete products is desirable in order to make the reconstruction activities more effective.
- Others: if the condition of construction is right, cement concrete rubble can be used for the development of breakwaters. For example, the utilization of preplaced-aggregate concrete can reduce the workload on crushing cement concrete rubble, because the recycled aggregate used for this type of concrete is available even with large diameter. However, the size and shape of the structures of preplaced-aggregate concrete should be designed appropriately, because the density of the recycled aggregate is rather small. The recycled aggregate grade L can be used for ready-mixed concrete if used only for leveling concrete which is a non-structural component. If the owner consents to the situation, it is possible to produce recycled aggregates from concrete rubble without the additional facilities.

■ **Asphalt concrete rubble**

- The sources of asphalt concrete rubble are existing roads, parking spaces, building exterior paving, etc. The asphalt concrete rubble is treated in plants which have some intermediate treatment facilities, and recycled as roadbed aggregate and AS recycled aggregate in a conventional manner.
- Asphalt concrete rubble may be contaminated with foreign substances such as dirt carried by tsunami. When using such asphalt concrete rubble as AS recycled aggregates, it is necessary to wash out the dirt with water before crushing and sieve classification. The required quality of AS recycled aggregate is shown in **Table 8-6-3**.

■ **Waste tiles (excluding cement roofing tiles), and others**

- Waste tiles (excluding cement roofing tiles) can be effectively used for soil pavements and backfilling materials. When used for soil pavements, waste tiles provide valuable material because of their permanent color, recharge feature, and heat island reduction effect due to their water retention. They must be crushed into granules generally less than 10 mm as a sand substitute. In stockpiles, fine powder scattering should be prevented.
- All other debris (waste mixed earth and sand, glass, bricks, etc.) should be disposed of in landfills.



* The primary separation materials may be used for roadbed materials. The foreign substances such as metals or wood chips shall be treated properly according to manifest.

Fig. 8-6-1 An example of production flow in a recycled aggregates plant described in the Handbook of Pavement Reproduction (in Japanese)

【Table 8-6-1】Intermediate treatment of cement concrete rubble

	Purpose of Use	Intermediate treatment
Roadbed	Roadbed (Recycled crusher-run stone)	Crushed to less than 40 mm (corresponding to recycled crushed stone RC40 (0-40 mm))
Soil improvement materials	Material for liquefaction countermeasure	
		Backfilling material (recycled crusher-run stone, recycled sand)
Cement concrete	Recycled coarse aggregate grade M	5-25 mm. Secondary crushing is required several times.
	Others	Depending on the application.

* “Recycled crushed stone RC40” must follow other standards.

* According to the Technical Manual for Utilization of Surplus Soil Third Edition provided by PWRI (Public Works Research Institute) (in Japanese), if the mixing ratio and the maximum diameter of soil with rubble is under 30 % and 30 cm, the soil can be treated equally with soil with gravel from the geotechnical viewpoint. However, it is necessary to consult with the local municipal waste department before applying it.

* Cement concrete rubble is classified as “debris”, but fragments of brick must be excluded from cement concrete rubble for reuse. Glass and ceramic scrap (such as tiles) are contaminated easily as well as fragments of brick. Concrete rubble containing such scraps should not be used from the viewpoint of quality control. (However, the limit value of contamination can be determined by administrative decision.)

【Table 8-6-2】Required quality of recycled materials for lower layer of roadbed

Item Application	Construction method, materials	Fixed CBR (%)	PI (Plasticity index)	Uniaxial compressive strength Material age, kgf/cm ² (MPa)
Low-cost pavement	Recycled crusher-run stone	over 10 [over 20]	under 9	---
Asphalt concrete pavement	Recycled crusher-run stone	over 20 [over 30]	Under 6	---
	Cement stabilization	---	---	7 days, 10 (1.0)
	Lime stabilization	---	---	10 days, 7 (0.7)
Cement concrete pavement	Recycled crusher-run	over 20 [over 30]	under 6	---
	Cement stabilization	---	---	7 days, 10 (1.0)
	Lime stabilization	---	---	10 days, 5 (0.5)

(1) In the case that the total thickness of an upper layer, a base layer and a surface layer is smaller than the values shown in the following < >, the fixed CBR values for using recycled crusher-run containing asphalt concrete recycled aggregate shall conform to the values of [] in **【Table 8-6-2】**.

< Hokkaido Region: 20 cm, Tohoku Region: 30 cm, Other District: 40 cm >

* If CBR test is carried out at 40 degree Celsius, a test result should just satisfy the usual value.

(2) The cement concrete recycled aggregate used for recycled crusher-run must not exceed 50% abrasion loss. The abrasion loss shall be evaluated by the Los Angeles abrasion loss test in which the grain must be adapted to crushed stone for road S-13 (13-5mm).

(3) PI value shall only apply in case of using recycled aggregate base course or roadbed material in order to produce the recycled crusher-run.

(4) When using a recycled crusher-run for cement concrete pavement, the maximum PI of particles passing sieve 425 μm can be 10 if the bearing capacity has already been confirmed by a roadbed study, or if the durability has been confirmed empirically in the previous example. In addition, the material that amount of passing sieve 425 μm is less than 10 % can be used if those PI is under 15. (Preliminary Draft Quality Standards for the Recycling of Cement Concrete Rubble by the Ministry of Land, Infrastructure, Transport and Tourism)

【Table 8-6-3】 Quality of asphalt concrete recycled aggregate, from Handbook of Pavement Reproduction (in Japanese).

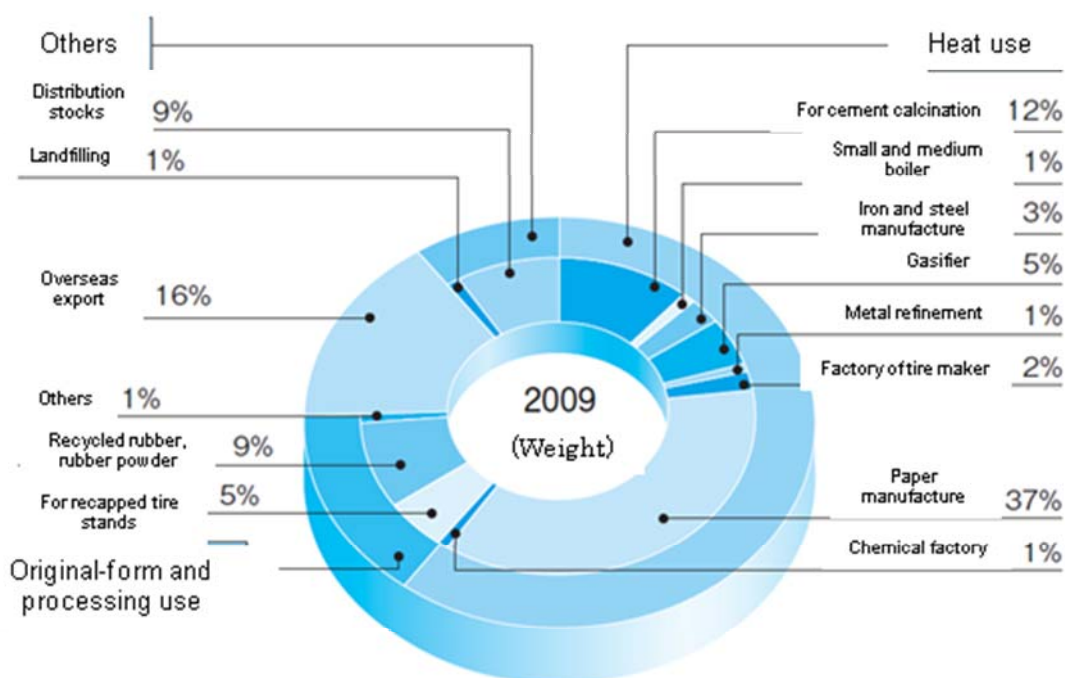
Content of old asphalt, %		Over 3.8
Characteristics of old asphalt	Degree of penetration, 1/10 mm	Over 20
	Coefficient of Pressure crack, MPa/mm	Under 1.70
Fine particle quantity of aggregate, %		Under 5
<p>Note 1: the asphalt contained in recycled aggregate produced from asphalt concrete is called “old asphalt”. Also the asphalt newly used for paving is called “new asphalt”.</p> <p>Note 2: the recycled aggregate produced from asphalt concrete is classified into 3 or 2 levels of particle size, namely, 20-13 mm, 13-5 mm, and 5-0 mm, or 20-13 mm and 13-0 mm. The standard shown in 【Table 8-6-3】 is applied to the particle size of 13-0 mm.</p> <p>Note 3: if the recycled aggregate produced from asphalt concrete with particle size under 13mm has been already classified into 2 levels, composite sample may be tested according to the proportion of each grade scale in the production of recycled aggregate, or test values may be determined by calculation according to the synthesis rate and separate tests. If the particle is not sieved by 13-0 mm or 13-5 mm and 5-0 mm, it is necessary to obtain a test sample of the particle size of 13-0 mm from specimen material.</p> <p>Note 4: the amount of old asphalt contained in the recycled aggregate produced from asphalt concrete and the amount of passing sieve 75 μm shall be expressed as a percentage of dry mass of the recycled aggregate.</p> <p>Note 5: the fine particle quantity of aggregate shall be evaluated by JIS A 1103: 2003 “Method of test for amount of material passing test sieve 75 μm in aggregates”.</p> <p>Note 6: cutting material in the asphalt mixture layer can be used for recycled hot asphalt mixture as long as its quality satisfies the value of 【Table 8-6-3】. In this regard, it is desirable to mix the cutting material with other materials produced from asphalt concrete rubble, because the particle size of the cutting material scatters easily.</p> <p>Note 7: the characteristics of old asphalt should satisfy either the standard concerning the degree of penetration or coefficient of pressure crack.</p>		

【Guide 8-7】 Tires

- Tires are fundamentally stable products and can be recycled. In the case of processing a huge number of waste tires, after estimating the quantity, it is necessary to plan a treatment method and process flow, and to recycle them as much as possible.
- When waste tires must be kept on a mid- and long-term basis, consideration is required because of particular issues from the viewpoint of safety or environmental preservation.

■ Key points

- Tires and wheels are very stable products, posing low risk to human health and environment. However, suitable methods are required when a large quantity of waste tires must be processed. In regions receiving heavy snowfall, many households own two sets of tires: for summer and winter, respectively.



【Fig. 8-7-1】 Actual conditions of waste tire disposal in Japan, 2009

(Source: Tire industry 2010, the Japan Automobile Tire Manufacturers Association and Japan)

- Since treatment/recycling processes and distribution routes have already been established (refer to 【Fig. 8-7-1】), using an existing route is fundamentally ideal when dealing with waste tires and wheels from a disaster area. However, in order to be acceptable for disposal via this route, waste tires and wheels need to be fairly clean.
- When large numbers of tires and wheels from the disaster area have been soaked in sea water, or buried in earth/sand, it is difficult to use the existing treatment/recycling route and it is therefore necessary to set a plan [see 【Fig. 8-7-2】 for reference]. For efficiency, temporary

storage sites for tires and wheels from disaster areas are needed, but due to the hollow structure of tires, efficient storage is difficult and large flat land areas are needed for temporary storage for a large quantity of waste tires. When it is difficult to obtain storage sites, crushing is an important method of reducing volume and in that case, requirements by companies accepting tire chips must be taken into consideration.

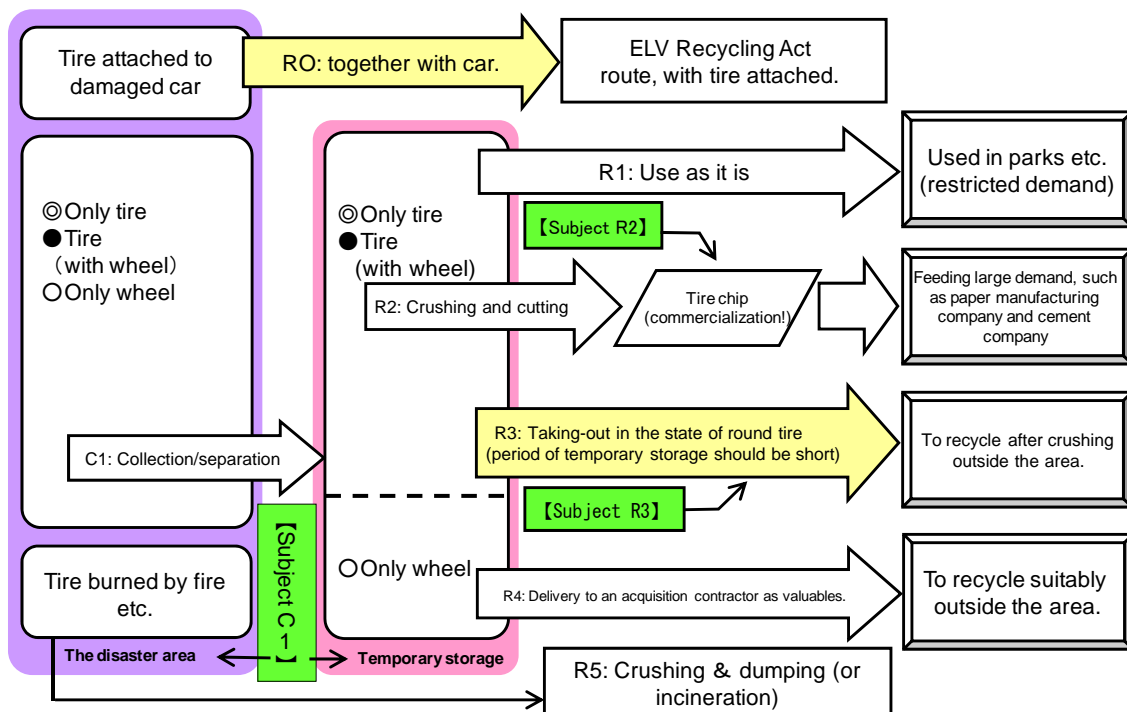
- All of the main tire makers in Japan are members of the Japan Automobile Tire Manufacturers Association (JATMA). In relation to the Great East Japan Earthquake, JATMA says, “When an inquiry is received from a municipality, correspondence will be given due consideration.” (From an interview at the headquarters on May 23, 2011). This association supported tire recycling very actively before the earthquake, so it has a lot of information about tire recycling methods, related treatment contractors, and recipients of crushed tire materials. We recommend contacting JATMA if necessary.

■ **Basic information on tires and wheels**

- The weight of an automobile tire is 7-8kg, a truck tire weighs about 50kg, and a heavy machinery tire weighs from hundreds of kg up to one ton, and these truck tires and heavy machinery tires cannot be lifted by workers without mechanical aid.
- Wheels are roughly divided into two types: 1) aluminum wheels (aluminium alloy, lightweight) and 2) steel wheels (mainly iron, general-use wheels). Usually, both types are bought by scrap collection agencies as valuable wastes. Although another type of wheel has magnesium as its main material, its distribution volume is relatively small.

■ **The overall flow of recovery, collection/temporary storage, and taking out/disposal**

[Fig. 8-7-2] shows overall flow and **[Table 8-7-1]** shows points requiring attention.



[Fig. 8-7-2] The estimated collection/disposal route and the subject of waste tires and wheels in a disaster area

- C1 : If a temporary storage site can be set up, waste tires and wheels are collected from a disaster area, and if possible, separated there. In that case, based on the capacity of each

temporary storage site (it is assumed that there is probably insufficient space for temporary storage sites) and capacity of carrying-out (acceptable amount of receipt for treatment/recycling), collection should be carried out step-by-step. Moreover, if a large number of tires are buried in earth, sand or rubble, heavy industrial machinery, such as a power shovel, is needed in order to dig them up (especially large-sized tires).

- R0~: First, in the case of tires attached to cars, give consideration to use of the route of the End-of-Life Vehicle Recycling Act for disposal of motor vehicles (R0). Reuse is aimed for (R1), if usability of tires is confirmed, such as intact tires found at a gas station impacted by the tsunami (photograph 1), tires in good condition that can clearly be reused as tires, and tires that can be used as shock-absorbent material in parks. But the quantity is restrictive and so value of examination is small. Fundamentally, for tires excepting those applicable to R0 above, following proposal R3 is realistic. That is, tires excepting R0 as described above are entrusted to a waste tire recycling/processing contractor and taken to the outside area by truck or vessel without shredding and cutting (although this is not efficient).
- R4 : Wheels are handed over to scrap contractors as valuable resources (R4). Tires with wheels may be accepted because wheels can be sold for a comparatively high price. Therefore, for the time being, it is not necessary to separate tires and wheels, considering time and effort.
- R2 : In order to use limited land space effectively, after securing a place where a shredder can be installed in a temporary storage site, the collected waste tires should be shredded and cut (if possible, processed into rubber chips), and transported to an outside area by a vessel or truck, and treated/recycled or, ideally sold (R2). For that purpose, with the intention of creating employment in a disaster area, the collaboration system (joint venture, etc.) between tire recycling/processing contractors (who have know-how concerning processing of waste tires) and local businesses is recommended in a disaster area, and implementation of shredding in the area should be given serious consideration. However, in order to realize the R2 route, the following prerequisites are necessary. Satisfying the terms of conditions of tire chips that receiving contractors requires, availability of port facilities (including storage space etc.), provision of necessary electricity for mechanical equipment, and prompt action by the supervising authority dealing with the regulations and laws concerned, such as the Ministry of Environment etc, but these prerequisites are not easily satisfied.
- R5: The recycling of tires which are burned in part is difficult; after being shredded, they are landfilled or incinerated (R5).



[Caption: An example of reuse in the disaster area (4/22 Sendai City)]

■ Important points about temporary storage

(1) In the case of temporary storage, a place surrounded by a strong wall is desirable, but such conditions cannot be expected in a disaster area, so what is called open-air storage is carried out. Points requiring careful consideration are as follows.

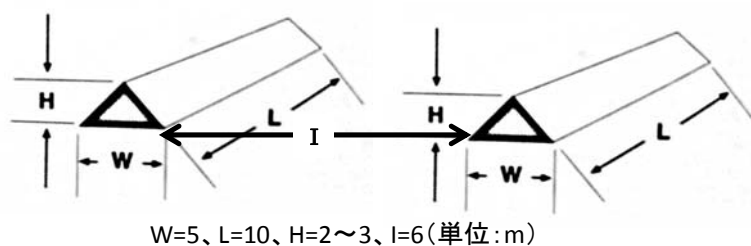
- Safety precautions: If waste tires are piled up haphazardly, the stack may collapse. In such a

situation, if people are in the vicinity, it may be dangerous. Moreover, although tires do not ignite easily, once they catch fire, they are very difficult to extinguish. Therefore it is necessary to leave a certain amount of distance between open-air storage stacks. According to the Fire Defence Act, the area of a temporary storage site should be no larger than 500m².

- Ensuring ease of work: passenger car tires can be lifted by workers, but working efficiency is low. Large-sized truck tires and those of heavy industrial machinery are too heavy for one human worker to lift them. Therefore it is necessary to use heavy machinery, such as a power shovel. Moreover, to transport accumulated tires, it is necessary for trucks (mostly 4/10-ton trucks) to enter the temporary storage sites. Overall, considering use of heavy industrial machinery and trucks, it is necessary to make sure of sufficient space between waste piles to facilitate ease of work.

Potential risk: although tires do not ignite easily, once they catch fire, extinguishing them is very difficult. In the U.S.A., there has been a case in which children playing with fire caused a disastrous fire in a waste tire dump. It is advisable to establish a fence around the storage site to prevent children from playing in the area. A primary danger is that of a waste tire pile collapsing. Other dangers are breeding of mosquitoes, which make use of water which accumulates in the hollow section of a tire (due to concern about infections that may be carried; the northern limit of the Asian tiger mosquito which carries dengue fever and West Nile fever seems to be moving further north) and use by field mice or noxious insects (especially, in summer due to high temperatures). Release of offensive odors from dirty water is also a matter of concern as a regional issue. Both inside and outside Japan, such problems are realistic issues always pointed out in relation to illegal dumping of waste tires. It is desirable not to establish piles of waste tires in open-air storage over a long time. The amount of waste tires collected from the disaster area should correspond to the quantity which can be treated and transported out.

- (2) Form/arrangement of temporary storage : To be specific, if there is an enclosure wall, the dimensions of a pile of tires in open-air storage is 10 x 20 x 5m (=length, width and height), which can contain approximately 70,000~80,000 automobile tires. However, if an enclosure wall cannot be employed in a disaster area, it is said to be appropriate to reduce the scale to half of the above-mentioned dimensions, that is, one pile of waste tires in open-air storage should measure 5 x 10 x 2-3 m, containing approximately 20,000-30,000 automobile tires. As for the space between piles in open-air storage, leaving at least a 6 m interval is desirable.



【Fig. 8-7-3】 Form of waste tire piles in open-air temporary storage

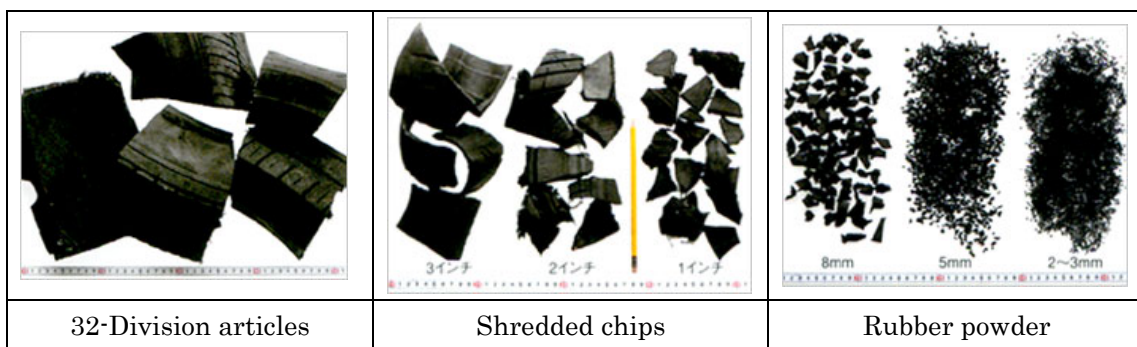
■ Trucks for conveyance of tires, shredder and cutting machine

- (1) Truck for conveyance of tires: If a 4-ton truck is used, and loaded carefully, it can carry about 400-450

tires per truck. If it is loaded haphazardly, only about 200 pieces can be loaded. When using a 10-ton truck, the load is twice as large as that of the 4-ton truck, and if loaded carefully about 800-900 tires can be loaded. If it is loaded haphazardly, it will carry only about 400 tires. In addition, since the specific gravity of tires is light, deep-framed trucks are most suitable. When using a detachable-type “skip truck” (arm roll vehicle); whose loading capacity is 25m³, as for round tires, a quantity equivalent to 4-4.5-tons can be loaded.

(2) Tire shredder and cutting machines

- If using a large-sized shredder (5.7 m long, 1.9 m wide, 4.2 m high, weighing 20 tons), two sets (225 kW) of motors can be operated with a 440V power supply, and about 10 tons of tires per hour can be shredded into about 2-inch chips (size of the tire chips used as auxiliary fuel in paper factories or cement plants).
- On the other hand, processing capability of a cutting machine (press type) which does not has capability like a crusher, is 12-15 tons per day using a 220V power supply, which for general automobile tires works out to about 1,500 tires per day.



【Fig. 8-7-4】 Types of tire chips (Japanese Scrap Tire Recycle Association HP)

- Self-propelled type shredders are available, and it is necessary to choose suitable machinery according to planned disposal flow.
 - If earth and sand adhering to or deposited inside a tire obstructs the work process, it is considered that a certain amount of earth and sand will fall off when picked up by a hydraulic shovel with a grip. As an alternative method, putting water in a big box, about 10m³ or so and dipping tires into it to release earth and sand is also suggested.
 - In addition, if a shredder is carried in and tires are processed as industrial waste, that shredder corresponds to a facility under Article 15 of the Wastes Management and Public Cleaning Act which applies to facilities with capacity to treat more than 5 tons/day of industrial waste, and approval is required, becoming subject to city planning deliberation (Article 51 of city planning). In the case of following usual procedures, a lot of time is needed, in order to obtain the required approval for bringing a shredder in and working in a disaster area. On the other hand, if the tires are regarded as general wastes, they can be put on a maker's recovery route on the assumption that they are to be recycled, in which case approval for conveying waste is not necessary.

		
<p>Photograph 1. Intact tires left at a gas station impacted by a tsunami (left-hand side of middle of the screen) (in Kamaishi City)</p>	<p>Photograph 2. Tires in front of a store (in Kamaishi City)</p>	<p>Photograph 3. Collected tires (in Taro Town)</p>
		
<p>Photograph 4. A pile of waste tires at a temporary storage site (in front of Rikuzen-Takata City hall)</p>	<p>Photograph 5. Earth, sand, and buried tires (in Rikuzen-Takata City)</p>	<p>Photograph 6. Wheels buried in earth and sand (in Rikuzen-Takata City)</p>
		
<p>Photograph 7. Burned tire of vehicle (at Otsuchi Station in Otsuchi Town).</p>	<p>Photograph 8. Large-sized tire (in Rikuzen-Takata City)</p>	<p>Photograph 9. Tire on riverside (in Rikuzen-Takata City)</p>

【Fig. 8-7-5】 Situations of tires in disaster areas after the Great East Japan Earthquake
(photographs taken by the task team ; April 16~18, 2011)

【Guide 8-8】 Specified Electrical Home Appliances under the Recycling Law

- Basically, the management of these home appliances should comply with the notification published on March 2011 by Ministry of the Environment (“Notification with regard to treatment of damaged home appliances specified by Electrical Home Appliances Recycling Law”)
- Municipalities judge their recyclability (whether recovery of valuable resources is possible or not).

■ Key points

- Treatment of home appliances specified by Electrical Home Appliance Recycling Law, such as televisions, air conditioners, refrigerators/freezers and washing machines/cloth dryers, should comply with the notification issued by the Ministry of Environment on March 2011; (“Notification with regard to treatment of damaged home appliances specified by Electrical Home Appliances Recycling Law” (see Appendix for the details). The summary is as follows:
- If sorting is possible, these home appliances should be separated from other disaster waste and stored at temporary storage sites.
- Municipal staffs are to judge their recyclability (whether valuable resources can be recovered) taking into account the extent of damage and corrosion. If recycling seems possible, the municipality brings them to the producers’ designated collection sites (Under normal circumstances, these specified home appliances are recycled by two producer groups (A and B), so basically their recycling is conducted in the same manner). If recycling is not possible, they should be disposed of together with other disaster waste.
- When assessment of recyclability is difficult, municipalities can contact the Association for Electric Home Appliances as stated in the notification.
- An example case is shown in Table 8-8-1. In fact, municipalities will consult with the person in charge of each group.

【Table 8-8-1】 A case of response about treatment of damaged electrical home appliances (Group A, 31 days after the disaster happened, April 14, 2011)

Policy for receiving damaged home appliances by group A	Basically, all damaged home appliances, which are specified by the Law, will be received regardless of the level of damage. Even if they are covered with sediment from tsunami, they will be received. However, there are some exceptions such as only the door of a refrigerator (accept even if the door is separated from a refrigerator unless they are not together), CRT television with broken tube, etc., because they cannot be recycled. They should be treated as municipal waste.
Reception in Sendai city from April 11 th	Reception of all specified items was started in Sendai city from April 11 th . Persons in a group organized by several home appliance manufacturers visited the prefectural office and discussed the receiving process. In the case of Sendai city, registered handling agents receive damaged home appliances and transport them to a designated recycling plant. If damaged home appliances are covered with sediment, registered handling agents wash them before the transportation to the recycling plant. Besides, tap water for washing was not available at some locations in the northern part of the prefecture, and the collectors may transport those damaged appliances with sediment to a recycling plant and the appliances will be washed there before recycling.

<p>Procedure of reception</p>	<p>The receiving procedure depends on how a municipality handed over those home appliances in normal circumstances before the disaster. Normally, tickets issued by post office are used as the manifest of the recycling scheme, to ensure handing over of appliances to producers, when a municipality hands over home appliances dumped illegally. This time, “municipality ticket” should be used because the number of damaged home appliances is so large. This “municipality ticket” serves as the manifest as well. If the municipality didn't participate in this system yet, registration for the system is necessary. It takes two weeks to complete registration for the system. Sorted home appliances will be received with the ticket at designated collection sites or transported from storage sites of disaster waste.</p>
<p>Storage site</p>	<ul style="list-style-type: none"> • Damaged home appliances should be sorted into two groups (Group A and Group B). If it is difficult to distinguish which group a product belongs to, it should be set aside. • They should be further sorted into 4 classifications: televisions, air conditioners, refrigerators/freezers, and washing machines/clothes dryers. • Transporting them to designated collection sites or producers’ recycling plant should be conducted by trucking firms contracted to the municipality. If such companies are no longer operating, manufacturers of home appliances will pick them up directly. • Damaged home appliances will surely be accepted by producers for recycling. So, never hurry to dispose of/shred them. If shortage of storage space is a concern, treatment of waste other than specified home appliances should be made a priority.

■ Treatment method and procedure

- Since specified home appliances are bulky and comprised of various complex materials, proper treatment is difficult. Thus, they should be treated under the conventional recycling route established by the Law as much as possible, if the situation is in less urgent or there is sufficient space for storage. Some new policies might be introduced by producers later. So, it is important to not rush into disposal if there is sufficient space for temporary storage. The order of priority on management is as follows in (1) and (2).

(1) If sorting of the damaged home appliance from other wastes is possible and recycling seems to be also possible: At first, contact the producer group in order to confirm whether the appliance is acceptable or not. Since severely damaged appliances are difficult to recycle, such as only the door of refrigerator, CRT television with broken tube, etc., they should be treated as municipal waste. Others, which are considered to be possible to recycle, are accepted by producer groups regardless of the extent of damage.

(1-1) When a recycling scheme is available

- Damaged home appliance is received by a retailer of home appliances or transported to designated collection site of producers. Several products will not be received, so confirmation should be made beforehand if the product will be received or not.
- Information about the designated collection sites in each area is available from the Association for Electric Home Appliances (http://www.rkc.aeha.or.jp/text/s_place.html).
- Though municipalities have to pay the recycling fee when damaged home appliances are handed over to producers, it is compensated by a subsidy from the national government. (Ministry of the Environment, No.398, October 2, 2001, “Notification about the handling of discarded electrical home appliances in case of disaster”)

(1-2) When a recycling scheme is not available

- If there is enough space in temporary storage sites, damaged home appliances should be stored at the sites until designated collection sites are restored. Appliances might be transported to a designated collection site in the other area, or received directly by producers. Municipal officers in charge should contact the Association for Electric Home Appliances and confer on the procedure with a person from each producer group.

(2) If sorting of damaged home appliances from other wastes is impossible and recycling seems to be impossible: Municipalities must treat damaged home appliances. This should be avoided as much as possible and regarded as an emergent measure. A procedure in this case is as follows:

- If waste treatment facilities, such as crushing/shredding facility for bulky/incombustible waste, are available, damaged home appliances are to be conveyed to the facilities and treated there.
- In the case of no treatment facility or no facility available:
 - Shredding of damaged home appliances is possible if a mobile type shredder/crusher (e.g. Impact crusher, etc.) is installed at a temporary storage site. Pretreatment of separating each material by using heavy machinery or by hand sorting is preferable. Separation of each material before shredding makes recovery of ferrous metals efficient and makes shredding plastics easier by using dual-shear shredders.
 - When a mobile shredder is unavailable, crushing is conducted by using heavy machinery. A magnet attachment for an excavator is effective to recover ferrous metals from shredded material.
- Direct disposal into a controlled-type landfill must be the last option only when none of above-mentioned methods is available. This should be avoided as much as possible.

■ **Storage at storage site**

- Notes on storing damaged home appliances at storage sites of disaster waste are as follows:
 - The damaged home appliances should be separately stored at a storage site distinguished by groups A and B. When it is difficult to distinguish which group an appliance belongs to, it should be set aside.
 - They should be stored by separating 4 items: televisions, air conditioners, refrigerators/freezers, and washing machines/clothes dryers.
 - Acceptance is case by case. However, a damaged home appliance can be received even if it is covered with mud from flood and tidal wave, etc. In this case it will be washed at the designated collection site /recycling plant.
- Please refer to Section 6-3 for other notices for storage at primary waste storage sites.

■ **Treatment procedure**

- When a municipality has to treat damaged home appliances, the main treatment process is shredding. Notices to be taken into account before shredding are summarized in Table 8-8-2.

【Table 8-8-2】 Notices for treatment of damaged home appliances

	Considering the environment	Effective shredding
Air conditioners	<ul style="list-style-type: none"> Fluorocarbons, which are contained as a refrigerant, should be removed. The removal procedure should be conducted by a designated company for fluorocarbon recovery. A capacitor containing PCB may be used in some products manufactured before 1972. Such a capacitor should be removed before treatment. 	<ul style="list-style-type: none"> Since compressors are hard and difficult to shred, they must be dismantled beforehand. Heat exchangers are mainly comprised of copper and aluminum. Recycling is feasible if they are dismantled separately.
Refrigerators	<ul style="list-style-type: none"> Fluorocarbons, which are contained as a refrigerant, should be removed. The removal procedure should be conducted by a designated company for fluorocarbon recovery. 	<ul style="list-style-type: none"> Since compressors are hard and difficult to shred, they must be dismantled beforehand. There may be some leftovers of food, etc. They should be removed before processing.
Laundry machines		<ul style="list-style-type: none"> Since motors are hard and difficult to shred, they must be dismantled beforehand. Washing tubs made of stainless steel should be separated and recycled if possible. Saline solution contained in balancer attached to upper part of a washing tub should be removed if possible.
Televisions	<ul style="list-style-type: none"> Capacitors containing PCB may be used in some products manufactured before 1972. Such capacitors should be removed before treatment. 	

【Guide 8-9】 Other WEEE (Waste Electrical and Electronic Equipment)

(WEEE not covered by Electrical Home Appliance Recycling Law, including PCs)

- Basically, PCs (personal computers) and mobile phones should be sorted and recycled by the relevant existing recycle systems wherever possible.
- Check the guiding principle of PC recycling in “Notification about Treatment of Affected PCs” announced by the Ministry of the Environment.
- Sort and store hazardous articles and parts (e.g., primary/secondary batteries, fluorescent lamps, oil heaters, gas cylinders for portable gas stoves) from products and recycle or treat them by existing collection systems.
- Basically, other WEEE is treated by incineration after being crushed and resource recovery.
- Personal information in PCs, mobile phones, digital cameras/videos and HDDs (hard disk drives) has a certain value for the owner similar to photo albums. These products should be sorted before crushing and returned to original owners as much as if possible.

■ Key points

- Other WEEE except for the home appliances designated in the “Electrical Home Appliance Recycling Law” (cf. **【Guide 8-8】**) is also to be collected and stored wherever possible.
- WEEE that can be recycled by currently existing recycling systems are PCs and mobile phones.
- Municipalities should consider how to recycle and treat PCs referring to “Notification about Treatment of Affected PCs” (http://www.env.go.jp/jishin/attach/hisai_pc.pdf) announced by the Ministry of the Environment.
- WEEE containing hazardous substances/parts needs to be handled cautiously.
- WEEE that should be stored as “personal valuables” are PCs, mobile phones, digital cameras, digital videos and HDDs.
- The basic treatment method for other WEEE is incineration after crushing and resource recovery.

■ Target WEEE

- WEEE except for home appliances designated by the “Home Appliance Recycling Law” includes the following appliances.
 - PCs : An existing recycling system is provided by the “PC 3R Promotion Association” (<http://www.pc3r.jp/e/>).
 - Mobile phones : An existing recycling system is provided by “mobile · recycle · network” (<http://www.mobile-recycle.net/> ; in Japanese).
 - Others (from households and business offices) : Microwave ovens, rice cookers, electric pots, cleaners, electric fans, fan heaters and other heating apparatus, water heaters, fuel tanks, VCRs, DVD players, video cameras, digital cameras, AV equipment, monitors (LCD and CRT), network equipment (routers, hubs etc), printers, telephones (FAX), copy machines
 - Hazardous articles : Batteries (including ones in electronic appliances), fluorescent lamps, oil tanks,

portable gas stoves

- PCs, mobile phones, digital cameras, digital videos and HDDs can be treated as “personal valuables” items.
- It is necessary to pay attention to differences in type of WEEE from different types of area (residential area, industrial area, etc.). Special, unordinary equipment could be discarded. Planning of different sorting rules and procedures for several areas might be necessary. Industrial wastes could be mixed in according to area. Specialists’ instructions might be needed, to ensure suitable sorting.

■ Separation and collection of WEEE

- Source separation at the early stages is desirable. In practice, according to the extent of damage and the situation of removal, sorting, and collection, the following separation would be more practical.
- (1) In case of houses collapsed by tsunami: At first, these wastes would be removed and stored in the nearest temporary storage site, and then moved to a primary waste storage site. It is common that WEEE is mixed with debris and other wastes due to tsunami or subsequent life-saving activities. In such a case, WEEE should be separated from other wastes at the temporary storage site as much as possible. The following WEEE items should be identified and separated whenever possible. They are then to be kept at a primary waste storage site, or a storage site for personal valuables.
 - a) Specified home appliances covered by the “Electrical Home Appliance Recycling Law”
 - b) PC and mobile phone
 - c) Personal valuables
 - d) Other WEEE (possibly, a), b), c), and d) include)
 - e) Hazardous articles and parts
 - (2) In case of household waste and waste from demolished houses: From the time of discarding and demolishing, WEEE should be sorted as much as possible.
 - At storage sites, WEEE should be separated from other waste and stored as much as possible (in a way that considers the processes of recycling and treatment). Items e), hazardous articles and parts, should be stored and treated as in **[Guide 8-14]** .

■ Treatment of PCs and mobile phones

- (1) Recycling systems for PCs and mobile phones exist, and therefore the systems should be utilized as far as possible. However, utilizing the recycling systems might be difficult in some cases. It is effective to share information on conditions of WEEE discarded and/or sorted with waste management companies because the condition (degree of damage, salt-water content, sawdust content, sludge content and others) of WEEE that they can dispose of may differ.
- (2) WEEE can be regarded as “personal valuables.” If a storage and handling system for personal valuables is available, consider having WEEE treated by such a system and stored for a certain period of time. Such consideration is unnecessary for WEEE privately carried in, because these items are carried in on the owners’ admission.
- (3) Confirmation of saved data in memory devices should not be carried out without its owner being present.
- (4) Treatment of PCs
 - The Ministry of the Environment suggested that PCs should be separated into two categories: those with

the “PC recycling label” that gives proof of payment of recycling cost, and those without the label. However, in reality, checking the label is difficult, and distinguishing between PCs and word processors is also difficult at the separation site, especially during removal. Recycling of these appliances should be judged on the basis of whether they are recyclable or not, regardless of the presence of the PC recycling label.

- In the process of treatment of PCs, determine the presence of a “PC recycling label” for each PC and record the number of PCs with the label.
- Data saved on HDD, etc. should be erased. However, the highest priority should be assigned not to erasing data, but to prompt treatment for waste disposal and reduction. Therefore, treatment should be commissioned to appropriate processing companies.

■ Treatment of other WEEE

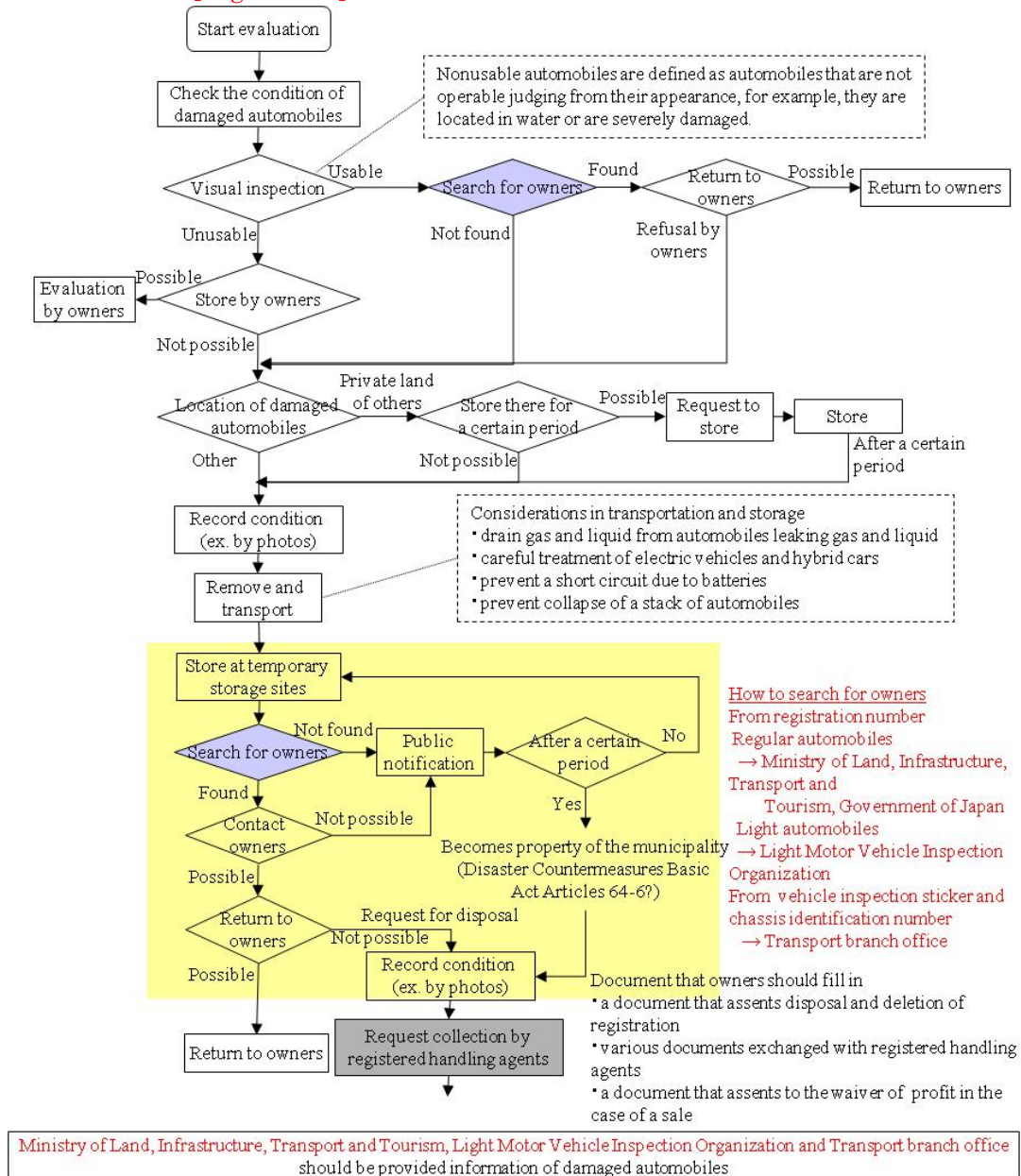
- Other WEEE, larger than 30 cm in one dimension (this size varies according to incineration plants) is basically to be crushed or shredded, iron is to be recovered if possible, and then the residue is to be incinerated.

【Guide 8-10】 Automobiles

- Basically follow the “Notification with Regard to Disposal of Automobiles Damaged by Great East Japan Earthquake (March 2011).”
- Damaged automobiles including wrecked cars should be recycled in accordance with the “ELV (End-of-Life Vehicle) Recycling Act,” in principle.

■ Key points

- Damaged automobiles should be removed from disaster areas, stored at temporary storage sites, then returned to their owners or disposed of, in accordance with the “Notification with regard to Disposal of Automobiles Damaged by Great East Japan Earthquake (March 2011)” of the Ministry of the Environment, Government of Japan (see Ministerial Guidelines for details). The flow of automobile disposal is shown in **【Fig. 8-10-1】**.



【Fig. 8-10-1】 Flow of automobile disposal (to owners or registered handling agents)

■ Management options and flow

- Damaged automobiles including wrecked cars should be recycled in accordance with the “ELV Recycling Act” in principle. Basically, they should be removed from disaster areas, stored at temporary storage sites, and a request for disposal should be made to certificated collection centers.
- There is no need to pay a recycling fee when a request for disposal is made to registered handling agents, in accordance with the “Notification with Regard to Handling of Automobiles of Unknown Identification Number Damaged by Great East Japan Earthquake” (http://www.env.go.jp/jishin/attach/car_recycling_charge.pdf; in Japanese).

■ Details of management

- The main task is to remove damaged automobiles from disaster areas and return them to their owners or to request a registered handling agent to collect them.

(1) Removal from disaster areas

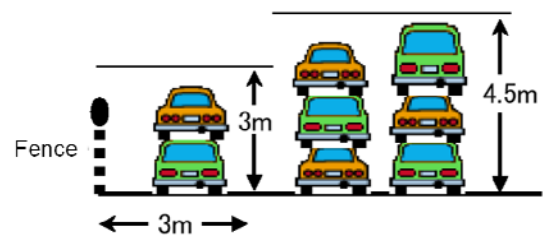
- The engine of submerged automobiles should not be started because of the possibility of water in the engine.
- The negative terminal lead of the battery should be disconnected in order to prevent a short circuit.
- Do not touch electric vehicles and hybrid vehicles without caution. Insulative protective clothing should be worn when removing electric vehicles and hybrid vehicles.
- Automobiles washed out to sea by the tsunami should be hauled out of the water using a rough-terrain crane or a truck crane (unic crane).
- In the case of a fuel leak, the fuel remaining in the tank should be drained off through the drain bolt and a fuel hose (the employment of a professional is recommended). Oil and coolant should be drained off through the drain bolt and a hose coupled to the tank.

(2) Transfer from disaster areas: transportation to temporary storage sites by wrecker trucks

(3) Storage at temporary storage sites: based on “Notification with regard to Disposal of Automobiles Damaged by Great East Japan Earthquake”

- Damaged automobiles may be stacked to a height of 3 meters within 3 meters of fences and to a height of 4.5 meters further away from fences.
- The height limit for large automobiles is the same as above. However, large automobiles should be laid out flat.
- When rack structures are safeguarded against the weight of damaged automobiles and their loading and unloading are safe, they may be stacked above the previously mentioned heights.
- When damaged automobiles are stacked, their centers of gravity should coincide so that the stack does not collapse.
- Other damaged items and materials should be separated from damaged automobiles.
- Sediment in damaged automobiles should be removed before treatment in order to prevent problems during the crushing process and an increase in automotive shredder residue (ASR).

(4) Information about the dismantlement of damaged automobiles is available from [\[Reference Information about Dismantlement of Damaged Automobiles \(for Businesses\)\]](#) .



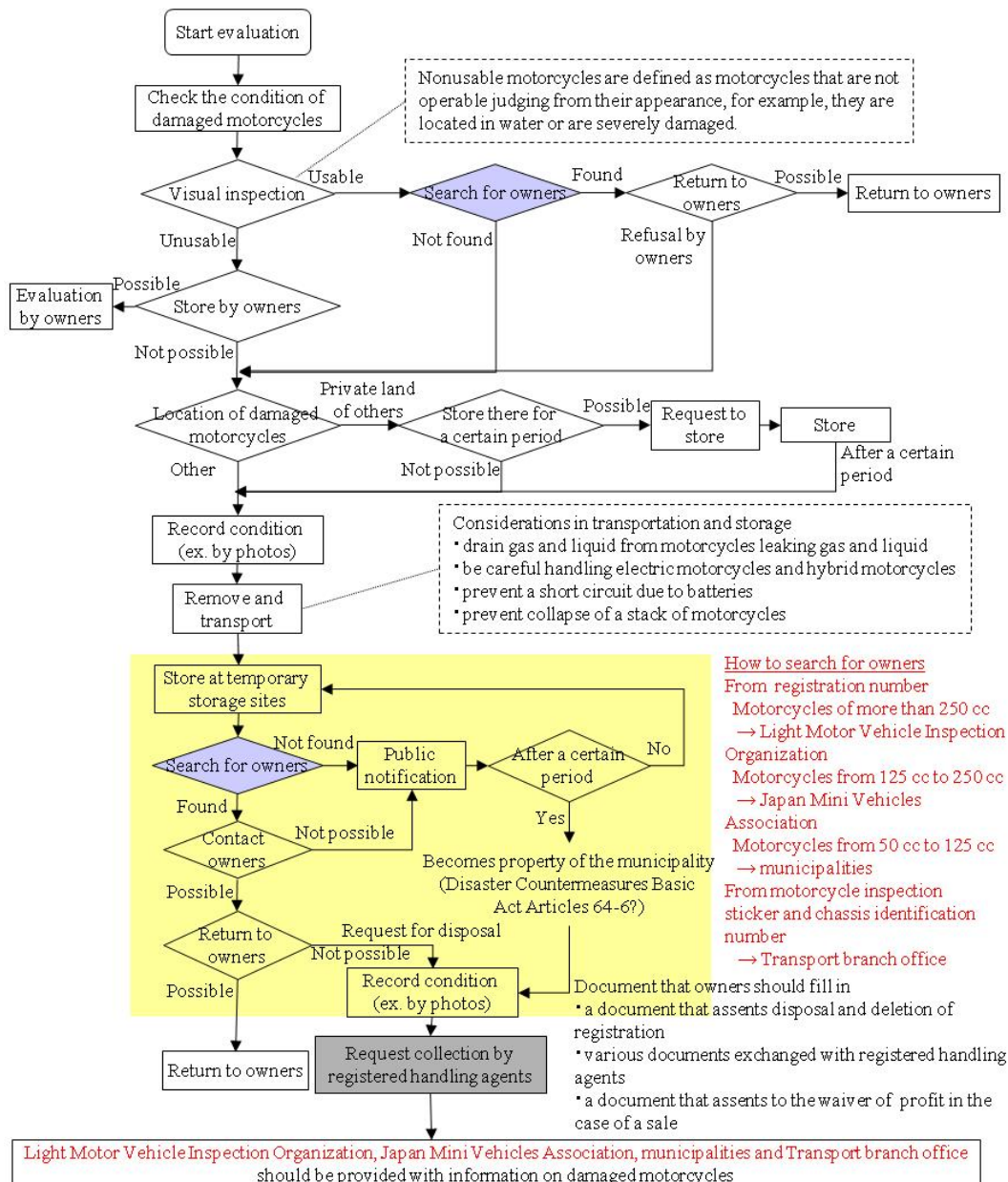
[Fig. 8-10-2] Storage of damaged automobiles (“Disposal of Automobiles Damaged by Great East Japan Earthquake”)

【Guide 8-11】 Motorcycles

- Basically follow “Notification with Regard to Disposal of Automobiles Damaged by Great East Japan Earthquake (March 2011).”
- Damaged motorcycles including handlebars, vehicle bodies, fuel tanks, engines and front and rear wheels should be recycled in accordance with the “Motorcycle Recycling System”.

■ Key points

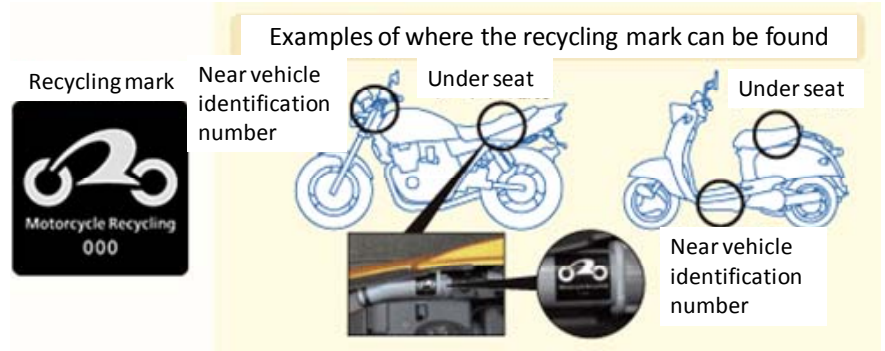
- Damaged motorcycles should be removed from disaster areas, stored at temporary storage sites, then returned to owners or disposed of, in accordance with the “Guidelines for removal of collapsed houses etc. resulting from the Great East Japan Earthquake (March 2011)” of the Ministry of the Environment, Government of Japan (see Ministerial Guidelines for details). The flow of motorcycle disposal is shown in **【Fig. 8-11】**. The flow of motorcycle disposal is similar to that of automobile disposal, and points of difference are indicated in red.



【Fig. 8-11】 Flow of motorcycle disposal (to owners or registered handling agents)

■ Management options and flow

- Damaged motorcycles including handlebars, vehicle bodies, fuel tanks, engines and front and rear wheels should be recycled through the “Motorcycle Recycling System.” Basically, they should be removed from disaster areas, stored at temporary storage sites, and a request for removal should be made to registered handling agents.
- There is no need to pay a recycling fee when motorcycles with a recycling mark are discarded. All motorcycles that left factories after October 2005 have a recycling mark. From October 2011, there will be no need to pay a recycling fee for motorcycles sold by the four motorcycle makers and the twelve importers in Japan, even though they have no recycling mark.



■ Details of management

- The main task is to remove damaged motorcycles from disaster areas and return them to their owners or to request registered handling agents to collect them.
- (5) Removal from disaster areas
- The engine of submerged motorcycles should not be started because of the possibility of water in the engine.
 - The negative terminal lead of the battery should be disconnected in order to prevent a short circuit.
 - Do not touch electric motorcycles and hybrid motorcycles without caution. Insulative protective clothing should be worn when removing electric motorcycles and hybrid motorcycles.
 - Motorcycles washed out to sea by the tsunami should be hauled out of the water using a rough-terrain crane or a truck crane (unic crane).
 - In the case of a fuel leak, the fuel remaining in the tank should be drained off through the drain bolt and a fuel hose (the employment of a professional is recommended). Oil and coolant should be drained off through the drain bolt and a hose coupled to the tank.
- (6) Transfer from disaster areas: transportation to temporary storage sites by vehicles for motorcycle transportation.

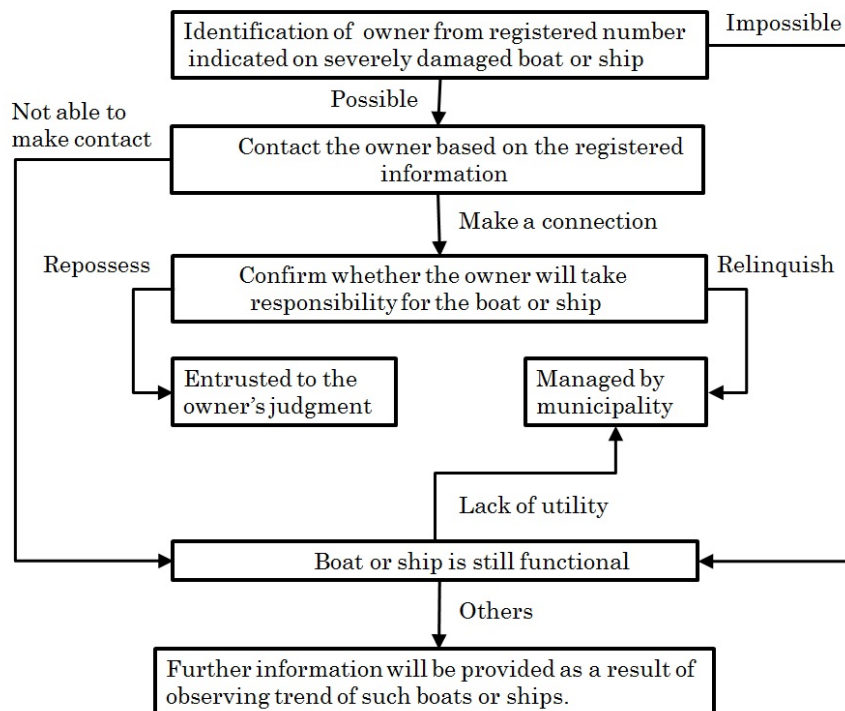
【Guide 8-12】 Boats and ships

- Basically, the management of damaged boats and ships should comply with the guideline published in April and July 2011 by the Ministry of the Environment (Guidelines on Disposal of Boats and Ships Damaged by the Great East Japan Earthquake).
- Material containing asbestos may be present, so attention is required when handling.
- Attention to publications on policy by industry groups and the government, etc. is necessary.



■ Key points

- Based on “Guidelines on Disposal of Boats and Ships Damaged by the Great East Japan Earthquake, April and July 2011, Ministry of the Environment,” management of damaged boats and ships should be carried out as indicated in Table 8-12-1. Basically, transportation and processing of damaged boats and ships are described in the guideline as follows:
- Severely damaged boats and ships, which can be moved, may be conveyed to temporary storage sites etc. at any time if necessary.
- If such boats and ships obviously lack utility, they can be processed as waste.
- It is a fundamental principle that the disposal of damaged boats and ships is done under their owner's responsibility. In the case of a disaster, a municipality may carry out the treatment and apply for a government subsidy.



【Fig. 8-12-1】 Judgement concerning treatment of severely damaged boats and ships

(Guidelines on Disposal of Boats and Ships Damaged by the Great East Japan Earthquake, April and July 2011, Ministry of Environment)

- The criteria for “utility” are as follows.

a) Boats and ships in the following condition are regarded as lacking utility	b) Boats and ships in the following condition are regarded as having utility. Confirmation of the owner's intention is necessary.
<ul style="list-style-type: none"> • Hull is severely damaged, is practically a hulk. • Hull damage is serious (no longer in original shape), and operation is impossible. • Embedded in house debris and other waste and difficult to separate without dismantling. 	<ul style="list-style-type: none"> • Possible to use if restoration and repairs are carried out, even in the case of damage or loss of part of the hull or if it cannot be operated due to damage to equipment.

In the case of b), a certain period might be necessary for the owner to assess damage. From two weeks to one month is a suitable period for confirmation.

- As for the procedure for finding the owner, the MLIT (Ministry of Land, Infrastructure and Transportation) and the Fisheries Agency announced “We will provide information on ownership of severely damaged boats and ships” (http://www.mlit.go.jp/report/press/kaiji06_hh_000033.html). Based on this, necessary items of information for establishing ownership are as follows; (1) Identification number (Inspection certificate number for small boats of less than 20 tons displacement), (2) distinctive letters on the boat, (3) registered number of fishing boat, (4) name of ship, (5) port of registration. Contact offices for inquiries etc. are provided.
- When contacting the owner, the following points should be confirmed.
 - (1) Does the owner know the location of his boat/ship?
 - (2) Is the owner receiving insurance compensation for his boat/ship? What is the situation of discussion on compensation?
 - (3) What is the owner's intention concerning his boat/ship? (a: Transportation and repair by owner and then reuse, b: Processing by the owner, c: Entrusting processing to the municipality)
 - (4) In case of a/b in (3), when does the owner plan to transport/repair the boat/ship, and to what location?
 - (5) In case of c in (3), inform the owner of his responsibility for deregistration.

*The following insurances are usually applicable to a boat or ship (freighter, passenger boat, fishing boat, etc.) used for business purposes.

Insurance on hull (In the case of fishing boats, it is “Regular nonlife insurance”)	Insurance which provides compensation for costs such as damage repairs. Generally, damage by earthquake/tsunami is covered by this insurance. (There are some exceptions) When the boat/ship is repaired and again in operation, the owner can receive compensation for the cost of repair including the cost of transport to the place where repair is conducted.
Protection and indemnity insurance (In the case of fishing boats, “Protection and indemnity insurance for fishing boat”)	Insurance which helps cover costs resulting from owner’s responsibilities. When a boat/ship that is completely wrecked due to the earthquake has to be removed and processed under the owner's responsibility, the insurance provides compensation for the necessary cost.

Refer to the guideline for details.

- The practicality of transporting a ship is judged according to its size.
- A vessel (larger than several hundred tons) stranded on a quay may be removed/moved by a floating crane etc. When the removal of the ship is difficult because of excessive weight or a location that is too far inland, at first reduce it to pieces of a size that can be transported.

- In the case of small boats, the following standards have been established.

<p>【Standard of transportation method according to length of ship】 ~9m : Unic truck crane can be used for lifting/transporting ~10m : Truck crane of 20 ton capacity or larger can be used for lifting and a truck is capable of transportation. ~13m : Truck crane of 20 ton capacity or larger can be used for lifting and a low-loading trailer is necessary for transportation.</p>

*Lifting of boats/ships should be conducted by firms specialized in handling slings. In addition, adherence to the Waste Management and Public Cleansing Act is important when transporting solid waste.

- The following section lists treatment methods. However, more concrete treatment procedures were announced by government or will be available from related industry groups. Section VI of this guideline mentions several important additional points concerning the treatment of boats/ships.

■ When a conventional management system is available

- When it is decided that damaged boats/ships are to be disposed of, treatment methods are classified as follows, based on construction materials used.

(1) FRP boats (widespread among small boats/ships, including fishing boats): A special feature of this type of boat is that FRP is a material regarded as being difficult to dispose of properly. Recycling is also difficult.

- Under normal circumstances, the boat is treated according to “Recycle system for FRP boats” (Japan Boating Industry Association: <http://www.marine-jbia.or.jp/recycle/recycle.html>). FRP boats can be received at marinas or consignment stores in each area. Recycling fees are stipulated according to type of boat and total length.
- Treatment is conducted by the following steps; At first, the boat is roughly shredded at the place of receipt. Then, it is pulverised at an intermediate treatment plant. Finally, fine FRP is utilized as fuel and raw material at a cement factory.
- To be accepted, the following items should be removed.
 - Ordinary waste (food waste, bottles, cans, etc. and items other than those associated with boats)
 - Sea shells, sea weed, fingerlings, etc.
 - Fuel, lubricant oil, (Crude petroleum, light oil, gasoline, oil, and coolant)
 - Bilgewater
 - Batteries, fire extinguishers, air conditioners and refrigerators
 - Fishing gear, ropes, fenders (tires, made of rubber, nylon, or styrene foam, etc.)

(2) Light alloy ship (aluminum etc.): It is received by an industrial waste treatment plant, dismantled and sorted, and resources are recovered.

(3) Steel vessel (large-scale) : It is received by an industrial waste treatment plant, and it is dismantled and sorted, and resources are recovered.

■ When conventional management systems are not available (Suggested processing method)

- If disposal of boats/ships is required after they have been brought to a temporary storage site, the following procedures are considered possible. Attention must be paid during processing work to the possibility of materials containing asbestos (see following description).

- In the guideline, materials and parts used for small boats are shown as follows.

Hull 1) FRP (Also laminated wooden boards with FRP coating.), 2) Light alloy (Aluminum alloy), 3) Wood
• Engine 1) Inboard engine: Mainly made of cast iron; some parts are aluminum alloy. 2) Outboard engine: Mainly made of aluminum alloys. 3) Fuel tank: Tanks may be made of FRP, stainless steel, aluminum alloy, and ABS, etc.
• Other equipment Stainless steel, aluminum alloy, and iron
• Dangerous and hazardous articles 1) Fuel (especially, gasoline), 2) batteries, 3) fire extinguishers, and 4) flares (maritime distress signaling device)

*Among these, the following items should be removed beforehand for safe processing:

Engines, fuel tanks, batteries, fire extinguishers and flares

(1) In the case of FRP boats

- After dismantling, metals such as those used in engines, nonferrous metals such as aluminum materials, wood, and urethane etc. should be separated. Then they should be allocated to the individual processing streams for metal scrap, wood waste, and combustible items, etc.
- It is preferable to pump out any fuel, lubricants, or water accumulated in the bilge of a boat/ship before dismantling/sorting.
- If it is possible to process FRP by the procedure indicated below (shredding the FRP to fine powder satisfying the acceptance standard for a cement factory), FRP should be utilized at a cement factory. If such process is not possible, FRP should be disposed of into an inert type landfill as plastic waste.
- Concrete examples of treatment procedure are indicated in **【Table 8-12】**.

【Table 8-12】 Example of methods of waste FRP boat recycling

Transportation	Truck (4t-10t) or unic truck crane (4t-10t) can be used for transport.
Dismantling	<ul style="list-style-type: none"> • For dismantling, heavy machinery, especially caterpillar excavator (8t-10t) with various attachments is useful. Recommendable attachments are forks, thumbs, grapples, etc. • Although it depends on the subsequent processing capacities, the size of crushing by heavy machinery is decided according to the size of shredder intake (e.g. less than 1m). • Dust generation (dispersion of glass fiber) is generally small when dismantling. • Wood, metal, and nonferrous metals are separated by hand sorting. • Ratios of metal and wood increase with the size of boat/ship. Large amounts of wood are used in fishing boats. The amount of interior materials is greater in motorboats.
Shredding/sorting	It has been reported that all FRP materials can be shredded by adopting general-purpose cold die steel DC53 for the material of the fixed blade and the rotating blade of a single-axis-shearing type shredder. However, when metals are mixed, the fixed blades can be damaged.

Treatment	<ul style="list-style-type: none"> • FRP processing requirements at a cement furnace are as follows: 1) The size of shredded material is below 20mm. 2) Concentration of chlorine and hazardous substances (Na₂O, SO₂, Zn, Pb, Cr) is below the limit value. 3) Foreign matter (metal and stone, etc.) must be removed. 4) The calorific value is 5000kcal/kg or more. 5) Dust such as glass fibers doesn't disperse. 6) Handling must be fully controlled. • When disposed of into landfill, it is preferable that shredding and sorting are conducted to reduce volume.
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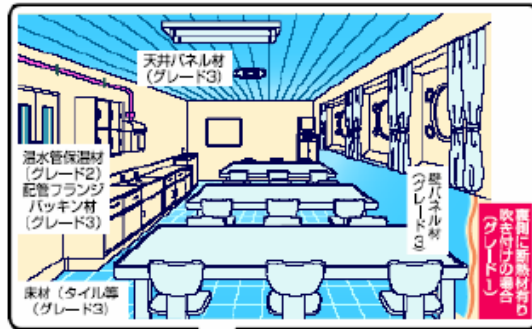
MLIT, Maritime Bureau, Project to create advanced recycling system of waste FRP vessels. Fiscal 2002. (<http://www.kaikoukan.jp/data/1-030303.pdf>)

(2) In the case of aluminum boats and steel vessels

- Many recoverable resources are contained in these boats/ships. After dismantling, metals used in engines, nonferrous metals such as aluminum materials, wood, and urethane etc. should be separated. Then they should be allocated to the individual processing streams for metal scrap, wood waste, and combustible items, etc.
- For instance, the following items can be recovered as metals from an aluminum fishing boat (by referring to Japan Aluminum Association “Pocket book of rolled aluminum goods, 2009” (in Japanese)).
 - Aluminum: Hull, deck, top rail, superstructure, partition, hatch, window frame, and mast
 - Stainless steel: Tiller plate and propeller shaft
 - Propeller: Brass

■ Identification and removal of hazardous substances (Especially asbestos)

- It is possible that hazardous substances such as asbestos and PCBs may be encountered in superannuated ships. When dismantling, it is necessary to ensure screening of hazardous substances, measures to prevent environmental pollution, measures to prevent worker's health impact, and appropriate removal/treatment of hazardous substances.
- Parts where asbestos may be encountered are shown in **【Fig. 8-12-2】** .
- To prevent dispersion of asbestos and to avoid exposure to it, work levels are classified as follows:
 - Work level 1 is stipulated for the removal of sprayed asbestos.
 - Work level 2 is stipulated for disassembly work on heat insulators containing asbestos.
 - Work level 3 is stipulated for disassembly work on molded plates containing asbestos.
- For details regarding removal/disassembling work, refer to the manual (Japan Ship Technology Research Association "Manual on proper handling of asbestos used in ships" (in Japanese) <http://www.jstra.jp/html/PDF/Asbestos%20manual%E3%80%80jap.pdf>)



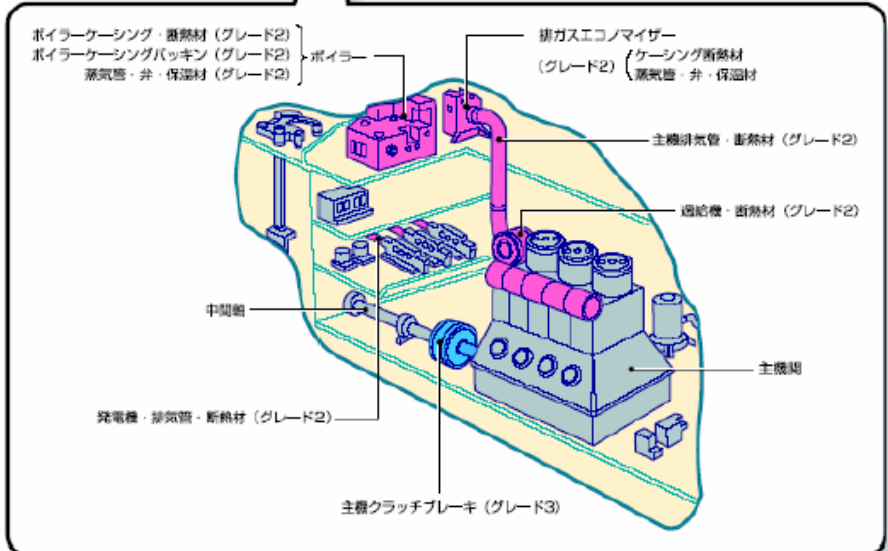
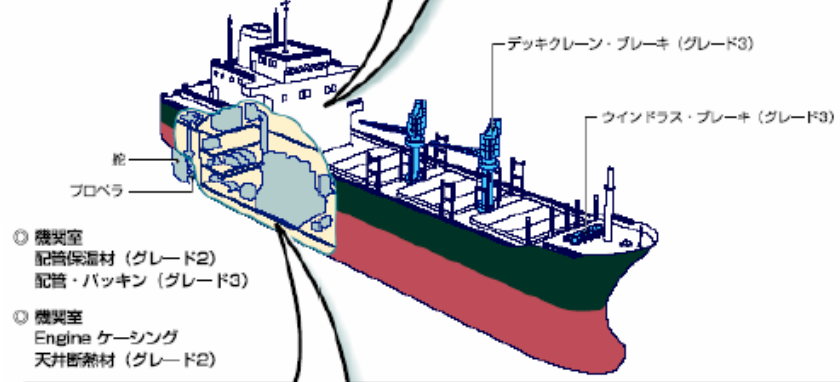
(1) Sprayed asbestos



(居住区壁裏の吹き付けアスベスト材)



(天井に吹き付けられた結露防止アスベスト材)



(2) Heat insulator



(タンクの保温。保温板の上に表面にアスベストクロスを貼り付けて、金網で補強、右はブリキ板で補強してあります。)



(アスベスト糸を布状にしたクロス)



(アスベストクロスを蒸気配管に巻いている)

【Fig. 8-12-2】 Parts where asbestos may be used in boats/ships

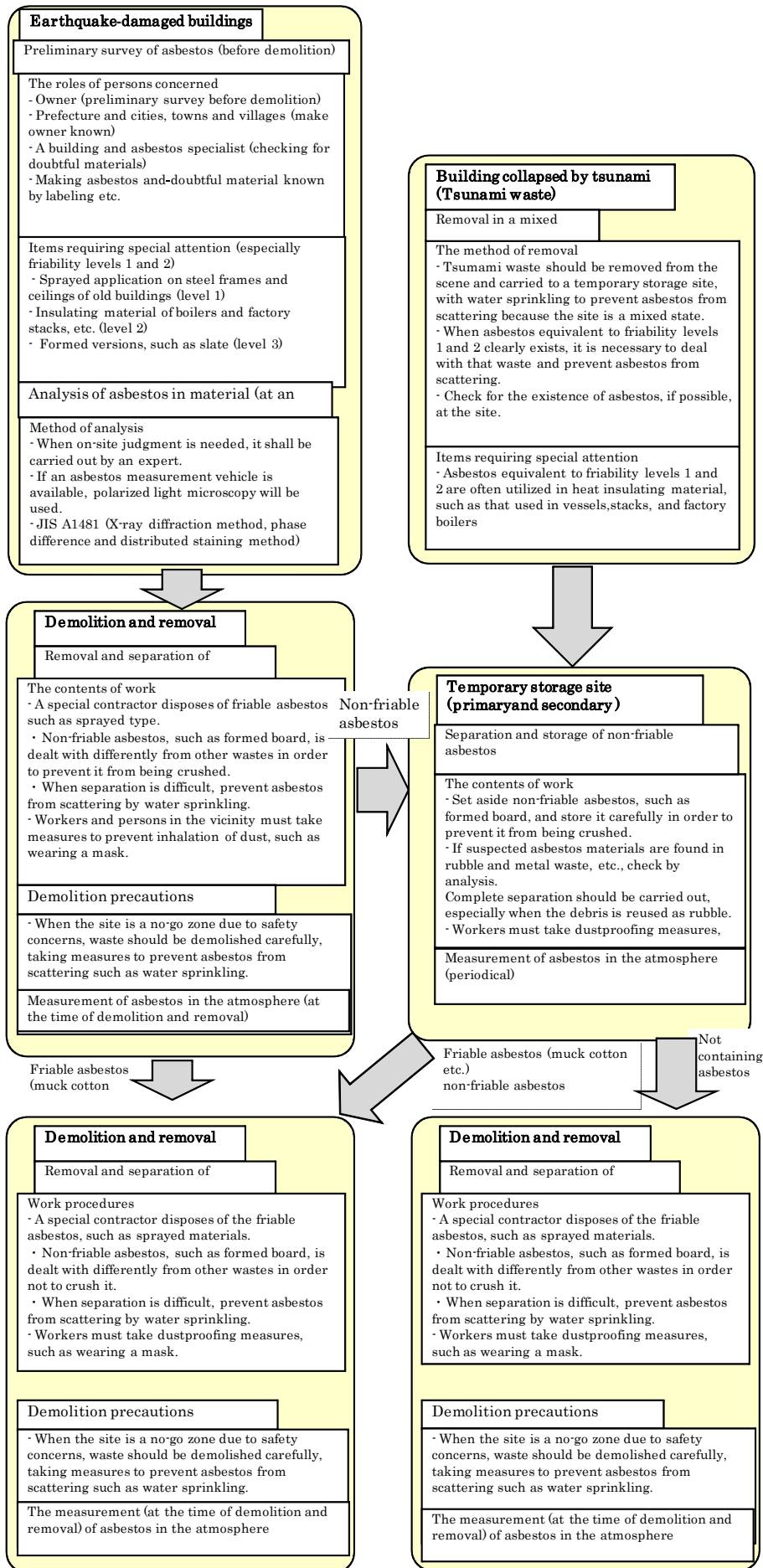
(Japan Ship Technology Research Association "Manual on proper handling of asbestos used in ships")

【Guide 8-13】 Asbestos

- Separation and removal of asbestos should be conducted to the fullest extent possible, so that emission of asbestos and exposure to people are prevented.
- Buildings collapsed by tsunami are in principle composed of mixed materials, and removal of asbestos from them is basically difficult. However, measures for prevention of emission such as water sprinkling are recommended when they are removed and transported away from the site. If materials containing friable asbestos are identified such as insulation in stacks and boilers of ships or factories, separate removal should be conducted.

■ Key points

- With regard to the handling of asbestos in an emergency, separation and removal of asbestos should be conducted to the fullest extent possible, in order not to mix asbestos in the disaster waste as well as other hazardous substances. Thus emission of asbestos and exposure to people can be prevented.
- For this purpose, earthquake-damaged buildings should be investigated prior to demolitions, so that asbestos is not mixed into the disaster waste and to ensure that appropriate separation and removal can be implemented.
- On the other hand, buildings collapsed by tsunami are in principle composed of mixed materials and removal of asbestos from them is basically difficult. However, measures for prevention of emission such as water sprinkling are recommended when they are removed and transported away from the site. If materials containing friable asbestos are clearly identified, such as insulation in the stacks or boilers of ships or factories, removal should be conducted separately from other waste.
- At temporary storage sites, qualitative analysis of asbestos is recommended when possible asbestos-containing materials are found among scrap metal, construction debris and others. In particular, when rubble is to be utilized as recycled gravel, careful separation and storage should be carried out in order not to mix any asbestos-containing material into it.
- Regarding non-asbestos waste disposal, a dust collection system is recommended for crushing, taking into consideration the possibilities of non-friable asbestos-containing materials being mixed in. Friable and non-friable asbestos waste should be disposed appropriately as “asbestos waste.”
- At sites for demolition and removal, temporary storage sites, and where material is crushed for treatment, measures for emission prevention such as water sprinkling are recommended. Workers and environmental sampling personnel at those sites must protect their health and safety by using specialized masks and other safeguard kits.



[Fig. 8-13] The outline of response to asbestos in a disaster area

【Guide 8-14】 Hazardous/dangerous articles

- Various products with harmful/dangerous characteristics may be mixed in disaster waste.
- It is preferable to extract and sort them as much as possible for safety in work/storage/processing.
- Such products should be appropriately stored at temporary storage sites until a proper treatment process is established because many of them do not require urgent treatment.



■ Key points

- Even in normal circumstances individual hazardous/dangerous articles (products) are classified as “Items difficult to dispose of appropriately” and they are not collected or treated by municipalities. Many of them can have negative impact on human health and the environment and may also become obstacles to reconstruction, if they are dispersed into the environment by earthquake/tsunami and proper collection/treatment measures are not taken. In disaster waste management plans formulated in the past by several municipalities, management policy concerning “Items difficult to dispose of appropriately” is stated as follows:
 - In principle, items corresponding to industrial waste (including industrial waste requiring special treatment) should be treated under the responsibility of the business entities that generated the waste even following a disaster, as well as under normal circumstances.
 - Since increased generation of “items difficult to dispose of appropriately” from households is expected following a disaster, announcements should be made to residents regarding prioritization of discharge (e.g. the beginning date of collection service, restraint concerning discharge until normal collection is resumed, etc.) and appropriate management procedures.
 - It is important to promote proper treatment of waste by taking measures to prepare a collection scheme by business entities. Moreover, cooperation of business entities should be requested. Information on take back by business entities should be announced to residents by leaflet, etc., and consultation services should also be provided.
- The following section mainly describes important points regarding items indicated in **【Table 8-14-1】**. However, it is necessary to confirm the most recent information because additional important announcements may be made by industry groups and the government.

【Table 8-14-1】 Hazardous/dangerous products

Feature	Product
Products containing hazardous substances	Agricultural chemicals, insecticides, and other chemicals (not home medicines)
	Coating medium, paint
	Batteries (Sealed type battery, Ni-Cd battery, micro cell, and car battery)
	Fluorescent lamps and mercury thermometers
Products having	Kerosene, gasoline, and engine oil

harmful/dangerous characteristics	Organic solvent (thinner etc.)
	High-pressure gas cylinders
	Gas canisters, spray cans
	Fire extinguishers
Infectious waste from household	Used injection syringe needles and disposable syringes, etc.

*Asbestos and waste electrical equipment containing PCB, etc. are excluded.

■ Collection/acceptance and treatment procedure of individual item

(1) If the conventional collection system for individual items is functioning in the same manner as in normal circumstances, go ahead promptly with treatment/recycling by asking the designated collection/processing entity to collect/take-back such items immediately.

【Table 8-14-2】 Collection/take-back and treatment procedure of individual hazardous/dangerous products

Product		Product	Contact information	Treatment
Agricultural chemicals, insecticides, and other chemicals (not home medicines)		Ask shop /manufacturer for collection or ask waste management company for collection and treatment	JA Group, Agricultural chemicals shop National Federation of Industrial Waste Management Associations http://server-4.zensanpairen.or.jp/index.php	Neutralization and incineration
Coating medium, paint		Ask shop /manufacturer for collection. Ask waste management company for collection and treatment		Incineration
Batteries	Ni-Cd battery, Nickel-hydrogen battery, Lithium-ion battery	To collection box in recycling cooperation shop	Japan Portable Rechargeable Battery Recycling Center http://www.jbrc.net/hp/contents/index.html	Shredding, sorting, and recycling
	Micro cell,	To collection box in electric appliance shop etc.	Battery Association of Japan http://www.botankaishu.jp/srch/srch10.php	Shredding, sorting, and recycling
	Car batteries	To auto-supply shop or gas station where recycling is carried out		Shredding, sorting, and recycling (metal recovery)
Fluorescent lamps		Collected as household hazardous waste or as incombustible		Shredding, sorting, and recycling (cullet, recovery of

	waste, depending on region		mercury)
Kerosene, gasoline, and engine oil	To automobile dealer or gas station		Incineration and recycling
Organic solvents (thinner etc.)	Ask shop /manufacturer for collection. Ask waste management company for collection and treatment		Incineration
High-pressure gas cylinders	Return to shop	LP Gas Sales Association http://www.japanlpg.or.jp/index.html	Reuse and recycle
Gas canisters, spray cans	After completely using it, make a hole in it then discharge as incombustible waste		Shredding
Fire extinguishers	Ask shop /manufacturer /waste management company	Fire Extinguisher Recycling Promotion Center http://www.ferpc.jp/index.html	Shredding, sorting, and recycling
Used injection syringe needles and disposable syringes, etc.	Collected as household hazardous waste, depending on region. Or collected at specified medical institution		Incineration, vitrification, landfilling

(2) If conventional collection system for individual items is not functioning

Hazardous /dangerous items should be stored at the temporary storage site until collection stations are set out. If necessary, they are transported to a collection station located in another area and then they are treated /recycled. Otherwise, by adding function of a collection station to temporary storage sites, and directly dealing with transport /treatment companies, prompt management may be achieved.

■ **Agricultural chemicals**

- (1) “Management and disposal of unused agricultural chemicals, December 2004” (<http://www.jcpc.or.jp/>; in Japanese) is useful for reference.
- (2) Basic concepts in normal circumstances are as follows; 1) To avoid left-over amounts, they should be used completely. 2) Washing solution from used container should be used in the field as a dilute solution for agricultural chemical spray.
- (3) The following aspects should be noted when agricultural chemicals become disaster waste.

- Agricultural chemicals that remain in container
 - Agricultural chemicals that remain in their container must not be transferred to other containers, in order to prevent misuse and accidental ingestion, etc.
 - Agricultural chemicals that remain in their container and residues in used containers must not be disposed of into rivers, lakes, irrigation channels, and sewers, etc.
 - In the case of a can container which contains volatile agricultural chemicals (for instance, chloropicrin etc.), it should be managed according to “Notification with regard to removal of agricultural chemicals residue from a used container and the disposal of empty containers, December 2004” (in Japanese), published by the Japan Crop Protection Association.
- When agricultural chemicals must be unavoidably discarded, they should be appropriately treated by one of the following methods.
 - The handling of agricultural chemicals should be consigned as much as possible to an authorized waste management company.
 - If a city, town, or village is responsible for their collection and disposal in normal circumstances, they should be stored until the normal function of the city, town, or village is regained.
 - If a regional cooperation system had been established to collect and manage agricultural chemicals in normal circumstances, these chemicals should be stored until the system is reestablished.

(4) Cautions

- In the case of poisonous or deleterious substances, the company that stores/transportes these substances must be registered, and management procedures for each substance are stipulated based on the Poisonous and Deleterious Substances Control Act.
 - Agricultural chemicals, which contain more than a certain limited proportion of simazine, thiuram, benthocarb (thiobencarb), organophosphorous compound (parathion, methyl parathion, methyl demeton, EPN), and 1,3-dichloropropene, may be classified as industrial waste requiring special treatment. Strong acid and strong alkali substances are subject to the same classification.
 - Additionally, full care must be taken when disposing of agricultural chemicals, including storage, transport, and treatment contract, because some liquid products might be classified as industrial waste such as waste acid/alkali.
- (5) When they are stored, all of them should be stored under a roof in order to prevent dispersal into the surrounding environment by wind and rain. If they are stored outside, they should be fully enclosed by waterproof plastic sheeting (including ground surface underneath them).

■ Coating medium, paint

- (1) If paints separated from the disaster waste are sorted as industrial waste, their transport and treatment should be consigned to an authorized waste management company.
- (2) Disposal of small amounts of paints used in households is not possible if they are in liquid state. In principle, containers should be disposed of after the contents are completely used up. If they have to be disposed of unavoidably, they should be treated according to the following instructions.
 - Paints: Paints should be poured out as much as possible, and daubed on newspaper etc. After the paint dries, the paper should be processed as a combustible waste. Another method uses paint treatment agent to solidify paints, after which it can be disposed of as combustible waste by being wrapped in newspaper etc.
 - Container: Paints in the container should be poured out completely until no paint remains in the bottom of the container. Then, the container should be dried outdoors not in vicinity of a fire, and disposed of as incombustible waste (or as metal scrap). Plastic containers should be disposed of as plastic waste.
 - Aerosol cans: The contents should be completely sprayed out. Then the can can be discarded, after confirming that no gas remains inside. Don't make a hole in it to discharge gas. Never throw it into a fire, as it may explode. If aerosol remains inside, it should be completely sprayed out onto newspaper etc and then dried. After discharging gas completely, containers should be disposed of as metal scrap. Caps should be disposed of as plastic waste.
 - Fluorocarbon might be contained in old products. So, it is necessary to check for its existence. If it is present, the products must be stored if possible.

■ Batteries

- Best efforts must be made to remove batteries from other wastes and to store them separately. Then they should be treated by the conventional recycling route. Especially, micro cell batteries containing mercury should be stored in designated containers and kept stored until the recycling route is reestablished.
- Because lithium-ion batteries may ignite, they should be stored in designated drums.

■ Fluorescent lamps

- Fluorescent lamps should be managed under the conventional collection system (recycling network) as far as possible. Since the amount generated is not estimated to be huge, they should be stored at temporary storage sites until the collection route is reestablished or transportation to a treatment facility becomes possible.
- In addition, they should be kept in a drum etc. because they are fragile.

■ High-pressure gas cylinders

- Gas leaks from high-pressure gas cylinders swept away by tsunami could result in cases of poisoning, ignition, and explosion. Careful handling is essential when collecting and transporting them.
- When a gas cylinder is discovered on site, do not approach it closely or touch it. Untrained personnel should not try to pick it up. Instead, contact the related group (e.g. <http://www.pref.fukui.jp/0902/gus.html>; in Japanese). The L.P. Gas Sales Association is conducting

collection of gas cylinders as indicated in **【Table 8-14-4】** with the announcement of “Measures taken by the L.P. Gas Sales Association for the Great East Japan Earthquake (ver.4)”

(<http://www.japanlpg.or.jp/info/data/20110405.pdf>; in Japanese).

- When it is difficult to store cylinders in a container yard, temporary storage is necessary in premises. In the case that the owner of a gas cylinder has been located, it should be returned to its owner. On the other hand, storage space is necessary for gas cylinders whose owners are deceased.

【Table 8-14-3】 Contents and external appearance of high-pressure gas cylinders

Gas	Color of cylinder	Characteristics of gas
Liquefied petroleum gas (LPG)	Generally, gray	Combustible gas
Oxygen	Black	Combustion enhancing gas
Acetylene	Brown	Combustible gas

【Table 8-14-4】 Gas cylinder collection by the L.P. Gas Sales Association

Collection area	Collection commenced in Miyagi prefecture where damage was most severe. In areas where debris removal had not taken place, the collection took place after its progress has been observed. In addition, gas cylinders used in evacuation shelters etc. established in each disaster area are also collected.
Collection procedure	<ul style="list-style-type: none"> • Collection work is done by small groups (About two cars, and 4-5 people) going around the area. • They collect gas cylinders from areas where debris removal has made progress. When collecting them, stopgap measures such as closing the valve etc. are taken first. Additionally, they cooperate in collection when high-pressure gas cylinders other than the L.P. gas type are found. • The collected gas cylinders are stored at predetermined storage yards in each prefecture.

■ Gas canisters, spray cans

- Gas canisters in which gas is still remaining may ignite /explode when handled by heavy machinery, loaded onto a truck, or shredded /sorted. Hence, they should be separated from other waste as far as possible.
- Fluorocarbon might be contained in old products, so it is necessary to confirm its existence. If fluorocarbon is contained, canisters should be stored.
- When gas canisters have been sorted from other waste, discharge of gas is necessary. The following points must be noted. After gas is completely discharged, gas canisters can be disposed of as incombustible waste.
 - Gas discharge work should be conducted under conditions of sufficient ventilation. Do this work outdoors, if possible.
 - Discharge work should be done in accordance with the instructions indicated by the manufacturer (e.g. Explanation regarding mechanism to release content etc).

- The work must be done at places where no ignition sources such as fire, thermostat, etc. exist.
- Making a hole with a nail might cause ignition by spark. Discharging gas by using the spray button, without making a hole, is better.

■ Fire extinguishers

- Fire extinguishers sorted at temporary storage sites can be used effectively to put out fires caused by sorting operations etc. Therefore, removal of them from the site is not urgent, but they must be separated from mixed disaster waste.
- The collection and recycling of fire extinguishers is basically conducted by the Fire Extinguisher Recycling Promotion Center. However, fire extinguishers will not be accepted if they are dismantled or broken to pieces.
- Measures for avoiding dispersion and leakage of extinguishant should be taken during collection and transportation of fire extinguishers. Existence of safety latches should be confirmed. If leakage of contents is found, the whole fire extinguisher should be put into a bag.

【Table 8-14-6】 Examples of fire extinguishers that are/are not supported by recycling system provided by the Fire Extinguisher Recycling Promotion Center

Supported	Not supported
<ul style="list-style-type: none"> • Small fire extinguishers (also, some other extinguishment devices) • Large fire extinguishers (also, some other extinguishment devices) 	<ul style="list-style-type: none"> • Fire Extinguishers Containing PFOS(*) • Products classified as “industrial waste requiring special treatment” • Aerosol fire extinguishers (Products manufactured as spray cans) • Fire extinguishers from manufacturers other than members of the Japan Fire Extinguisher Manufacturer's Association. (Inquiry to manufacturer is necessary for such products)

*PFOS (Perfluorooctane Sulphonate) might be used in some fire extinguishers. If so, they should be properly stored and managed, because PFOS is classified as a class I specified chemical substance under the Japanese Chemical Substances Control Law. Most of such extinguishers are installed at facilities where inflammable substances (gasoline etc.) are used, such as gas stations, chemical industrial complexes etc., and parking lots. For pertinent products, a description such as “Strengthened liquid (neutral) fire extinguisher,” “Mechanical foam fire extinguisher,” “Mechanical foam (neptunian film) fire extinguisher,” etc. appears on the label of the fire extinguisher. Also, they are listed in the document “Handling of fire extinction chemicals and fire extinguisher containing PFOS” (<http://www.jfema.or.jp/pdf/pfos.pdf>; in Japanese) published by the Japan Fire Extinguisher Manufacturer's Association.

【Guide 8-15】 Personal Valuables

- Allow people the opportunity to recover items of personal valuables, such as mortuary tablets, photo albums etc. (valuables and memorabilia) to the fullest extent possible.
- Place personal valuables in safe-keeping, avoiding damage to them, whenever you find them while demolishing damaged houses.

■ Key points

- Allow people the opportunity to recover items of personal and sentimental value, such as mortuary tablets, photo albums etc. (valuables and memorabilia) to the fullest extent possible. For example, hand them in to local government office and give owners the chance to check or get them back.
- Place personal valuables in safe-keeping, avoiding damaging them, whenever you find them while demolishing damaged houses. Clear distinction should be made from items that citizens have brought by themselves because such items are regarded as waste.

■ Collection and Checking

- Items that should be collected include mortuary tablets, photo albums, photos, wallets, bankbooks, notes, “Inkan” seals, jewelry, certificates, PCs, HDDs, mobile phones, video and digital cameras. If you find something else, you should basically judge subjectively at the spot whether it should be kept.
- Deposit the items collected at the local government office, providing the opportunity for owners to check and recover their property. Basically, valuables should be handed over for safe-keeping at a police station. If items are dirty, you should try to remove dirt from them. You may ask volunteers to work with you on this.



Governmental staff of Sendai city collected personal valuables, storing them in a cultural center. Volunteers removed dirt from them. (April 23rd, Sendai city)



**Checking is done in the cultural center*

Items piled up at the entrance for checking. (April 4th, Sendai city)

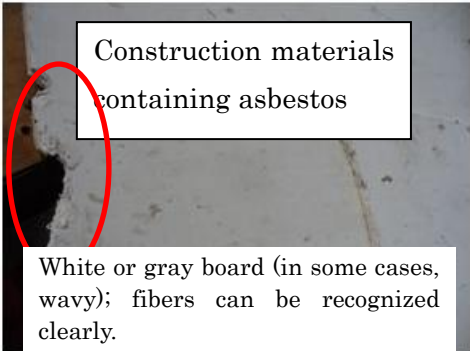
【Quick Reference for Handling Disaster Waste】 Cautions for workers and volunteers (please read this before commencing work)

Disaster wastes include a variety of wastes. It is necessary to process disaster wastes as quickly as possible for recovery of a disaster area. You should separate different types of waste as much as possible during the process, considering final processing and disposal. It is also essential to watch out for dangerous materials and items. Read the following reference carefully before working. Try to work with the recommendations below in mind.

[Safety first] You must wear a mask (helmet and goggles), hard-soled shoes or boots, and clothes that do not expose your skin. Always work with others, not alone.

【Articles that must be separated, packed, and labeled】

Construction materials containing asbestos

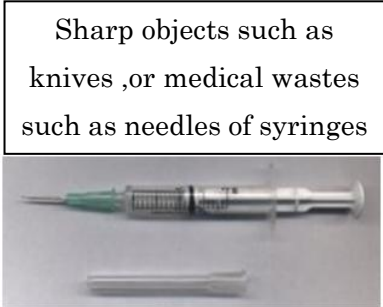


White or gray board (in some cases, wavy); fibers can be recognized clearly.

Transformers and condensers containing PCBs



Sharp objects such as knives, or medical wastes such as needles of syringes



【Materials that should be separated for safety and hygiene】

Gas cylinders and oil stoves



Fire extinguishers



Toxic wastes, fluorescent lamps, batteries, lead-acid batteries, (motorcycles) and spray cans

Deposits (sludge)



【Items that should be separated in order to reuse, recycle and dispose of in the future】

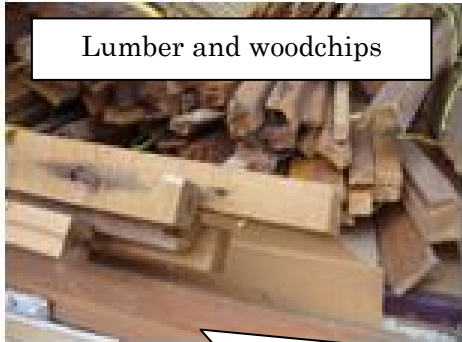
Automobiles, motorcycles, ships and boats

Products covered by Electric Appliance Recycling Law, PCs




Concrete rubble, asphalt rubble, earth and sand, tires

Lumber and woodchips



Tatami mats and mattresses



Tatami mats are easy to deal with when cut into one third of the original size

Scrap metal



Wood with green surface (probably coated with chemical preservative) or wood soaked with seawater should be separated because problems may arise in recycling etc.

【Reference information about dismantling of damaged automobiles (for businesses)】

● **Airbags**

The document “Onsite treatment of Airbags in Damaged Automobiles”

(<http://www.jarp.org/pdfs/information/0412.pdf>; in Japanese)” has been published by the Japan Auto Recycling Partnership. This document provides safety measures to be taken against dangers such as the scattering of parts of damaged automobiles and smoke emission due to short circuits in onsite treatment of airbags in damaged automobiles. The following precautions should be made: to close doors in order to prevent the scattering of parts of the damaged automobiles, to keep enough space around them in case of such scattering, to set up protection barriers and wear helmets, confirm the absence of combustible materials, and to check that no smoke is emitted from the automobile after the treatment.

Some airbags with electric inflators cannot be inflated because of flooding and damage. If airbags cannot be inflated, they should be removed manually.

If airbags cannot be removed even manually, please contact the Japan Auto Recycling Partnership.

● **Collection of chlorofluorocarbons (CFCs)**

The document “Collection of CFCs from Damaged Automobiles (in Japanese)

(<http://www.jarp.org/pdfs/information/0414.pdf>)” has been published by the Japan Auto Recycling Partnership. It states that the suction of seawater causes CFC collection machines to malfunction. When CFCs are collected from automobiles damaged by the tsunami, check whether CFC collection is necessary using a pressure manometer before collecting CFCs.

● **Removal of liquids**

Liquids such as oils (engine oils, differential oils, ATF, transfer oils and so forth) and fuel in automobiles damaged by the tsunami may need to be removed by a different method from the normal methods, because the liquids may include seawater.

Collected oils and fuel can usually be sold; however, those which include seawater should be disposed of by incineration, etc.

● **ASR (Automobile Shredder Residue)**

Items which should be removed beforehand, which should not be included in ASR, are airbags, tires, batteries, liquids such as fuel, oil and coolant, fluorescent lamps, garbage in automobile interiors and trunks, and soil accumulated in the interior. These items should be removed by scrappers as part of their responsibilities. In the case of damaged automobiles from which it is difficult to remove parts or liquids, those with soil adhered by the tsunami, those with high chloride levels due to inundation by sea water, and so on, the difficulty of dismantling may be increased. The amount of ASR may be increased because of soil accumulated in damaged automobiles, making the automobiles unable to meet the criteria for restricted amounts of ASR.

- **Electric vehicles and hybrid vehicles**

The document “Precautions for Handling of Damaged Electric Vehicles and Hybrid Vehicles (in Japanese) ([http:// www.jarp.org/information/2011/http1.doc](http://www.jarp.org/information/2011/http1.doc))” has been published by the Japan Automobile Manufacturers Association. This document warns of the possible leakage of electricity and liquids from damaged electric vehicles and hybrid vehicles, because they are equipped with high-voltage batteries. When damaged vehicles are removed (transported or stored), the following precautions should be taken: to wear insulation gloves in order to prevent electric shocks, not to touch orange high-voltage cables, to wear protective glasses and masks in order to prevent accidents, handle batteries carefully in order to avoid the risk of electric shocks, and to dry batteries suspected of liquid leakage. Follow guidelines for the removal of batteries from damaged hybrid vehicles published by the battery manufacturers when the vehicles are dismantled. Websites giving these guidelines are listed in this document.