2.3 Study of Health-care Waste Management in Medical Institutions

2.3.1 Outline of the Study

a. Study Objective

The study aims to clarify the current conditions of health-care waste management at generation sources in the PIM by visiting those hospitals (one location) and clinics on factory premises (nine locations) and conducting direct interviews to survey the types of waste generated, amount discharged and conditions of health-care waste management, etc.

b. Study Method

A local consultant (OPCA) was consigned to conduct the study. The local consultant visited and conducted interviews with medical institutions using a questionnaire form made by the study team.

The study team produced a draft of the questionnaire form to use as the basis for discussion with the C/P, and then revisions were made based on that discussion. The following items were included in the questionnaire:

Table 2-18: Content of the Medical Institution Survey

1. Basic Items	2. Current Waste Management	3. Comment/Notes
・ Location of Medical Institution ・ Medical Services Provided ・ No. of Employees ・ No. of Beds ・ Number of Inpatients/Outpatients ・ Others	The following items are surveyed, making a division between infectious/hazardous waste and common waste. ・ Generation amount ・ Separation at Source ・ Storage Methods and Containers Used ・ Discharge Methods and Containers Used ・ Treatment Methods (e.g. Incineration, Sterilization), if any, and other Methods ・ Contracted Collection Company and Collection Method ・ Location and Methods of Disposal ・ Others	・ Management system of infectious/hazardous waste ・ Knowledge of an implementation of regulations for health-care waste management ・ Reporting on infectious/hazardous waste management conditions, if any, and who is reported to. ・ Education, if any, and methods for employees to handle infectious/hazardous waste ・ Fees for Collection, Treatment, Disposal of infectious/hazardous waste ・ Awareness of environmental consideration ・ Others

2.3.2 Health-care Waste Categories

a. ABNT NBR 12808 (1993) and RDC 306/2004-ANVISA

Health-care waste (i.e. Health Service Waste) is regulated by the Brazilian Association of Technical Standards (ABNT) NBR 12808 and the National Health Surveillance Agency (ANVISA). Handling health-care waste is prescribed by both the ABNT NBR 12809 and the RDC 306/2004-ANVISA.

In this study the questionnaire for the medical institutions survey has been prepared based on the health-care waste categories described in the ABNT NBR 12809 and the survey was conducted using the questionnaire. After the questionnaire survey was completed, it was pointed out that the RDC 306/2004-ANVISA is being used at present. The results of the survey were, therefore, converted into the health-care waste categories described in the RDC 306/2004-ANVISA. The following table shows conversion of health-care waste categories of the RDC 306/2004-ANVISA and the ABNT NBR 12809.

Table 2-19: Conversion of Health-care Waste Categories between

RDC 306/2004-ANVISA			**ABNT NBR 12809**	
Group		Description	Class, Type	Description
1. Group A	A.1	Biologic	Class A, Type A.1	Biologic
			Class A, Type A.2	Blood and Derivates
	A.2	Animals	Class A, Type A.5	Contaminated animal
	A.3	Body part	Class A, Type A.3	Surgical, anatomopatologic and exudates
	A.4	Patient care etc.	Class A, Type A.6	Patient care
	A.5	Prions	Not applicable	---
2. Group B		Chemical etc.	Class B, Type B.2	Pharmaceutical waste
			Class B, Type B.3	Hazardous chemical waste
3. Group C		Radioactive waste	Class B, Type B.1	Radioactive waste
4. Group D		Common waste	Class C	Common waste
5. Group E		Piercing or Cutting	Class A, Type A.4	Piercing or Cutting

b. Health-care Waste Categories used in the Study

In this study, health-care waste was divided into five large groups according to RDC 306/2004-ANVISA. The details of each group are explained in the table below.

Table 2-20: Categories of Health-care Waste used in the Study

Waste Group	Description	
1. Group A:	Wastes with the possible presence of biological agents which, due to their characteristics of higher virus concentration, may present infection risk.	
	A.1	1. cultures and stocks of microorganisms; wastes from the manufacturing of biologic products, except the haemoderivates; disposal of vaccines of live or attenuated microorganisms; means of culture and instrumentals used for transfer, inoculation or mix of cultures; wastes from genetic manipulation laboratories; 2. wastes resulting from health care of individuals or animals, suspected or surely having biologic contamination by agents from class risk 4, microorganisms with epidemiologic relevance and risk of dissemination or causer or emerging disease which may become epidemiologically important or whose transmission mechanism is unknown; 3. transfusion bags containing blood or haemocomponents rejected due to contamination or bad conservation, or with the validity date expired, and those coming from incomplete collection; 4. residues of laboratory samples containing blood or corporeal liquids, recipients and materials resulting from health care process, containing blood or corporeal liquids in free form;
	A.2	1. carcass, anatomic parts, viscera and other wastes proceeding from animals submitted to experimental processes with inoculation of microorganisms, as well as their furring, and the corpses of animals suspected of carrying epidemiologically important microorganisms and holding dissemination risk, which have been submitted or not to anatomic-pathologic studied or diagnostic confirmation;

	A.3 1. anatomic parts (limbs) of human body; fecundation product without vital signs, weighing less than 500 grams or measuring less than 25 centimeters or pregnancy age lower than 20 weeks, not holding scientific or legal values and which has not been requested by the patient or family;
	A.4 1. disposed arterial, endoveined and dyaliser kits; 2. air filters and gases aspirated from contaminated area; filtering membrane from medical-nosocomial and research equipment, and other suchlike; 3. residues of laboratory samples and their recipients containing faeces, urine and secretions, proceeding from patients not carrying nor being suspect of carrying Class Risk 4 agents, and neither present epidemiologic relevance and dissemination risk, or microorganism causer of emerging disease which may become epidemiologically important or whose transmission mechanism is unknown or suspected of contamination with prions. 4. waste of adipose tissue coming from liposuction, liposculpture or another plastic surgery procedure which may generate this kind of waste; 5. recipients and materials resulting from health care process not containing blood or corporeal liquids in free form; 6. anatomic parts (organs and tissues) and other wastes coming from surgical procedures or anatomic-pathological studies or diagnosis confirmation; 7. carcasses, anatomic parts, viscera and other wastes proceeding from animals not submitted to experimental processes with the inoculation of microorganisms, as well as their furring; and 8. empty transfusion bags or containing pos-transfusion residual volume.
	A.5 1. organs, tissues, organic fluids, piercing or scratching materials and other materials resulting from health care to individuals or animals, suspect or carrying contamination with prions.
2. Group B:	Wastes containing chemicals which may present risk to public health or the environment, depending on their flammability, corrosiveness, reactivity and toxicity characteristics. a) hormonal and antimicrobial products; cystostatic; antineoplastic; immunesupressor; digital; immunemodulators; anti-retroviral, when disposed by health services, pharmacies, drugstores and medicine wholesalers or the apprehended ones and the wastes and the pharmaceutical inputs of medicines controlled by governmental Decree MS 344/98 and its updates; b) sanitation, disinfectants and disinfesting wastes; wastes containing heavy metals; reagents for laboratories, including the recipients contaminated by those; c) effluents from image processing equipment (developers and fixers); d) effluents from automatic equipment used in clinical analysis; and e) other products considered as hazardous, according to the classification of NBR 10.004 by ABNT (toxic, corrosive, inflammable and reactive).
3. Group C:	Any materials resulting from human activities containing radionuclide in quantities superior to the elimination limits specified by the rules of the Nuclear Energy National Commission -CNEN and for which the reuse is either inadequate or nor foreseen. a) this group comprises any materials resulting from research and learning laboratories in health care area, clinical analysis and nuclear medicine and radiotherapy laboratories which may contain radionuclide in a quantity superior to the elimination limits.
4. Group D:	Wastes which do not present biologic, chemical or radiological risk to health or the environment, and thus may be considered as domestic waste. a) toilet paper and diaper, feminine napkin, wastable clothes, leftovers of patients, material used in anti-sepsis and hemostasy, serum equipment and other suchlike not classified as A1; b) leftovers and cooking; c) leftovers of canteens; d) wastes coming from administrative areas; e) sweeping wastes, flowers, trimming and garden; and f) gypsum wastes coming from health care services.
5. Group E:	Piercing or scratching materials such as: shaving blades, needles, scalps, glass ampoules, bits, endodontic fines, diamond points, scalpels blades, lancets; capillary tubes; micropipettes; blades and little laminas; spatulas; and all glass utensils broken in the laboratory (pipettes, blood collection tubes and Petri plates) and other suchlike.

2.3.3 Selection of Target Medical Institutions

There are 475 factories in the factory list provided by SUFRAMA, and of those, 18 factories are located outside the target area, the MFZ. A total of 457 PIM factories in the MFZ area were contacted to confirm whether they had an attached clinic. The following results were

found according to their responses.

- Factories that responded by telephone: 334
- Factories that have closed: 17
- Factories that refused to reply: 25
- Factories that could not be reached by telephone: 81

In this survey, it was revealed that 440 factories are PIM factories operating in the MFZ, including those which could not be reached by telephone (which was likely due to a changed phone number, etc.) and excluding the 17 which have closed.

It was found that at least 1/3 of the total (35.3%), or 124 factories, have an attached clinic. Of those 124, nine within the PIM were chosen for direct interview using the prepared survey questionnaire. A summary of these medical facilities, including one general hospital in the PIM, is given below.

Table 2-21: Summary of Medical Facilities

Type	No. Surveyed	No. of Employees *1	No. of Beds	Avg. No. of Inpatients/Day	Avg. No. of Outpatients/Day
General Hospital	1	439	70	48	900 (*3)
Attached factory clinic	9	4.1 (*2)	1.2 (*2)	No reply	19 (*2)

Notes: *1: Including part-time employees
*2: Average of 9 clinics
*3: Of this number, 22 were emergency room outpatients

2.3.4 Execution of the Survey

A local consultant (OPCA) was consigned to conduct the study on 19 June 2009. Immediately after the contract was signed, the local consultant contacted all PIM factories approved by SUFRAMA by telephone, etc., and inquired about the existence of a clinic on premises, then selected the target medical facilities before beginning the direct interview process. Finally, working with the study team, the survey results were compiled by the end of August. The interview survey and summary of results was completed by the end of July, as planned, and the results were analyzed together with the study team in August before being summarized into a report.

Although questionnaire survey and analysis of the survey results were done base on the waste categories of ABNT NBR 12809, those have been revised based on the waste categories the designated by the RDC 306/2004-ANVISA.

2.3.5 Results of the Survey

The results of the questionnaire survey are given below.

a. General Information

Q.1. What is the number of employee (all staffs including doctors, nurses, etc. who work in the institution)?
Q.2. Category of the medical institution.

Base: Population = 10					
Q1 and Q2		Full time		Part time	
Category of the institution	Number	Total	Average	Total	Average
1. General Hospital	1	240	240	199	199
2. Clinic	9	25	2.8	12	1.3
Grand Total	10	265	---	211	---

Q.3. Type of institution:

Base: Population = 10		
Q3	Answer	%
1. Public	0	0.0
2. Private	10	100.0
3. Others	0	0.0
Total	10	100.0

Q.4. Outline of institution:

1. Number of beds [beds]

Base: Population = 10					
Category	Number	Number of Beds			
		Total	Average	Maximum	Minimum
1. General Hospital	1	70	---	---	---
2. Clinic	9	11	1.2	5	0
Total	10	81	---	---	---

2. Average bed occupation rate [%]
3. Average number of in-patients [patients /day]
4. Average number of out-patients [patients /day]

Base: Valid answer : General hospital = 1 , Clinic = 2			
Category	Average Occupation rate	Average Number of in-patients	Average Number of out-patients
	%	patients/day	patients/day
1. General Hospital	42	48	22
2. Clinic	No answer	No answer	19

b. Waste Management

b.1 Generation

Q.5. How many quantity do you generate common waste (Group D)?

Base: Valid answer : General hospital = 1 , Clinic = 8					
Category	Number	Quantity (kg/week)			
		Total	Average	Maximum	Minimum
1. General Hospital	1	658	---	---	---
2. Clinic	8[*1]	65.25	8.2	26.5	0.15

Total	9	723.25	---	---	---

（Note ）: 1 clinic did not an answer

Q.6. Please describe what types of hazardous health-care waste (Group A, B, C and E,) you generate and the approximate quantities of such wastes.

Base: Population 10

Types	Group A					Group B	Group C	Group D	Group E
No. of Medical institution	A1	A2	A3	A4	A5				
1	YES		YES	YES		YES		YES	YES
2	YES			YES				YES	YES
3	YES			YES		YES		YES	YES
4				YES				YES	
5				YES		YES		No answer	YES
6	YES		YES					YES	
7	YES			YES				YES	YES
8				YES		YES		YES	YES
9	YES			YES		YES		YES	
10				YES				YES	

Base: Population : General hospital = 1, Clinic = 9

Group		General Hospital		Clinic				
		Generation Yes/No	Quantity (kg/week)	Generation Yes	Total (kg/week)	Average (kg/week)	Maximum (kg/week)	Minimum (kg/week)
Group A	A.1	Yes	42.1	5	10.2	1.1	5.0	0.5
	A.2	No	0	0				
	A.3	Yes	56.8	1	6.1	0.7	6.1	6.1
	A.4	Yes	60.5	8	16.4	1.8	6.8	0.023
	A.5	---	---	---	---	---	---	---
Group B		Yes	11.7	4	17.3	1.9	15.8	0.023
Group C		No	0	0				
Group E		Yes	23.8	5	26.8	3.0	25.9	0.023
Total		---	194.9	---	76.8	8.5	---	---

b.2 Storage, Discharge, Collection

b.2.1. Collection system inside the Institution

Q.7. Specify the present waste collection system in your institution.
(Please tick in the following table)

a. We use a standard system with containers or colored bags with labels
b. Others

Base: Population : General hospital = 1, Clinic = 9

Group		General Hospital		Clinic		
		Yes/No	Answer	Generation Yes	a	b
Group A	A.1	Yes	a	5	1	4

A.2	No	---	0	0	0
A.3	Yes	a	1	1	0
A.4	Yes	a	8	2	6
A.5	---	---	---	---	---
Group B	Yes	a	4	2	2
Group C	No	---	0	0	0
Group E	Yes	a	6	2	3
Group D	Yes	a	9	5	4

Q.8. Describe the present container for collection of common/hazardous health-care waste in your institution.

(Please tick in the following table)

a. Plastic bag
b. Paper bag
c. Open container
d. Container with lid
e. Cardboard box
f. Others

Base: Population : General hospital = 1, Clinic = 9

Group		General Hospital		Clinic							
		Yes/No	Answer	Generation Yes	a	b	a & b	d	a & d	e	No answer
Group A	A.1	Yes	a & b	5	2			3			
	A.2	No	---	0							
	A.3	Yes	a & b	1				1			
	A.4	Yes	a & b	8	1	1	1	4			1
	A.5	---	---	---	---	---	---	---		---	---
Group B		Yes	a & b	4	1			1	1		1
Group C		No	---	0							
Group E		Yes	e	6				1		3	2
Group D		Yes	a & b	9	2			2			5

b.2.2. Storage

Q.9. How do you store common waste and hazardous health-care waste?

Base: Population = 10

Q9		Answer	%
1. We mix them all together.	(Go to Q.10)	1	10.0
2. We store them separately.	(Go to Q.11)	9	90.0
Total		10	100.0

Q.10. Why don't you separate hazardous health-care waste?

Base: Population = 1

Q10	Answer	%
1. There is no reason to separate them.	0	0.0
2. It is troublesome to separate them.	0	0.0
3. The waste collectors separate them.	0	0.0
4. Others (Description => No answer)	1	100.0
Total	100.0	100.0

Q.11. How do you store your waste within your institution?
(Please tick in the following table)

a. Plastic bag
b. Paper bag
c. Open container
d. Container with lid
e. Cardboard box
f. Others

Base: Population : General hospital = 1, Clinic = 9

Group		General Hospital		Clinic					
		Yes/No	Answer	Generation yes	a	a&b	d	e	No answer
Group A	A.1	Yes	a & d	5			3	1	1
	A.2	No	---	0					
	A.3	Yes	a & d	1			1		
	A.4	Yes	a & d	8		1	5		2
	A.5	---	---	---	---	---	---	---	---
Group B		Yes	a & d	4			3		1
Group C		No	---	0					
Group E		Yes	e	6			2	2	2
Group D		Yes	a & b	9	1		3		5

Q.12. Is there cool storage room or faculties for pathological wastes in your institution?

Base: Population = 9

Q12	Answer	%
1. Yes	0	0.0
2. No	9	100.0
Total	9	100.0

b.2.3. Disposal (Intermediate treatment and final disposal)

Q.13. What do you do with your waste?
(fill in first two columns of following table)

a. Place outside for collection by SEMMA/SEMULSP or other collectors
b. Directly carry the waste to a waste collection vehicle
c. Take the waste to waste collection point of SEMMA/SEMULSP or other collectors
d. SEMMA/SEMULSP or other collectors collects from institution (including own bin)
e. Bury on site
f. Open burning
g. Recycle
h. Incinerate by the incineration in the institution
i. Autoclave disinfection on site
j. Open dumping outside property
k. Other

Base: Population : General hospital = 1, Clinic = 9

Group		General Hospital		Clinic					
		Yes/No	Answer	Generation yes	c	d	c & d	g	No answer
Group A	A.1	Yes	d & i	5	1	4			
	A.2	No	---	0					

A.3	Yes	d	1			1		
A.4	Yes	d	8	1	3			4
A.5	---	---	---	---	---	---	---	---
Group B	Yes	b	4		2			2
Group C	No	---	0					
Group E	Yes	d	6		4			2
Group D	Yes	d & g	9	1	1	1	3	3

Q.14. For the health-care waste collection by SEMMA/SEMULSP or other collectors, how are they disposed of?

a. Disposed of to the Manaus city landfill together with other waste
b. Buried in a special pit at the landfill
c. Burned at the landfill
d. Incinerated at an incinerator
e. Others

Base: Population : General hospital = 1, Clinic = 9					
Group		General Hospital	Clinic		
		Answer	Generation yes	d	No answer
Group A	A.1	b&e	5	4	1
	A.2	---	0		
	A.3	b	1		
	A.4	b	8	5	3
	A.5	---	---	---	---
Group B	B.1	b	4	2	2
Group C	B.2	---	0		
Group E	B.3	b	6	5	3

Q.15. If you chose **g.** in Q.13, go to "Additional Sheet A".

A general hospital and three clinics are recycling some common waste (Group D).

Item	Valid answer	Quantity (Average) (kg/week)	Price (R$/kg)	Buyer	Method	Collection frequency
(1) Paper	3	2.1	---	Recycler	The Recycler collects	Weekly / Monthly
(2) Cardboard	3	18.1	0.03	Recycler	The recycler collects	Weekly / Bimonthly
(3) Glass bottles	0					
(4) Metal	0					
(5) Organic waste	0					
(6) Other	2	2.0	---	Recycler	The Recycler collects	Monthly

Q.16. If you chose **h.** in Q.13, please provide the following information for the incinerator.
- All medical institutions treat their waste through incineration.

Q.17. If you chose **i.** in Q.13, please provide the following information for the autoclave.
- The general hospital reported it treats its Group A.1 (Biologic) using an autoclave, however the specifications were not included.

Q.18. If you ticked **j.** in Q.13, where do you dump your waste outside your institution?
- None of the medical institution are disposing of waste via "open dumping".

b.2.4. Discharge

Q.19. How do you discharge health-care wastes?

Base: Population = 10		
Q19	Answer	%
1. We separate store but mix discharge.	2	20.0
2. We separate store and separate discharge.	8	80.0
3. We mix store and mix discharge.	0	0.0
Total	10	100.0

Q.20. In case of "**separate store but mix discharge**", who mixes them?

Base: Population = 2		
Q20	Answer	%
1. Collector	0	0.0
2. Our employee	2	100.0
3. Others	0	0.0
Total	2	100.0

Q.21. Please tick appropriate boxes on the answer table to indicate your discharge manner of health-care wastes.

Base: Population = 10

Group		General Hospital	Clinic				
			1. separated discharge	2. Mixed discharge			3. not generated
				same class*1	Group A, B and C*2	All class*3	
Group A	A.1	Separated	3		2		4
	A.2	Not generated	0				9
	A.3	Separated	1				8
	A.4	Separated	6		1		2
	A.5	---	---	---	---	---	---
Group B		Separated	2		2		5
Group C		Not generated	0				9
Group E		Separated	5	1	1		2
Group D		Separated and mixed	9				

Remark
*1 : Mixed discharge with other waste of the same class
*2 : Mixed discharge with Group A, Group B and Group C.
*3 : Mixed discharge with Group A, B, C, D and E.

b.2.5. Collection of Hazardous health-care waste

Q.22. Are you provided with a hazardous health-care waste collection service? (either direct collection or nearby waste collection points or direct pickup from institution – items **a, b, c or d** in Q.13)

Base: Population = 10		
Q22	Answer	%

1. Yes	10	100.0
2. No	0	0.0
Total	10	100.0

Q.23. Who collects your waste?

Base: Population = 10		
Q23	Answer	%
1. SEMMA/SEMULSP	1	10.0
2. Private company other than SEMMA/SEMULSP	9	90.0
3. Don't know	0	0.0
Total	10	100.0

Q.24. How often do you discharge your garbage and how often is it collected? (tick one)

Base: Population = 9

Q24		Group A		Group B and C	
		Discharge	Collection	Discharge	Collection
1.	Once daily	5	2	2	1
2.	Every 2-3 days				
3.	Every 4-5 days	1		1	
4.	Weekly	2	2	1	1
5.	Less than weekly		0		
6.	Irregularly		2		2
7.	Other	1	3	1	1

Q.25. Do you pay the SEMMA/SEMULSP or a private collector an official waste collection fee for hazardous health-care waste?

Base: Population = 10		
Q25	Answer	%
1. Yes	6	60.0
2. No	4	40.0
Total	10	100.0

If Yes, how much is this fee? And what type of wastes does it cover?

Base: Population = 6

Waste Type	Payment
Health-care waste	3.6 R$/kg (Average : 3 institutions) 210 R$/week (1 Institutions) 415 R$/month (2 institutions)

Q.26. Are you satisfied with the existing hazardous health-care waste collection and disposal service?

Base: Population = 10		
Q26	Answer	%
1. Yes	7	70.0
2. No	3	30.0
Total	10	100.0

If No, Why? (tick one or more)

Base: Population = 3			
		Answer	Why?
1.	Discharge system is poor (e.g. no bins, bins are broken or too small)		
2.	Waste collection point is too far away		
3.	Waste collection/sweeping is not properly done		
4.	Waste collection service/sweeping is irregular		
5.	Waste collection/sweeping frequency is too low		
6.	Collection time is too early or too late		
7.	Waste collection workers behave badly		
8.	Waste collection workers demand payment for waste collection	1	Due to the quantity of wastes generated being insignificant we pay for the price of one removal
9.	Waste collection fee of the SEMMA/SEMULSP or a private collector is too high	1	Due to the quantity of wastes generated being insignificant we pay for the price of a normal removal + transportation fee
10.	Lack of recycling		
11.	Problems with handling health-care waste		
12.	Other	2	- We lack a company to work with that kind of waste to carry out the incinerations process - The updating of the requested documents takes too much time

Q.27. How many times have you complained about the hazardous health-care waste collection service in the last year?

Base: Population = 10		
Q27	Answer	%
1. None	10	100.0
2. Once only	0	0.0
3. Several times	0	0.0
4. More than five times	0	0.0
Total	10	100.0

Q.28. Is any staff member of your institution responsible for ensuring that hazardous health-care waste is collected and disposed of properly?

Base: Population = 10		
Q28	Answer	%
1. Yes	10	100.0
2. No	0	0.0
Total	10	100.0

b.2.6. Improvements to hazardous health-care waste collection and disposal

(1) General

Q.29. What improvements would you like to see to hazardous health-care waste collection and disposal? (Please tick one or more and priorities the top three improvements you would like to see (1 = first priority, 2 = second priority, 3 = third priority)

Base: Population = 8	
Q29	Priority

	First	Second	Third
1. Improved waste discharge system			
2. Shorter distance to waste collection point			
3. More reliable waste collection service			
4. Improved collection frequency	1		
5. Greater recycling of waste	1		1
6. Improved collection and disposal of health-care waste			
7. Improvement of landfill operation	2	1	
8. Education to change people's bad habits	3	4	1
9. Other	1		

Q.30. Improved waste collection and disposal will cost additional money. Who do you think should pay these costs? (tick one or more)

Base: Population = 9		
Q30	Answer	%
1. Amazonas state	3	30.0
2. Manaus city	2	20.0
3. Individual medical institution	3	30.0
4. Other	2	20.0
Total	10	100.0

Q.31. Suppose that you are satisfied with the hazardous health-care waste management service, either as is or as a result of improvement. Think for a moment about the largest amount of money that your medical institution would be willing to pay each month as the collection fee.

Base: Population = 5			
Valid Answer	Average (R$/month)	Maximum (R$/month)	Minimum (R$/month)
5	145	500	25

Q.32. If the current hazardous health-care waste collection fee is more than this amount, your medical institution will not be able to afford to pay and will not be able to use the waste collection service. If you are still not willing to pay the current waste collection fee, explain the reason why below:

Base: Population = 10		
Q32	Answer	%
1. I pay	0	0.0
2. I don't pay.	10	100.0
Total	10	100.0

(2) Training and Instructions

Q.33. Is there some written instruction to separate and manage hazardous health-care waste in the institution?

Base: Population = 10			
	Q33	Answer	%
1. Yes		10	100.0
2. No	(Go to Q.35)	0	0.0
	Total	10	100.0

Q.34. How often the staff of waste management is trained as a caution against contaminated or hazardous health-care waste?

Base: Population = 10		
Q34	Answer	%
1.Only at the start of the job	2	20.0
2.Once a year	5	50.0
3. Very often, please explain how often	3	30.0
4. Never	0	0.0
Total	10	100.0

(3) Environmental education and general cleanliness

Q.35. Has anyone of this institution received any health and environmental education or information relating to hazardous health-care waste? Yes/No
If YES, no of people: [_____]

Base: Population = 10					
Q35-1	Answer	%	Number of people		
			Average	Maximum	Minimum
1. Yes	8	80.0	336	1,500	1
2. No	2	20.0	---	---	---
Total	10	100.0	---	---	---

And where did this information come from?

Base: Population = 10		
Q35	Answer	%
1. School	0	0.0
2. Leaflets/posters, etc.	3	30.0
3. Medical worker/centre/hospital	4	40.0
4. Community organization/NGO	0	0.0
5. Newspaper	0	0.0
6. Radio program	0	0.0
7. TV program	0	0.0
8. SEMMA/SEMULSP	0	0.0
9. Government of Amazonas State	0	0.0
10. Federative Republic of Brazil (e.g. Ministry of Health, Ministry of Environment, etc.)	1	10.0
11. Other	6	60.0
Total	14	---

Q.36. Do you think that a campaign to raise the awareness of people for maintaining a cleaner city and environment is necessary? (tick one)

Base: Population = 10		
Q36	Answer	%
1. Very necessary	9	90.0
2. Somewhat necessary	1	10.0
3. Not very necessary	0	0.0
4. Not necessary at all	0	0.0
Total	10	100.0

c. Financial Matter

Q.37. How much do you pay for hazardous health-care waste collection services per month?

Q.38. How much do you pay for common waste (Class C) collection services per month?
Amount of money: [_____] R$/month

Base: Population = 10

Group		Answer	Collection fee (R$/month)		
			Average	Maximum	Minimum
Group A	A.1	3	107	280	15
	A.2	0			
	A.3	0			
	A.4	5	265	500	8.4
	A.5	---	---	---	---
Group B		3	29	50	8.4
Group C		0			
Group E		6	120	270	8.4
Group D		3	609	1,643	170

d. Cooperation for Waste Management

Q.39. Coping with wastes requires efforts of not only the municipality but also the general public. Do you think there is something which your institution can do for good waste management?

Base: Population =

Q39	Answer	%
1.Very necessary	10	100.0
2. Somewhat necessary	0	0.0
3. Not very necessary	0	0.0
4. Not necessary at all	0	0.0
Total	10	100.0

Q.40. What do you think your institution can do? (plural answer question)

Base: Population =

Q40	Answer	%
1. Discharging wastes neatly.	7	70.0
2. Minimizing waste generation.	8	80.0
3. Reusing wastes.	5	50.0
4. Recycling wastes.	5	50.0
5. Treating toxic/infectious wastes appropriately.	5	50.0
6. Raising the environmental awareness of the public.	10	100.0
7. Providing information to the public.	4	40.0
8. Researching activities.	2	20.0
9. Others	0	0.0
Total	46	100.0

Q.41. Do you think the medical institutions should cooperate with the country and/or municipality in managing wastes?

Base: Population = 10		
Q41	Answer	%
1.Yes	10	100.0
2. No	0	0.0
3. I don't know.	0	0.0
4. Others	0	0.0
Total	10	100.0

Q.42. How is the trend of your cost for waste management?

Base: Population = 10		
Q42	Answer	%
1. It is getting significantly higher.	2	20.0
2. It is getting higher.	4	40.0
3. It is relatively stable.	2	20.0
4. It is getting lower.	1	10.0
5. Others	0	0.0
No answer	1	10.0
Total	10	100.0

Q.43. How do you give the priority on the management of your wastes?

Base: Population = 10		
Q43	Answer	%
1. We give very high priority.	7	70.0
2. We give moderate priority.	3	30.0
3. We give little priority.	0	0
4. Others	0	0
Total	10	100.0

Q.44. Do you feel you need a support from the government or municipality or any other relevant organizations for the management of your waste? (plural answer question)

Base: Population = 10		
Q44	Answer	%
1. Yes, we need financial support.	3	30.0
2. Yes, we need technical support.	5	50.0
3. Yes, we need support of other kinds	2	20.0
4. No, we don't.	1	10.0
5. Others	0	0.0
Total	11	100.0

- The medical institutions which answered (3.) indicated a need for the following support.

1. Basic sanitation
2. Government support for the awareness of the population and installation of more collectors for recycling in strategic points.

e. Other

Q.45. Do your medical institution use radioactive material or Source?

Base: Population = 10			
	Q45	Answer	%
1. Yes	go to "Additional Sheet B"	0	0.0
2. No		10	100.0
	Total	10	100.0

Q.46. If there any additional comments you would like to make about solid waste management provision and your needs, please comment below:

- One (1) medical institution provided the following comment.

1. The payment is for both common and health-care waste.

f. Results of Waste Amount, Generation Rate and Waste Streams

f.1 Generation Amount of Health-care Waste in ABNT NBR 12809 Category

The generation amount of health-care waste in ABNT NBR 12809 Category for the 10 medical institutions is given below.

Table 2-22: Amount of Health-care Waste (in ABNT NBR 12809 Category) Generated by Target Medical Institutions

Unit: kg/day

Category of Health-care Waste	General Hospital	Clinics (*1)
Class A: Infectious Waste	**26.16**	**0.96**
A.1. Infectious waste	4.19	0.16
A.2. Blood and derivates	1.83	0.01
A.3 Surgical, anatomo-pathologic and exudates	8.11	0.10
A.4 Piercing or cutting	3.40	0.43
A.5 Contaminated animal	---	---
A.6 Patient care	8.63	0.26
Class B: Special Waste	**1.67**	**0.27**
B.1 Radioactive waste	---	---
B.2 Pharmaceutical waste	1.00	0.11
B.3 Hazardous chemical waste	0.67	0.16
Total of Class A and B (Hazardous Waste)	**27.83**	**1.22**
Class C: Common Waste	**94.0**	**1.17 (*2)**
Total	**121.83**	**2.40**

Note: *1: Average number for 9 clinics

*2: This number is less than the amount of hazardous health-care waste generated. The reason being that it is discharged as non-process, non-hazardous waste from another place within the factory, and the clinic does not that this discharge into consideration. One clinic did not respond.

f.2 Generation Amount of Health-care Waste in RDC 306/2004-ANVISA Category

The generation amount of health-care waste in RDC 306/2004-ANVISA Category for the 10

medical institutions is given below.

Table 2-23: Amount of Health-care Waste (in RDC 306/2004-ANVISA Category) Generated by Target Medical Institutions

Unit: kg/day

Category of Health-care Waste	General Hospital	Clinics
Group A	**22.76**	**0.52**
A.1. Biologic	6.01	0.16
A.2. Animals	---	---
A.3 Body part	8.11	0.10
A.4 Patient care etc.	8.64	0.26
A.5 Prions	---	---
Group B: Chemical etc.	**1.67**	**0.27**
Group C: Radioactive	**---**	**---**
Group E: Piercing or Cutting	**3.40**	**0.44**
Total of Group A, B, C and E (Hazardous Waste)	**27.83**	**1.22**
Group D: Common waste	**94.00**	**1.17**
Total	**121.83**	**2.40**

f.3 Number of Factories with a Clinic

124 factories of 334 surveyed have a clinic within their compound. It is estimated 163 (= 124 x 440/334) factories have a clinic in PIM in total.

f.4 Generation Rate and Amount of Health-care Waste Generated from Factories in PIM

As 163 factories have a clinic in PIM in total, the generation amount of health-care waste generated from factories in PIM and generation rate per an employee is calculated as follows:

Generation Amount of Factories in PIM = Generation Rate per a Clinic x 163

Generation Rate per an Employee = Generation Amount of Factories in PIM / Number of Employees in PIM (116,192)

Table 2-24: Generation Rate and Amount of Health-care Waste Generated from Factories in PIM

Group		Description	Generation Rate per a Clinic (kg/clinic/day)	Generation Amount of Factories in PIM (kg/day)	Generation Rate per an Employee (g/employee/day)
1.Group A	A.1	Biologic	0.16	26.1	0.22
	A.2	Animals	0.00	0.00	0.00
	A.3	Body part	0.10	16.3	0.14
	A.4	Patient care etc.	0.26	42.4	0.36
	A.5	Prions	---	---	---
2. Group B		Chemical etc.	0.27	44.1	0.38
3. Group C		Radioactive waste	0.00	0.00	0.00
4. Group E		Piercing or Cutting	0.44	71.9	0.62
Hazardous Health-care Waste Sub-total			1.23	200.8	1.73
5. Group D		Common waste	1.17	191.1	1.64
Total			2.40	391.9	3.36

The amount of health-care waste generated in PIM including a general hospital is shown in the table below.

Table 2-25: Amount of Health-care Waste Generated in PIM

Unit: kg/day

Category	Whole Factories in PIM (B x 440 /334) (kg/day)	General Hospital (kg/day)	Whole PIM (E = C + D) (kg/day)
Group A	84.8	22.7	107.5
Group B	44.0	1.7	45.7
Group C	0.0	0.0	0.00
Group E	71.7	3.4	75.1
Hazardous Health-care Waste Total	200.5	27.8	228.3
Class D	190.7	94.0	284.7
Health-care Waste Total	391.2	121.8	513.0

f.5 Health-care Waste Generation

Health-care waste generation from factories in PIM excluding a general hospital is as follows:

- Hazardous Health-care Waste: 200.5 kg/day
- Non-hazardous Health-care Waste: 190.7 kg/day
- Total Health-care Waste: 391.2 kg/day

Given the above information, the daily generation amount from the target area (PIM), including the one general hospital, of hazardous and non-hazardous health-care waste is estimated as follows:

- Hazardous Health-care Waste: 228.3 kg/day
- Non-hazardous Health-care Waste: 284.7 kg/day
- Total Health-care Waste: 513.0 kg/day

f.6 Present Health-care Waste Management Stream

The present health-care waste management stream in PIM, according to the survey of medical institutions, is shown in the following figures.

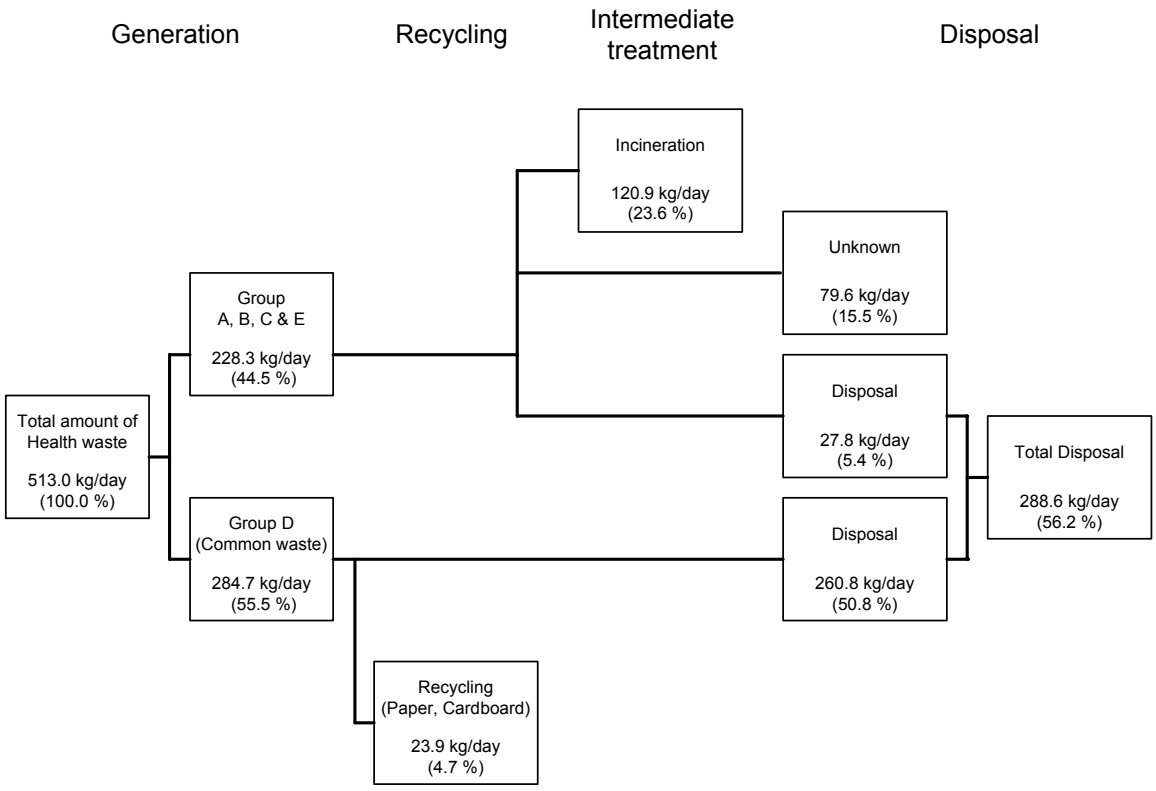

Figure 2-7: Health-care Waste Management Stream in PIM including General Hospital

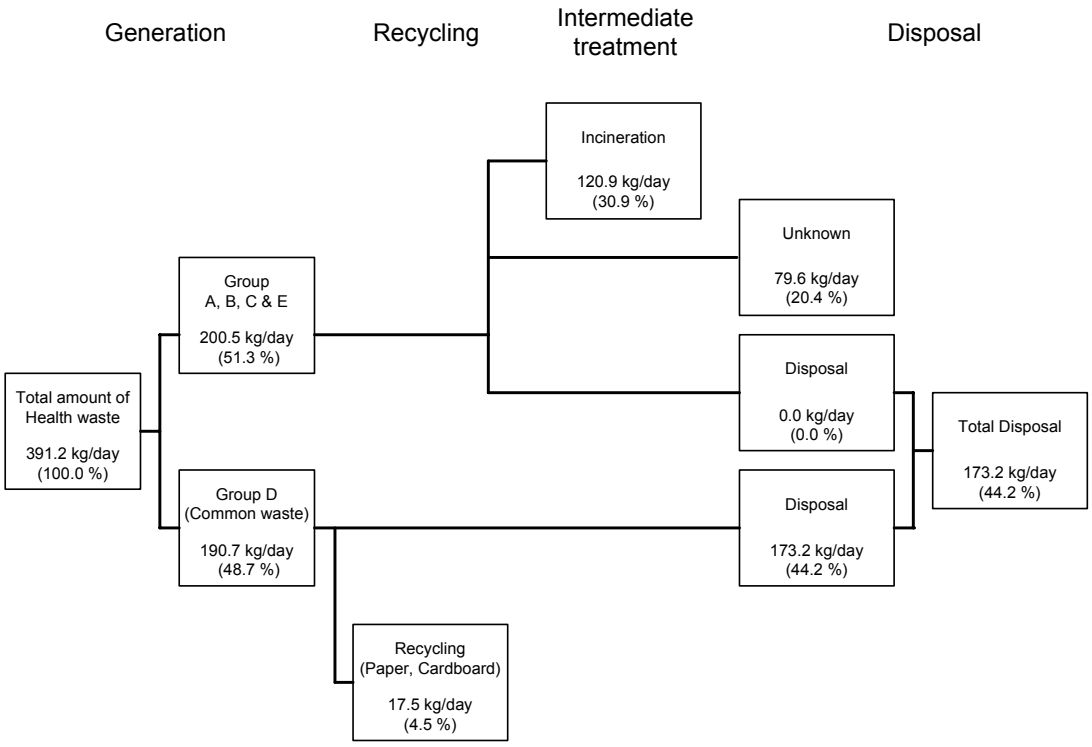

Figure 2-8: Health-care Waste Management Stream in PIM excluding General Hospital

2.3.6 Questionnaire of Medical Institution Survey

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Introduction of the Medical Institution Survey

"The Study for the Development of an Integrated Solution related to Industrial Waste Management in the Industrial Pole of Manaus" is being carried out by JICA (Japan International Cooperation Agency) Study Team with the cooperation of SUFRAMA.
The questionnaire survey to the medical institutions is being carried out by SUFRAMA and by the JICA Study Team. The purpose of this survey is to understand the generation amount of common waste and hazardous health-care waste, the waste management practices of the medical institutions in PIM in terms of segregation, storage, discharge, collection, treatment and final disposal, and the opinions of the institutions for the improvement of health-care waste management.
The health-care waste generated in a medical institution in this context is divided into Class A : Infectious waste (hazardous health-care waste), Class B : Special waste (hazardous health-care waste), and Class C : Common waste (non-hazardous health-care waste). The results of this survey, together with other engineering investigations (Factory survey, Waste management company survey, etc.), will be used for the formulation of Waste stream (Waste Stream) for PIM.
Your institution has been selected to participate in this survey. The questionnaire should be answered by a responsible person on SWM in your institution. It should take about 1-2 hours to complete. All answers are confidential and your help is greatly appreciated.

Questionnaire to Medical Institutions

No.

1_General Information

Date : _____

Name of the medical institution : _____
Name of interviewee : _____
Position within this medical institution : _____
Address : _____
Phone and facsimile number : Phone _____
: Fax _____
E-mail : Address _____
Name of Interviewer : _____

1_2 General Information

Q.1. What is the number of employee (all staffs including doctors, nurses, etc. who work in the institution)? full-time [_____] persons
part-time [_____] persons

Q.2. Category of the medical institution.
[ ] 1. General hospital
[ ] 2. Clinic
[ ] 3. Others (specify :_____)

Q.3. Type of institution:
[ ] 1. Public
[ ] 2. Private
[ ] 3. Others (specify: _____)

Q.4. Outline of institution:
1. Number of beds : [_____] beds
2. Average bed occupation rate : [_____] %
3. Average number of in-patients : [_____] patients /day
4. Average number of out-patients : [_____] patients /day

2_Waste Management

2_1 Definition of waste generated in medical institutions

The **NBR 12808** defines the **waste generated in a medical institution** as "health-care waste". In this questionnaire it is divided 3 classes i.e. **Class A. Infectious waste, Class B. Special waste** and **Class C. Common waste.**.

A detailed classification of health-care waste is summarized in the table below.

Waste Class	Waste Type	Description
1. Class A: Infectious Waste	Type A.1 Biologic	Culture, inoculums, mix of micro organisms and inoculated culture from clinical or research laboratory, expired or out of use vaccine, filter of gases vacuumed up from areas contaminated with infectious agents and any waste contaminated by such materials.
	Type A.2 Blood and derivates	Blood bag after transfusion with expired date or positive serology, blood sample for analysis, serum, plasma and other sub products.
	Type A.3 Surgical, anatomopatologic and exudates	Tissue, organ, fetus, anatomic parts, blood and other organic liquids arisen from surgeries, necropsy and other waste contaminated by such materials.
	Type A.4 Piercing or cutting	Needle, ampoule, pipette, bistoury blade

		and glass.
	Type A.5 Contaminated animal	Skeleton or part on inoculated animal, exposed to pathogenic microorganisms or possessing infectious contagious disease, as well as other waste which could have been in touch with those.
	Type A.6 Patient care	Secretions, excretions and other organic liquids coming from patients, as well as the waste contaminated by such material, including leftovers.
2. Class B: Special waste	Type B.1 Radioactive waste	Radioactive or material contaminated with radionuclide coming from clinical analysis laboratories, nuclear medicine services and radiotherapy (see Resolution CNEN-NE- 6.05).
	Type B.2 Pharmaceutical waste	Expired, contaminated, prohibited or not used medicine.
	Type B.3 Hazardous chemical waste	Toxic, corrosive, flammable, explosive, reactive, genotoxic or mutagenic waste, as per NBR 10004.
3. Class C: Common waste		All those not fitting types A and B and which, due to their similarity to domestic waste, offer no additional risk to public health. Such as, administrative activity waste, sweeping and garden cleaning and leftovers with have not been in touch with patients.

Source : NBR 12808 : Waste from health care units – Classification (Jan 1993)

2_2 Generation

The interviewer should get enough information to estimate generation amount of each waste!! For this purpose in case the answer is bags/week, please specify the volume of a bag.

[_____] litters/bag

If you are not sure of the weight or volume, please estimate the number of garbage loads (e.g. handcarts, containers) collected from your institution per week: [_____]

Q.5. How many quantity do you generate common waste (Class C)?

Class	Quantity	unit (kg/day or kg/week)
Class C (Non-hazardous health-care waste)		

Q.6. Please describe what types of common waste and hazardous health-care waste you generate and the approximate quantities of such wastes.

Types		Yes/No	Quantity (units)	
			kg/week	liter/week
Class A	A.1 Infectious waste			
	A.2 Blood and derivates			
	A.3 Surgical, anatomopatologic and exudates			
	A.4 Piercing or cutting			
	A.5 Contaminated animal			
	A.6Patient care			

Class B	B.1 Radioactive waste			
	B.2 Pharmaceutical waste			
	B.3 Hazardous chemical waste			

2_3 Storage, Discharge, Collection

2_3_1 Collection system inside the Institution

Q.7. Specify the present waste collection system in your institution.
(Please tick in the following table)
c. We use a standard system with containers or colored bags with labels
d. Others

Waste Class / Types		Main method	Other method, if any (specify)
Class A	A.1 Infectious waste	a.	b.
	A.2 Blood and derivates	a.	b.
	A.3 Surgical, anatomopatologic and exudates	a.	b.
	A.4 Piercing or cutting	a.	b.
	A.5 Contaminated animal	a.	b.
	A.6Patient care	a.	b.
Class B	B.1 Radioactive waste	a.	b.
	B.2 Pharmaceutical waste	a.	b.
	B.3 Hazardous chemical waste	a.	b.
Class C		a.	b.

Q.8. Describe the present container for collection of common/hazardous health-care waste in your institution.
(Please tick in the following table)
a. Plastic bag
b. Paper bag
c. Open container
d. Container with lid
e. Cardboard box
f. Others

Waste Class / Types		Main method	Other method, if any (specify)
Class A	A.1 Infectious waste	a. b. c. d. e.	f.
	A.2 Blood and derivates	a. b. c. d. e.	f.
	A.3 Surgical, anatomopatologic and exudates	a. b. c. d. e.	f.
	A.4 Piercing or cutting	a. b. c. d. e.	f.
	A.5 Contaminated animal	a. b. c. d. e.	f.
	A.6Patient care	a. b. c. d. e.	f.
Class B	B.1 Radioactive waste	a. b. c. d. e.	f.
	B.2 Pharmaceutical waste	a. b. c. d. e.	f.
	B.3 Hazardous chemical waste	a. b. c. d. e.	f.
Class C		a. b. c. d. e.	f.

2_3_2 Storage

Q.9. How do you store common waste and hazardous health-care waste?
[ ] 1. We mix them all together. (Go to Q.10)
[ ] 2. We store them separately. (Go to Q.11)

Q.10. Why don't you separate hazardous health-care waste?

[ ] 1. There is no reason to separate them.
[ ] 2. It is troublesome to separate them.
[ ] 3. The waste collectors separate them.
[ ] 4. Others (specify :_____)

Q.11. How do you store your waste within your institution?
(Please tick in the following table)
a. Plastic bag
b. Paper bag
c. Open container
d. Container with lid
e. Cardboard box
f. Others

Waste Class / Types		Main method	Other method, if any (specify)
Class A	A.1 Infectious waste	a. b. c. d. e.	f.
	A.2 Blood and derivates	a. b. c. d. e.	f.
	A.3 Surgical, anatomopatologic and exudates	a. b. c. d. e.	f.
	A.4 Piercing or cutting	a. b. c. d. e.	f.
	A.5 Contaminated animal	a. b. c. d. e.	f.
	A.6Patient care	a. b. c. d. e.	f.
Class B	B.1 Radioactive waste	a. b. c. d. e.	f.
	B.2 Pharmaceutical waste	a. b. c. d. e.	f.
	B.3 Hazardous chemical waste	a. b. c. d. e.	f.
Class C		a. b. c. d. e.	f.

Q.12. Are there cool storage room or faculties for pathological wastes in your institution?
[ ] 1. Yes.
[ ] 2. No.

2_3_2 Disposal (Intermediate treatment and final disposal)

Q.13. What do you do with your waste?
(fill in first two columns of following table)
a. Place outside for collection by SEMMA/SEMULSP or other collectors
b. Directly carry the waste to a waste collection vehicle
c. Take the waste to waste collection point of SEMMA/SEMULSP or other collectors
d. SEMMA/SEMULSP or other collectors collects from institution (including own bin)
e. Bury on site
f. Open burning
g. Recycle
h. Incinerate by the incineration in the institution
i. Autoclave disinfection on site
j. Open dumping outside property
k. Other (specify :_____)

Waste Class / Type		Main method	Other method, if any	Disposal by local authority (Q.14)
Class A	A.1 Infectious waste	a. b. c. d. e. f. g. h. i. j.	k.	
	A.2 Blood and derivates	a. b. c. d. e. f. g. h. i. j.	k.	

	A.3 Surgical, anatomopatologic and exudates	a. b. c. d. e. f. g. h. i. j.	k.	
	A.4 Piercing or cutting	a. b. c. d. e. f. g. h. i. j.	k.	
	A.5 Contaminated animal	a. b. c. d. e. f. g. h. i. j.	k.	
	A.6 Patient care	a. b. c. d. e. f. g. h. i. j.	k.	
Class B	B.1 Radioactive waste	a. b. c. d. e. f. g. h. i. j.	k.	
	B.2 Pharmaceutical waste	a. b. c. d. e. f. g. h. i. j.	k.	
	B.3 Hazardous chemical waste	a. b. c. d. e. f. g. h. i. j.	k.	
Class C		a. b. c. d. e. f. g. h. i. j.	k.	

Q.14. For the health-care waste collection by SEMMA/SEMULSP or other collectors, how are they disposed of? (fill in right-hand side of above table)

a. Disposed of to the Manaus city landfill together with other waste
b. Buried in a special pit at the landfill
c. Burned at the landfill
d. Incinerated at an incinerator
e. Other (specify :_____).

Q.15. If you chose **g.** in Q.13, go to "Additional Sheet A".

Q.16. If you chose **h.** in Q.13, please provide the following information for the incinerator.

Information	Description
1. Location:	
2. Capacity (furnace volume (m^3) and waste burning capacity (kg/h):	
3. Description (e.g. no of chambers, operating principle):	
4. Combustion fuel:	
5. Height of chimney	
6. Proximity of living/working spaces to incinerator:	
7. Scrubbing/filtering of exhaust gases: Yes/No	
8. Normal operating hours:	
9. Ash disposal (amount and frequency):	
10. Age:	
11. Reliability (no of days out of service per year; average outage time):	
12. Problems:	

Q.17. If you chose **i.** in Q.13, please provide the following information for the autoclave.

Information	Description
1. Location:	
2. Type	
3. Capacity (Treatment volume (m3) and waste capacity (kg/h):	
4. Description (e.g. no of autoclave, operating principle):	
5. Normal operating hours:	
6. Average daily treatment amount (kg/day):	
7. Disposal method of treated waste	
8. Reliability (no of days out of service per yr; average outage time):	
10. Problems:	

Q.18. If you ticked **j.** in Q.13, where do you dump your waste outside your institution?

[ ] 1. On banks of igarape/river, or in igarape/river

[ ] 2. On vacant land
[ ] 3. Other (specify :_____).

2_3_4 Discharge

Q.19. How do you discharge health-care wastes?
[ ] 1. We separate store but mix discharge.
[ ] 2. We separate store and separate discharge.
[ ] 3. We mix store and mix discharge.

Q.20. In case of "**separate store but mix discharge**", who mixes them?
[ ] 1. Collector
[ ] 2. Our employee
[ ] 3. Others (specify:_____)

Q.21. Please tick appropriate boxes on the answer table to indicate your discharge manner of health-care wastes.

Class/Type of waste		1. separated discharge	2. mixed discharge			3. not generated
			same class*1	Class A and B*2	All class*3	
Class A	A.1 Infectious waste					
	A.2 Blood and derivates					
	A.3 Surgical, anatomopatologic and exudates					
	A.4 Piercing or cutting					
	A.5 Contaminated animal					
	A.6Patient care					
Class B	B.1 Radioactive waste					
	B.2 Pharmaceutical waste					
	B.3 Hazardous chemical waste					
Class C						
Remark	*1 : Mixed discharge with other waste of the same class *2 : Mixed discharge with class A and B *3 : Mixed discharge with class A, B and C					

2_3_5 Collection of Hazardous health-care waste

Q.22. Are you provided with a hazardous health-care waste collection service? (either direct collection or nearby waste collection points or direct pickup from institution – items **a, b, c or d** in Q.13)
[ ] 1. Yes
[ ] 2. No – Do you want to receive a waste collection service?
– Answer: [ ] 1. Yes / [ ] 2. No – then go to Next Section (2.3.6)

Q.23. Who collects your waste?
[ ] 1. SEMMA/SEMULSP
[ ] 2. Private company other than SEMMA/SEMULSP
[ ] 3. Don't know

Q.24. How often do you discharge your garbage and how often is it collected? (tick one)

	Class A		Class B	
	Discharge	Collection	Discharge	Collection
1. Once daily				
2. Every 2-3 days				
3. Every 4-5 days				

4.	Weekly				
5.	Less than weekly				
6.	Irregularly				
7.	Other				

Q.25. Do you pay the SEMMA/SEMULSP or a private collector an official waste collection fee for hazardous health-care waste?

[ ] 1. Yes
[ ] 2. No

If Yes, how much is this fee? And what type of wastes does it cover?

Answer	Waste Type	Payment (R$/week)

If necessary, calculate as [____] R$/vehicle x [_____] loads per week

Q.26. Are you satisfied with the existing hazardous health-care waste collection and disposal service?

[ ] 1. Yes
[ ] 2. No

If No, Why? (tick one or more)

		Answer	Why?
1.	Discharge system is poor (e.g. no bins, bins are broken or too small)		
2.	Waste collection point is too far away		
3.	Waste collection/sweeping is not properly done		
4.	Waste collection service/sweeping is irregular		
5.	Waste collection/sweeping frequency is too low		
6.	Collection time is too early or too late		
7.	Waste collection workers behave badly		
8.	Waste collection workers demand payment for waste collection		
9.	Waste collection fee of the SEMMA/SEMULSP or a private collector is too high		
10.	Lack of recycling		
11.	Problems with handling health-care waste		
12.	Other		

Q.27. How many times have you complained about the hazardous health-care waste collection service in the last year?

[ ] 1. None
[ ] 2. Once only
[ ] 3. Several times
[ ] 4. More than five times

Q.28. Is any staff member of your institution responsible for ensuring that hazardous health-care waste is collected and disposed of properly?

[ ] 1. Yes
[ ] 2. No

If you answered Yes, please explain position of persons and their duties below

Name and position of person: [ ]
Please describe their duties: [_____]

2_3_6 Improvements to hazardous health-care waste collection and disposal

1.General

Q.29. What improvements would you like to see to hazardous health-care waste collection and disposal? (Please tick one or more and priorities the top three improvements you would like to see (1 = first priority, 2 = second priority, 3 = third priority)

	Tick	Priority
1. Improved waste discharge system		
2. Shorter distance to waste collection point		
3. More reliable waste collection service		
4. Improved collection frequency		
5. Greater recycling of waste		
6. Improved collection and disposal of health-care waste		
7. Improvement of landfill operation		
8. Education to change people's bad habits		
9. Other (specify:)		

Q.30. Improved waste collection and disposal will cost additional money. Who do you think should pay these costs? (tick one or more)

[ ] 1. Amazonas state
[ ] 2. Manaus city
[ ] 3. Individual medical institution
[ ] 4. Other (specify :_____)

Q.31. Suppose that you are satisfied with the hazardous health-care waste management service, either as is or as a result of improvement. Think for a moment about the largest amount of money that your medical institution would be willing to pay each month as the collection fee.

Amount of money: [_____] R$/month

Q.32. If the current hazardous health-care waste collection fee is more than this amount, your medical institution will not be able to afford to pay and will not be able to use the waste collection service. If you are still not willing to pay the current waste collection fee, explain the reason why below:

Reasons:……..

2.Training and Instructions

Q.33. Is there some written instruction to separate and manage hazardous health-care waste in the institution?

[ ] 1.Yes
[ ] 2.No (Go to Q.35)

Q.34. How often the staff of waste management is trained as a caution against contaminated or hazardous health-care waste?

[ ] 1.Only at the start of the job
[ ] 2.Once a year
[ ] 3.Very often, please explain how often _____
[ ] 4.Never

3. Environmental education and general cleanliness

Q.35. Has anyone of this institution received any health and environmental education or information relating to hazardous health-care waste? Yes/No

If YES, no of people: [_____]

And where did this information come from?

[ ] 1. School
[ ] 2. Leaflets/posters, etc.
[ ] 3. Medical worker/centre/hospital
[ ] 4. Community organization/NGO [name:_____]
[ ] 5. Newspaper
[ ] 6. Radio program

[ ] 7. TV program
[ ] 8. SEMMA/SEMULSP
[ ] 9. Government of Amazonas State
[ ] 10. Federative Republic of Brazil (e.g. Ministry of Health, Ministry of Environment, etc.)
[ ] 11. Other (specify :_____)

Q.36. Do you think that a campaign to raise the awareness of people for maintaining a cleaner city and environment is necessary? (tick one)
[ ] 1.Very necessary
[ ] 2. Somewhat necessary
[ ] 3. Not very necessary
[ ] 4. Not necessary at all

3_Financial Matter

Q.37. How much do you pay for hazardous health-care waste collection services per month?

Answer Table for health-care waste		
Type of waste		Collection fee (R$/month)
Class A	A.1 Infectious waste	
	A.2 Blood and derivates	
	A.3 Surgical, anatomopatologic and exudates	
	A.4 Piercing or cutting	
	A.5 Contaminated animal	
	A. 6Patient care	
Class B	B.1 Radioactive waste	
	B.2 Pharmaceutical waste	
	B.3 Hazardous chemical waste	

Q.38. How much do you pay for common waste (Class C) collection services per month?
Amount of money: [_____] R$/month

4_Cooperation for Waste Management

Q.39. Coping with wastes requires efforts of not only the municipality but also the general public. Do you think there is something which your institution can do for good waste management?
[ ] 1. Yes.
[ ] 2. No.
[ ] 3. I don't know.
[ ] 4. Others (specify: _____)

Q.40. What do you think your institution can do? (plural answer question)
[ ] 1. Discharging wastes neatly.
[ ] 2. Minimizing waste generation.
[ ] 3. Reusing wastes.
[ ] 4. Recycling wastes.
[ ] 5. Treating toxic/infectious wastes appropriately.
[ ] 6. Raising the environmental awareness of the public.
[ ] 7. Providing information to the public.
[ ] 8. Researching activities.
[ ] 9. Others (specify: _____)

Q.41. Do you think the medical institutions should cooperate with the country and/or

municipality in managing wastes?
[ ] 1. Yes.
[ ] 2. No.
[ ] 3. I don't know.
[ ] 4. Others (specify: _____)

Q.42. How is the trend of your cost for waste management?
[ ] 1. It is getting significantly higher.
[ ] 2. It is getting higher.
[ ] 3. It is relatively stable.
[ ] 4. It is getting lower.
[ ] 5. Others (specify: _____)

Q.43. How do you give the priority on the management of your wastes?
[ ] 1. We give very high priority.
[ ] 2. We give moderate priority.
[ ] 3. We give little priority.
[ ] 4. Others (specify: _____)

Q.44. Do you feel you need a support from the government or municipality or any other relevant organizations for the management of your waste? (plural answer question)
[ ] 1. Yes, we need financial support.
[ ] 2. Yes, we need technical support.
[ ] 3. Yes, we need support of other kinds (specify: _____)
[ ] 4. No, we don't.
[ ] 5. Others (specify: _____)

5_Other

Q.45. Do your medical institution use radioactive material or Source?
[ ] 1. Yes
[ ] 2. No
If you tick "Yes", go to "Additional Sheet B".

Q.46. If there any additional comments you would like to make about solid waste management provision and your needs, please comment below:
[_____]

Thank-you very much for your co-operation

"Additional Sheet A"

Recycling: ONLY answer this section if you ticked Q.13 (g).

Write your answers to the following questions in the table below:

1. What items do you recycle? (specify any other materials in the blank cells)
2. How much do you recycle per week?
3. What price do you sell these items for?
4. Who do you sell/give these materials to? (e.g. individual collector, shop, middleman, industry)
5. How does this recycling system work? (put a, b, etc. in method column)

a. Take directly to shop for refund
b. Give to collector who comes to premises
c. Take directly to middlemen for sale
d. Take directly to community group/NGO for sale
e. Take directly to industry for sale
f. Other – specify in table

6. How often are these materials collected/taken for recycling? (daily, 2-3 times per week, weekly, monthly, other, irregularly)

Item	Quantity (kg/week)	Price (R$/kg)	Buyer	Method	Collection frequency
(1) Paper					
(2) Cardboard					
(3) Glass bottles					
(4) Metal					
(5) Organic waste					
(6) Other					

・Additional space for answers: [_____]

・Contact details (address/telephone numbers for buyers): [_____].

7. Are there any problems with this recycling system? Answer: Yes/No
If YES, please explain why below: [ ].

"Additional Sheet B"

Radioactive material/source: ONLY answer this section if you ticked Q.45 (1 Yes).

1. For what purpose do you use the radioactive materials/source?
   Please describe your purpose : [_____]
2. What kind of radioactive materials/source do you use? : [_____]
   Please describe radioactive materials/source : [_____]
3. How do you store the radiation source?
   a. It is stored inside of the controlled area with special container.
   b. It is stored inside of the controlled area and installed inside of the X-ray equipment.
   c. Others (specify : .....)
4. Do you generate radioactive waste?
   [ ] 1. Yes
   [ ] 2. No
   If yes, please answer the following questions.
5. How many kilograms of radioactive waste do you generate in a year?

Generation source	Kind of radioactive waste	Amount of radioactive waste (kilograms/year)
1. Clinical analysis laboratories 2. Nuclear medicine services 3. Radiotherapy 4. Other (specify)		

6. How do you treat and dispose the radioactive waste?
   a. It is stored inside of the controlled area of our compound with special container.
   b. It is entrusted to the contractor for disposal outside.
   c. Others (Specify : .....)
   If the answer is b. or c., please answer the following questions.
7. How do you transport the radioactive waste?
   a. We transport it by ourselves.
   b. We entrust outside transporter for radioactive waste

c. Others (Specify : .....)

8. How do you dispose the radioactive waste?
   a. Final disposal facilities of Federal government.
   b. Final disposal facilities of State government.
   c. Others (Specify : .....)
   d. I don't know.

********** Please Go Back! **********

****

2.4 Study of Construction Waste Management

2.4.1 Outline of the Study

a. Study Objective

The study aims to clarify the generation of construction waste, its disposal and management at PIM factories (including those outside of the DI) where construction projects exist.

b. Study Method

A local consultant (OPCA.) was consigned to conduct the study. The local consultant used a questionnaire produced by the Japanese study team and conducted interviews with those in charge of construction at factories.

The study team produced a draft questionnaire, which was discussed with the C/P and then revisions were made as necessary. The questionnaire contained the following items

- Overview of construction work, contract amount for work, type of work, number of workers
- Generation amount of construction waste
- Type of construction waste
- Final disposal aspects
- Recycling aspects
- Others

2.4.2 Construction Waste Categories

a. Construction Waste Categories in CONAMA Resolution 307

The National Environment Council (CONAMA) issued Resolution 307 in the form of guidelines for construction waste management on 5 July 2002. Construction wastes are categorized in CONAMA Resolution 307 as shown in the following table.

Table 2-26: Construction Waste Categories in CONAMA Resolution 307

Class	Description
Class A:	The reusable or recyclable waste as aggregates, such as:
	a) from construction, demolition, refitting and repair of pavement and other infrastructure constructions, including land preparation;
	b) from the construction, demolition refitting and repair of edifications: ceramic components (bricks, blocks, tiles, insulation planks, etc.), cement and concrete;
	c) from manufacturing and/or demolition process of concrete pre-modulated pieces (blocks, pipes, gutter, etc.) produced in the construction sites.
Class B	The recyclable waste for other purposes, such as: plastics, paper/carton, metals, glass, wood and others.
Class C	Waste which has no economically feasible technology or applications which may allow it to be recycled/recovered, such as the products arisen from plaster.
Class D	Hazardous waste arisen from construction process, such as paints, solvents, oils and so forth, or those contaminated or harmful to health arisen from

	demolitions, refitting and repairs of radiology clinics, industrial facilities and others, as well as tiles and other objects and materials containing asbestos or other products harmful to health. *(new text given by Resolution n. 348/04)*.

b. Target Wastes

The target wastes are construction wastes generated by works at PIM factories which are designated in CONAMA Resolution 307.

c. Construction Waste Categories used in the Study

The waste categories in CONAMA Resolution 307 identify criterion for whether or not certain construction waste is recyclable. Thus, it would be difficult to get a detailed picture what kinds of waste were being generated if the survey were conducted based on these categories. The study team discussed the matter with the C/P and decided upon 43 materials (see below) into which construction waste could be categorized and used for the survey. In addition, it was determined in which of the 4 classes given in CONAMA Resolution 307 these 44 wastes would be placed.

- Excavated soil, concrete debris, asphalt debris, brick debris, glass tile and ceramic materials, foam polystyrene, vinyl materials, synthetic rubber, used tires, plastic sheet, vinyl sheet, iron-bar, steel materials, small metal waste, old temporary scaffoldings and fences, natural rubber waste, sludge, mud, plaster boards, packaging material which organic materials stick to, lead battery, wood debris of demolish waste, timber form for concreting, scaffolding material, interior timber materials, packing materials (such as cardboard), wall paper, cloth and old rags, rope, carpet, machine oil, heavy oil, asphalt, waterproof sheet, ash of materials used for construction (such as old rags, cardboard, timber), materials containing asbestos, materials which are sprayed with asbestos, transformer, condenser, stabilizer for fluorescent light, sulfuric acid, coolant for a freezer, volatile oil, kerosene, diesel oil, mixed waste.

The 44 construction waste categories and the questions asked are presented in the Section 2.4.6 of this report.

2.4.3 Selection of Target Factories

The 457 factories located in the MFZ in the factory list provided by SUFRAMA, were contacted to confirm whether they had conducted any construction projects in the past year, from June 2008 to May 2009. The following results were found according to their responses.

- Factories that responded by telephone: 334
- Factories that have closed: 17
- Factories that refused to reply: 25
- Factories that could not be reached by telephone: 81

In this survey, it was revealed that 440 factories are PIM factories operating in the MFZ, including those which could not be reached by telephone (which was likely due to a changed phone number, etc.) and excluding the 17 which have closed.

It was found that, of the 334 factories, 123 factories, over one-third (36.8%), have conducted construction projects between June 2008 and May 2009. Ten of the 123 factories were chosen at random for direct interview using the prepared survey questionnaire. A summary of these

factory construction projects is given below.

Table 2-27: Summary of Construction Projects

Type of Construction Project	No. of Respondents	Ratio (%)
1. New construction	2	20.0
2. Additional construction	0	0.0
3. Demolition	0	0.0
4. Renovation	6	60.0
5. Others *1	2	20.0
Total	10	100.0

(Note) *1: In detail,
1. Installation of a waste water treatment facility (WWTF)
2. Construction of a retaining wall and drainage of the rain water.

2.4.4 Execution of the Survey

A local consultant (OPCA) was consigned to conduct the study on 19 June 2009. Immediately after the contract was signed, the local consultant contacted all PIM factories approved by SUFRAMA by telephone, etc., and inquired about any construction works that took place over the past year, before selecting the target factories and beginning the direct interview process. The direct interview survey and compiling the survey result were completed as planned by the end of July, and then, working with the study team, the survey results were analyzed in August before being summarized into a report.

2.4.5 Results of the Survey

The results from these responses are as follows.

a. General Information

Q.1. Type of the project

Base: Population = 10		
Q1	Answer	%
1. New construction	2	20.0
2. Additional construction	0	0.0
3. Demolition	0	0.0
4. Renovation	6	60.0
5. Others	2	20.0
Total	10	100.0

Others : 1. Installation of the WWTF(Waste water treatment facility)
2. Construction of a retaining wall and drainage of the rain water.

Q.2. Type of the construction work

Base: Population = 10		
Q2	Answer	%
1. Manufacturing building	3	30.0
2. Office building	0	0.0

3. Manufacturing/Office building	2	20.0
4. Others	5	50.0
Total	10	100.0

- Others were indicated in the responses as follows.

Base: Population = 5
1. Renovation of the canteen
2. Warehouse annex factory
3. Renovate canteen/expansion production/installation of the wastewater treatment system
4. Renovation of the canteen
5. Kitchen

Q.3. Scale of the project:

Base: Population = 10					
Q3		Answer	Average	Maximum	Minimum
1. Total floor area	m^2	10	3,159	10,000	25
2. Total project amount	R$	10	1,551,000	13,000,000	800
	R/m^2$	10	432	1,300	14
3. Construction period	month	10	2.3	6.0	0.1

Q.4. Do you have construction license of this project?

Base: Population = 10		
Q4	Answer	%
1. Yes	6	60.0
2. No	4	40.0
Total	10	100.0

Q.5. Do you make "Construction Waste Management Integrated Plan (CWMP) of this project?

Base: Population = 10		
Q5	Answer	%
1. Yes	5	50.0
2. No	5	50.0
Total	10	100.0

b. Waste Management

b.1 Construction waste management

Q.6. How many quantity do you generate common waste (not construction waste) from site office?

Construction area was set as shown in the following table in order to survey the related generation amount, and the generation amount for common waste was calculated according

to each range.

Base: Population = 9						
Range of Construction area		Answer	Average Area (m^2)	Generation amount (kg/day)		
				Average	Maximum	Minimum
1. Small	< 500 m^2	3	102	47.0	100	5
2. Middle	500-5000 m^2	3	1,551	296.0	529	50
3. Large	> 5000 m^2	2	8,705	18.0	33	3
Total		9	3,453	133.1	529	3

note: 1 factory did not provide an answer concerning the generation amount of their common waste

Q.7. Interviewee shall fill the following an answer sheets according to the construction waste type.

<How to fill in the answer sheets>

The name of the construction wastes are listed on the left-hand side of **the answer sheet**. Please tick the box next to any construction waste that is presently generated at your site or will be in the future. Then continue to write the details in Q7-2 through Q7-8.

(1) Generated waste

< Please tick the generated waste in your site.>

Base: Population = 10			
Waste No	Waste materials generated in your site 1	Generated waste in target factories	Number of Answer
01	Excavated soil	x	5
02	Concrete debris	x	7
03	Asphalt debris	x	1
04	Brick debris	x	5
05	Glass		
06	Tile and ceramic materials	x	2
07	Foam polystyrene		
08	Vinyl materials		
09	Synthetic rubber		
10	Used tires		
11	Plastic sheet, vinyl sheet	x	1
12	Iron-bar, steel materials	x	5
13	Small metal waste	x	6
14	Old temporary scaffoldings and fences, etc		
15	Natural rubber waste		
16	Sludge, mud		
17	Plaster boards		
18	Packaging material which organic materials stick to.		
19	Lead battery		
20	Wood debris of demolish waste	x	4
21	Timber form for concreting	x	1
22	Scaffolding material	x	1
23	Interior timber materials	x	2
24	Packing materials like cardboard for construction materials, etc.	x	5
25	Wall paper, etc.		
26	Cloth and old rags		

27	Rope		
28	Carpet, rug		
29	Machine oil	x	1
30	Heavy oil		
31	Asphalt		
32	Waterproof sheet		
33	Ash of materials used for construction such as old rags, cardboards, timbers, etc.	x	2
34	Materials containing asbestos		
35	Materials which asbestos sprayed		
36	Transformer		
37	Condenser		
38	Stabilizer for fluorescent light		
39	Sulfuric acid (neutralizing discharged water)		
40	Coolant for a freezer		
41	Volatile oil		
42	Kerosene		
43	Diesel oil		
44	Mixed construction waste	x	2
Total		16	48

(2) Waste code in CONAMA 307

< Describe the waste code according to the waste classification CONAMA 307, if known.>

Base: Population = 10

Waste No	Waste materials generated in your site	Total Number of Answer	Classification of CONAMA Resolution 307 (05 July 2002)			
			Class A	Class B	Class C	Class D
01	Excavated soil	5	5			
02	Concrete debris	7	7			
03	Asphalt debris	1	1			
04	Brick debris	5	5			
06	Tile and ceramic	1	1			
11	Plastic/vinyl sheet	1		1		
12	Iron-bar, steel materials	5	4	1		
13	Small metal waste	5	2	3		
17	Plaster boards	1	1			
20	Wood debris	3	2	1		
21	Timber form	1		1		
22	Scaffolding material	1		1		
23	Interior timber	3	2	1		
24	Packing (cardboard)	4	2	2		
29	Machine oil	1	1			
33	Ash	2	2			
44	Mixed construction waste	2	2			
Total		48	37	11	0	0

(3) Generation amount

< How many tons (or kg) of this construction waste is generated in your site? Please enter the amount of generated wastes.>

The following is the total amount of waste generated for 10 construction works.

<Calculation of the average daily generation amount for construction waste>

=> The generation amount of construction waste is for construction works during a one-year period from June 2008 to May 2009. The amount generated during this construction period as indicated by each factory was totaled and, taking 1 year for 365 days, the average daily generation amount was calculated. The following table shows the average daily generation amount for 10 factories for each type of waste.

Breakdown of Construction Waste Generation Amount according to CONAMA code categories (total 10 companies)

Base: Population = 10

Waste No	Waste materials generated in your site	Generation Amount	Classification of CONAMA Resolution 307 (05 July 2002)			
		kg/day	Class A	Class B	Class C	Class D
01	Excavated soil	90.4	90.4			
02	Concrete debris	147.5	147.5			
03	Asphalt debris	171.2	171.2			
04	Brick debris	8.3	8.3			
06	Tile and ceramic	0.0	0.0			
11	Plastic/vinyl sheet	1.2		1.2		
12	Iron-bar, steel materials	0.7	0.4	0.3		
13	Small metal waste	1.6	0.1	1.5		
17	Plaster boards	0.1	0.1			
20	Wood debris	3.7	2.8	0.8		
21	Timber form	0.6		0.6		
22	Scaffolding material	3.4		3.4		
23	Interior timber	3.2	2.9	0.3		
24	Packing (cardboard)	2.6	0.3	2.3		
29	Machine oil	0.2	0.2			
33	Ash	0.5	0.5			
44	Mixed construction waste	1,846.6	1,846.6			
Total		2,281.4	2,271.2	10.3		

(4) Recycling/Reuse

< Do you sell it? To whom?>

Base: Population = 10

Waste No	Waste materials generated in your site	Total Number of Answer	Sell ?	
			Yes	No
01	Excavated soil	5		5
02	Concrete debris	7		7
03	Asphalt debris	1		1
04	Brick debris	5		5
06	Tile and ceramic	1		1
11	Plastic/vinyl sheet	1		1
12	Iron-bar, steel materials	5	1	4
13	Small metal waste	5	1	4
17	Plaster boards	1		1
20	Wood debris	3	1	2
21	Timber form	1		1
22	Scaffolding material	1		1

23	Interior timber	3	1	2
24	Packing (cardboard)	4	1	3
29	Machine oil	1		1
33	Ash	2		2
44	Mixed construction waste	2		2
Total		48	5	43

One of the 10 factories (five items) responded that they are selling it.
< Do you give it to somebody? To whom and where?>

Base: Population = 10

Waste No	Waste materials generated in your site	Total Number of Answer	Give ?	
			Yes	No
01	Excavated soil	5	2	3
02	Concrete debris	7	4	3
03	Asphalt debris	1		1
04	Brick debris	5	4	1
06	Tile and ceramic	1	1	
11	Plastic/vinyl sheet	1	1	
12	Iron-bar, steel materials	5	3	2
13	Small metal waste	5	3	2
17	Plaster boards	1	1	
20	Wood debris	3	1	2
21	Timber form	1	1	
22	Scaffolding material	1	1	
23	Interior timber	3	1	2
24	Packing (cardboard)	4	3	1
29	Machine oil	1		1
33	Ash	2		2
44	Mixed construction waste	2	2	
Total		48	28	20

6 of the 10 factories (14 items) responded that they offer these to a number of companies.

(5) Transport
< How is the construction waste carried from your site to the outside?>
a. Own truck.
b. Truck of an employed sub-contractor
c. Manaus city
d. Other

Most construction waste is transported by a sub-contractor. Also, the waste item, Ash, is collected by Manaus city collection service.

Base: Population = 10

Waste No	Waste materials generated in your site	Total Number of Answer	Answer			
			a	b	c	d
01	Excavated soil	5		4		1
02	Concrete debris	7		7		
03	Asphalt debris	1		1		

04	Brick debris	5		5		
06	Tile and ceramic	1		1		
11	Plastic/vinyl sheet	1		1		
12	Iron-bar, steel materials	5		5		
13	Small metal waste	5	1	4		
17	Plaster boards	1		1		
20	Wood debris	3		3		
21	Timber form	1		1		
22	Scaffolding material	1		1		
23	Interior timber	3		3		
24	Packing (cardboard)	4		4		
29	Machine oil	1		1		
33	Ash	2			2	
44	Mixed construction waste	2		2		
Total		48	1	44	2	1

(6) Manifest

< Do you use a manifest for construction waste?>

Base: Population = 48

Q7-6	Category of Waste	Answer	sub-total
a. Yes	Brick debris	2	
	Concrete debris	2	
	Excavated soil	1	
	Interior timber	1	
	Iron-bar, steel materials	2	
	Packing (cardboard)	1	
	Timber form	1	
	Plaster boards	1	11
b. No	Ash	2	
	Asphalt debris	1	
	Brick debris	2	
	Concrete debris	4	
	Excavated soil	4	
	Interior timber	2	
	Iron-bar, steel materials	2	
	Machine oil	1	
	Mixed construction waste	2	
	Packing (cardboard)	2	
	Plastic/vinyl sheet	1	
	Scaffolding material	1	
	Small metal waste	4	
	Wood debris	2	30
c. I don't know.	Brick debris	1	
	Concrete debris	1	
	Iron-bar, steel materials	1	
	Packing (cardboard)	1	
	Small metal waste	1	
	Tile and ceramic	1	

Wood debris	1	7
Total	48	

(7) Disposal
< Where do you dispose of it?>
a. Manaus city disposal site
b. Private disposal site
c. Other
d. I don't know.

Base: Population = 10

Waste No	Waste materials generated in your site	Total Number of Answer	Answer			
			a	b	c	d
01	Excavated soil	5	3	1	1	
02	Concrete debris	7	5	1		1
03	Asphalt debris	1	1			
04	Brick debris	5	3	1		1
06	Tile and ceramic	1				1
11	Plastic/vinyl sheet	1	1			
12	Iron-bar, steel materials	5	2	1	1	1
13	Small metal waste	5	1	1	2	1
17	Plaster boards	1	1			
20	Wood debris	3		1	1	1
21	Timber form	1	1			
22	Scaffolding material	1	1			
23	Interior timber	3	1	1	1	
24	Packing (cardboard)	4	2		1	1
29	Machine oil	1		1		
33	Ash	2	2			
44	Mixed construction waste	2	2			
Total		48	26	8	7	7

c. Results of Waste Amount, Generation Rate and Waste Stream

c.1 Generation Amount of Construction Waste

In the year from June 2008 to May 2009, the amount of construction waste generated from construction projects at the 10 factories came to a total of 832.7 tons, as shown in column A in the following table. Moreover, the amount generated per day is shown in column B (B = A/365).

Table 2-28: Generation Amount of Construction Waste from Survey of 10 Factories

Waste No	Description of Waste	Total Number of Answer	**A.** Generation Amount (kg)	**B.** Generation Amount (kg/day)	Classification & Generation of Waste by CONAMA Resolution 307 (kg/day)			
					Class A	Class B	Class C	Class D
01	Excavated soil	5	32,985	90.4	90.4			
02	Concrete debris	7	53,830	147.5	147.5			

03	Asphalt debris	1	62,500	171.2	171.2			
04	Brick debris	5	3,015	8.3	8.3			
06	Tile and ceramic	1	10	0.0	0.0			
11	Plastic/vinyl sheet	1	430	1.2		1.2		
12	Iron-bar, steel materials	5	250	0.7	0.4	0.3		
13	Small metal waste	5	571	1.6	0.1	1.5		
17	Plaster boards	1	20	0.1	0.1			
20	Wood debris	3	1,335	3.7	2.8	0.8		
21	Timber form	1	200	0.6		0.6		
22	Scaffolding material	1	1,230	3.4		3.4		
23	Interior timber	3	1,150	3.2	2.9	0.3		
24	Packing (cardboard)	4	960	2.6	0.3	2.3		
29	Machine oil	1	74	0.2	0.2			
33	Ash	2	165	0.5	0.5			
44	Mixed construction waste*1	2	674,000	1,846.6	1,846.6			
	Total	48	832,725	2,281.4	2,271.2	10.3	0.0	0.0

Note: *1: Large-scale construction projects were confirmed at two factories which took place over the course of 6 months and 1 year produced a large amount of construction waste.

c.2 Number of Factories in PIM

123 factories of 334 surveyed have a construction works within their compound. It is estimated 162 (= 123x 440/334) factories have a construction works in PIM in total.

c.3 Generation Rate and Amount of Factories in PIM

As 162 factories have a construction works in PIM in total, the generation amount of construction waste from factories in PIM and generation rate per employee is calculated as follows:

Generation Amount of Factories in PIM
= Generation Rate per a factory with construction works x 162

Generation Rate per an Employee
= Generation Amount of Factories in PIM / Number of Employee in PIM (116,192)

Table 2-29: Generation Rate and Amount of Factories in PIM

Waste No	Description of Waste	Generation Rate per a factory (kg/factory/day)	Portion (%)	Generation Amount of Factories in PIM (C=Bx440/334) (ton/day)	Generation Rate per an Employee (kg/employee/day)
1	Excavated soil	9.04	4.0	1.46	0.013
2	Concrete debris	14.75	6.5	2.39	0.021
3	Asphalt debris	17.12	7.5	2.77	0.024
4	Brick debris	0.83	0.4	0.13	0.001
6	Tile and ceramic	0.003	0.0	0.00	0.000
11	Plastic/vinyl sheet	0.12	0.1	0.02	0.000
12	Iron-bar, steel materials	0.07	0.0	0.01	0.000

13	Small metal waste	0.16	0.1	0.03	0.000
17	Plaster boards	0.01	0.0	0.00	0.000
20	Wood debris	0.37	0.2	0.06	0.001
21	Timber form	0.06	0.0	0.01	0.000
22	Scaffolding material	0.34	0.1	0.06	0.001
23	Interior timber	0.32	0.1	0.05	0.000
24	Packing (cardboard)	0.26	0.1	0.04	0.000
29	Machine oil	0.02	0.0	0.00	0.000
33	Ash	0.05	0.0	0.01	0.000
44	Mixed construction waste	184.66	80.9	29.91	0.257
	Total	228.18	100.0	36.95	0.318

From the above, it was estimated that the daily generation amount of construction waste in the target area (PIM/MFZ) is 37.0 ton/day. The categorization according to CONAMA Resolution 307 for construction waste which is generated is as follows. Note that there was no hazardous construction waste confirmed in this study.

- Class A (reusable or recyclable as aggregate): 36.8 ton/day
- Class B (recyclable as material other than aggregate): 0.2 ton/day
- Class C (not economically feasible for recycling): 0.0 ton/day
- Class D (hazardous): 0.0 ton/day

c.4 Present Construction Waste Management Stream

The Present construction waste management stream in PIM, according to the survey of construction works, is shown in the following figure.

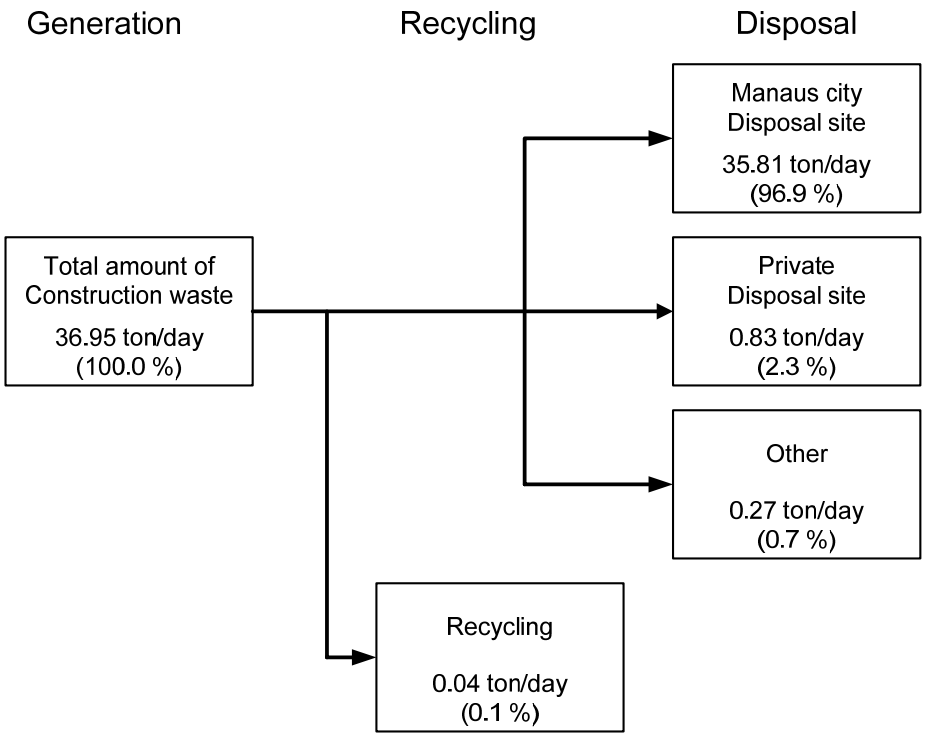

Figure 2-9: Construction Waste Management Stream in PIM

2.4.6 Questionnaire of Construction Work Survey

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Introduction of Survey for Construction Waste（Draft）

"The Study for the Development of an Integrated Solution related to Industrial Waste Management in the Industrial Pole of Manaus" is being carried out by JICA (Japan International Cooperation Agency) Study Team with the cooperation of SUFRAMA.
The purpose of this survey is to understand the generation amount of the construction wastes in Industrial District (DI) excluding those generated outside SUFRAMA jurisdiction and the waste management practices of the construction sites in DI excluding those outside SUFRAMA jurisdiction in terms of storage, segregation, discharge, collection, treatment and final disposal.
The results of this survey, together with other engineering investigations (Factory survey, Waste management company survey, etc.), will be used for the formulation of Waste stream (Waste Stream) for PIM. Your construction work has been selected to participate in this survey. The questionnaire should be answered by a responsible person on Waste Management in your works. It should take about 1-2 hours to complete. All answers are confidential and your help is greatly appreciated.

Questionnaire to Construction Work's

No.

a. General Information

Date : _____
Name of company : _____

Name of the project : _____
Address of the project site : _____
License number of the project : _____
Name of Interviewee : _____

a.1 General Information

Q.1. Type of the project
[ ] 1. New construction
[ ] 2. Additional construction
[ ] 3. Demolition
[ ] 4. Renovation
[ ] 5. Others (Specify : _____)

Q.2. Type of the construction work
[ ] 1. Manufacturing building
[ ] 2. Office building
[ ] 3. Manufacturing/Office building
[ ] 4. Others (specify : _____)

Q.3. Scale of the project:
1. Total floor area : [_____] m^2
2. Total project amount : [_____] R$
3. Construction period : [_____] week/mouth/year

Q.4. Do you have construction license of this project?
[ ] 1. Yes
[ ] 2. No

Q.5. Do you make "Construction Waste Management Integrated Plan (CWMP) of this project?
[ ] 1. Yes
[ ] 2. No

b. Waste Management

b.1 Definition of waste generated in construction work

A. Waste

CONAMA's 307 Resolution (05 July 2002) classified the waste generated in construction work as "construction waste". In this questionnaire it is divided into 4 classes: Class A, Reusable or Recyclable waste as aggregates ; Class B, Recyclable waste for other purposes; Class C, Waste which has no economically feasible technology or applications which may allow it to be recycled/recovered; and Class D, Hazardous waste arisen from construction waste.

A detailed classification of construction waste is summarized in the table below.

Class	Description
Class A:	The reusable or recyclable waste as aggregates, such as:
	a) from construction, demolition, refitting and repair of pavement and other infrastructure constructions, including land preparation;
	b) from the construction, demolition refitting and repair of edifications: ceramic components (bricks, blocks, tiles, insulation planks, etc.), cement and concrete;
	c) from manufacturing and/or demolition process of concrete pre-modulated pieces (blocks, pipes, gutter, etc.) produced in the construction sites.
Class B	The recyclable waste for other purposes, such as: plastics, paper/carton, metals, glass, wood and others.
Class C	Waste which has no economically feasible technology or applications which may allow it to be recycled/recovered, such as the products arisen from plaster.
Class D	Hazardous waste arisen from construction process, such as paints, solvents,

	oils and so forth, or those contaminated or harmful to health arisen from demolitions, refitting and repairs of radiology clinics, industrial facilities and others, as well as tiles and other objects and materials containing asbestos or other products harmful to health. *(new text given by Resolution n. 348/04)*.

Source）CONAMA's 307 Resolution, from 05 July 2002, Published in the Federal Government Journal n. 136, on 17 July 2002, Section 01, pages 95-96

B. Reuse

To use waste again, or repeatedly, without transforming and/or modifying, or only with simple treatment (e.g. use a used bottle after rinsing).

C. Recycle

To use waste again as raw material (including as energy source) with chemical, physical and/or biological processing (e.g. producing compost from food waste, manufacturing cement using wastewater sludge).

b.2 Construction waste management

Q.6. How many quantity do you generate common waste (not construction waste) from site office?

	Quantity	unit (kg/day or kg/week)
Common waste form your site office		

Q.7. Interviewee shall fill the following an answer sheets according to the construction waste type.

<How to fill in the answer sheets>

The name of the construction wastes are listed on the left-hand side of **the answer sheet**. Please tick the box next to any construction waste that is presently generated at your site or will be in the future. Then continue to write the details in Q7-2 through Q7-8.

Q7-1	Name of Generated Waste	Please tick the generated waste in your site.
Q7-2	Waste Code in CONAMA 307	Describe the waste code according to the waste classification CONAMA 307, if known.
Q7-3	Generation Amount	How many tons (or kg) of this construction waste is generated in your site? Please enter the amount of generated wastes.
Q7-4	Recycling/Reuse: Do you sell it? To whom?	
Q7-5	Recycling/Reuse: Do you give it to somebody? To whom and where?	
Q7-6	Transport: How is the construction waste carried from your site to the outside? a. Own truck. b. Truck of an employed sub-contractor c. Manaus city d. Other	
Q7-7	Manifest: Do you use a manifest for construction waste? a. Yes b. No. c. I don't know.	
Q7-8	Disposal: Where do you dispose of it? a. Manaus city disposal site b. Private disposal site c. Other d. I don't know.	

Answer Sheet for Generated Construction waste

	Q7-1	Q7-2	Q7-3	Q7-4	Q7-5	Q7-6	Q7-7	Q7-8
Waste materials generated in your site	Is it/Will it be generated in your site? (please tick)	CONAMA Classification Code (Class A,B, C and D)	Generation amount?	Do you sell it? To whom?	Do you give it somebody? To whom and where?	How is the construction waste transported?	Do you use a manifest? a. Yes b. No c Don't know	Where do you dispose of it? a. Manaus city b. Private site c. Other d. Don't know
1. Excavated soil								
2. Concrete debris								
3. Asphalt debris								
4. Brick debris								
5. Glass								
6. Tile and ceramic materials								
7. Foam polystyrene								
8. Vinyl materials								
9. Synthetic rubber								
10. Used tires								
11. Plastic sheet, vinyl sheet								
12. Iron-bar, steel materials								
13. Small metal waste								
14. Old temporary scaffoldings and fences,								
15. Natural rubber waste								

	Q7-1	Q7-2	Q7-3	Q7-4	Q7-5	Q7-6	Q7-7	Q7-8
Waste materials generated in your site	Is it/Will it be generated in your site? (please tick)	CONAMA Classification Code (Class A,B, C and D)	Generation amount?	Do you sell it? To whom?	Do you give it somebody? To whom and where?	How is the construction waste transported?	Do you use a manifest? a. Yes b. No c Don't know	Where do you dispose of it? a. Manaus city b. Private site c. Other d. Don't know
16. Sludge, mud								
17. Plaster boards								
18. Packaging material which organic materials stick to.								
19. Lead battery								
20. Wood debris of demolish waste								
21. Timber form for concreting								
22. Scaffolding material								
23. Interior timber materials								
24. Packing materials like cardboard for construction materials, etc.								
25. Wall paper, etc.								
26. Cloth and old rags								
27. Rope								
28. Carpet, rug								

	Q7-1	Q7-2	Q7-3	Q7-4	Q7-5	Q7-6	Q7-7	Q7-8
Waste materials generated in your site	Is it/Will it be generated in your site? (please tick)	CONAMA Classification Code (Class A,B, C and D)	Generation amount?	Do you sell it? To whom?	Do you give it somebody? To whom and where?	How is the construction waste transported?	Do you use a manifest? a. Yes b. No c Don't know	Where do you dispose of it? a. Manaus city b. Private site c. Other d. Don't know
29. Machine oil								
30. Heavy oil								
31. Asphalt								
32. Waterproof sheet								
33. Ash of materials used for construction such as old rags, cardboards, timbers, etc.								
34. Materials containing asbestos								
35. Materials which asbestos sprayed								
36. Transformer								
37. Condenser								
38. Stabilizer for fluorescent light								
39. Sulfuric acid (neutralizing discharged water)								
40. Coolant for a freezer								
41. Volatile oil								

	Q7-1	Q7-2	Q7-3	Q7-4	Q7-5	Q7-6	Q7-7	Q7-8
Waste materials generated in your site	Is it/Will it be generated in your site? (please tick)	CONAMA Classification Code (Class A,B, C and D)	Generation amount?	Do you sell it? To whom?	Do you give it somebody? To whom and where?	How is the construction waste transported?	Do you use a manifest? a. Yes b. No c Don't know	Where do you dispose of it? a. Manaus city b. Private site c. Other d. Don't know
42. Kerosene								
43. Diesel oil								

---------- Thank you very much !! ----------

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2.5 Study of Radioactive Waste Management

2.5.1 Outline of the Study

a. Study Objective

The study aims to clarify the current management practices of radioactive waste management by visiting PIM factories where radioactive materials are used and there is a possibility that wastes will be generated, and conducting interviews to assess the types of radioactive materials used, the management conditions, and whether or not radioactive waste is generated.

b. Study Method

The management of radioactive waste was confirmed with stakeholders that attended the first weekly meeting in the study. There it was revealed that a single entity, the National Commission of Nuclear Energy, Ministry of Science and Technology (CNEN), manages radioactive waste, with the exception of small-scale businesses in the medical sector. Still, it became apparent that the management practices of radioactive materials used by businesses in the target area (MFZ) are unclear.

Thus, members of the study team visited the CNEN headquarters in Rio de Janeiro to conduct an interview. There it was discovered that there are 14 institutions using radioactive materials in Manaus, as shown in the table below.

Table 2-30: Institutions in PIM that use radioactive material

No	Purpose of Use	Reg No.	Institution
1	Large-sized irradiators	14522	Amazonas State Hematology and Hemotherapy Foundation
2	Nuclear medicine (with non-sealed sources)	11649	Amazonas State Nuclear Medicine and Ultrasonography Center
3		14234	Rio Solimões Institutional Support Foundation – UNISOL
4	Nuclear measurers – Process control -	13686	Amapoly Industria e Comercio Ltda
5		14606	Brasil Norte Bebidas Ltda
6		14386	Cervejarias Kaiser Brasil S/A - Manaus/Am
7		14569	Cia de Bebidas das Americas - Ambev - Filial Manaus
8		14579	Microservice Tecnologia Digital da Amazônia Ltda
9	Research	12546	Amazon National Research Institute - INPA
10	Prospection of Oil	10571	Schlumberger Servicos de Petroleo Ltda – Urucu
11	Radiotherapy	11457	FCECON – Oncology Control Center Foundation
12		14886	IMAM - Instituto de Mama do Amazonas Ltda
13	Analytical techniques	13760	COIMPA Industrial Ltda
14		14932	Instituto Nokia de Tecnologia

(Note) *1: Listed in the "Profile of the Companies with Projects Approved by SUFRAMA - Dez/2008"

Eight of the 14 facilities listed above were selected and visited for direct interviews. The study team provided a draft questionnaire form, which was used as the basis for discussion with the C/P, and then revised. The questionnaire contained the following items:

- Existence of usage permit and management standards
- Intended purpose for radioactive materials
- Types and management of radioactive materials
- Whether or not radioactive waste is generated
- Types of radioactive waste and generation amount
- Treatment and disposal methods of radioactive wastes
- Other

c. Basic Concepts of Radioactive Waste Management

The management of radioactive materials in general, whether as ore, product or waste, should fulfill the rules set by CNEN – Nuclear Energy National Commission. Complementarily, the use and operation of radioactive products and equipment should follow the rules of the environmental, medical and work authorities.

The concept of *waste* set by CNEN was amended by CONAMA (Res. 358/2005) and by ANVISA (RDC 306/2004) in their resolutions concerning to health-care wastes, among which are in the radioactive wastes and the respective wastes in Group C.

We consider as *radioactive wastes* the materials "which contain radionuclide in quantities superior to the exemption limits set in CNEN-NE-6.02, and for which the reuse is either not fit or not forecasted". The *low and medium radiation wastes* are those which contain, "predominantly, Beta and Gamma emission radionuclide with around 30 years half-life, with quantities and Alpha emissions equal or inferior to 3.7×10^3 Bq/g, and whose heat rates do not exceed $2kW/m^3$".

"The radioactive wastes cannot be considered *wastes* until the necessary decay time to reach the elimination limit is gone".

The *decay rate* or *half-life* of the nuclide contained in the material are data in the tables of CNEN, and the time of use, plus the provisory storage should be sufficient so the nuclide may drop to a radioactivity level equal or inferior to the one ordinarily present in nature and thus causes no harm to living beings – in that sense the waste becomes a *waste*, whose disposal will now depend on their chemical characteristics. An eventual intervention to reduce the radioactive activity of the waste to that acceptable level would be a *treatment* of the waste. Licensed enterprises may deliver to institutions authorized and supervise by CNEN for the storage and maybe treatment, their low or medium activity wastes, mainly sealed sources or also opened ones, in that case when the decay demands a very long and inconvenient for the generating enterprise.

High radioactivity wastes do not result from the current medical or industrial use, but from strict uses, such as nuclear reactors fuel. It may be feasible to reprocess it for other purposes, in specialized plants, or it may require a special chemical treatment, maybe followed by vitrification, stowage and storage in warehouses. There is no high radioactive *waste processing plant* in Brazil.

d. Origin of Radioactivity and Current Use Sources

Some chemical elements may be presented with instable nuclei due to the excess of energy, and they are called *radioactive*, or *radio-isotope* when they refer to a same element with different atomic masses. That exceeding energy may be emitted from the nucleus as particles (matter), so called *alpha and beta radiations*, or as electromagnetic waves, the *gamma radiations*, of the same nature as the transmission waves of radio, television and X-ray.

The radioactive activity is measured by the velocity of the disintegration of the instable atoms of the radioactive element, which is 1 Bq (one Becquerel); the multiple equal to 3.7×10^{10}Bq is 1 Ci (one Curie).

The radioactive sources emit particles or nuclear radiations which originate in the nucleus of the atoms, the Alpha, Beta and Gamma radiations. The X-ray machines are electromagnetic waves, atomic radiations of the same nature as the gamma radiations, but do not originate in the nucleus of an atom: they are radiations or energy lost in the braking of electrons launched by a high voltage accelerator against atoms. The X-ray equipment are not radioactive materials, but sources which, during their operation, emit those radiations as hazardous as gamma radiations and, because of that, require the attentions and rules of CNEN.

Ioning radiations are applied in industry, medicine, teaching and scientific research, using for that *sealed and non-sealed* or opened radioactive sources, as well as *X-ray equipment and particles accelerators*.

A sealed source is a radioactive material solidly incorporated in inert solid matter in into a hermetically closed and resistant to mechanic or thermal shocks inert capsule, in such a way it cannot be opened unless it is destroyed. Sealed sources are used in beta and neutron X-rays, industrial gamography, level, density or thickness measurers, radio-therapy, sterilization of clinical products, preservation of food, chemical and elements analysis, field ore analysis, and many other applications.

A non-sealed or open source is used in very small quantities, in liquid form, and very rarely as gas. It has a wide application for medical diagnosis, being injected into the blood to be followed from outside by a detecting device; and in healing medicine, irradiating a cancer in the thyroid, for instance. Besides that and many other applications in diagnosis and medical treatments, the open sources are used in the industry to measure flows, speed of fluids in pipes or filtering system, detection of leakages, and other applications.

CNEN authorizes the enterprises which propose to install and operate radioactive equipment, authorizes and controls the purchasing and use of radioactive materials, as well as the storage, treatment and elimination of the resulting wastes. CNEN keeps and makes available for verification, the registration data of the authorized enterprises and professionals qualified to work with radioactive materials, once the licensed facilities need a radioprotection supervisor registered by the organization.

Through such record were selected the enterprises aimed for the research we show from now on.

2.5.2 Legislation and Management

a. Establishment of CNEN by Laws 4118/62 and 6189/74

The basic Brazilian legislation states in **laws 4118/62 and 6189/74**, which establish the monopoly of the Federacy over research and permit of nuclear ores, the industrialization and commerce of all nuclear ores, products and sub-products.

The aforementioned laws create the Nuclear Energy National Commission-**CNEN** as a federal government office, granting it exclusive Power to set guidelines, safety rules, regulate, license, authorize and monitor all industrial, commercial, service and research activities, as well as the use and waste of all radioactive or radioactive contaminated material, including equipment, instruments and tools. Law 6189/74 grants competence to **CNEN** so it may produce radio-isotopes, radioactivity substances and nuclear sub-products, and trade them; and creates the Brazilian Nuclear Companies Inc.-**NUCLEBRÁS** to set the industrial rules over the other nuclear products, as a monopoly.

Not only the radioactive (and nuclear) facilities are under the control of CNEN, but also all radioactive material, from the purchasing and use up to the final destination.

The purchasing of a radioactive material can only be done by licensed enterprises and require an authorization from CNEN, to buy them both in Brazil and abroad – by the way, the Brazilian customs monitor and inform CNEN about a possible entrance of radioactive material.

Environmental License and others necessary for medical and industrial institutions operating radioactive equipment are granted by the regulating authorities, which rectify the concepts and requirements of CNEN, helping with the monitoring and surveillance of the activities.

The management of radioactive wastes in some facilities should be permanent, followed by a main *Radio-Protection Supervisor*, providing a substitute Supervisor so the activities will never lack surveillance. Those professionals should be certified by CNEN, which on regular basis holds tests in several cities of Brazil, with that purpose.

The person in charge for the adoption and fulfillment of the protection measures for human health and the environment exposed to the radiation to be emitted, and the supervisor, are in the Operation Authorization issued by CNEN to the industry or institution, always with a set deadline.

b. Related Legislation for Management of Radioactive Materials

CNEN is the regulating entity to receive and dispose the radioactive wastes, authorize other institutions to store and provide the elimination of low and medium radioactivity wastes, under its supervision, or to re-export wastes of products purchased abroad. There are three institutions authorized by CNEN: IEN – Nuclear Energy Institute (RJ), IPEN – Energy and Nuclear Research Institute (SP) and CDTN – Nuclear Technology Development Center (MG), all licensed to receive sealed source wastes, and non-sealed sources whose decay deadline is too long for temporary storage in the generating enterprise.

The rules and regulating positions applied to radioactive facilities, their equipment and operation, are the following:

CNEN NN 6.01 Requirements for the registration of individuals for the preparation, use and handling of radioactive sources.

CNEN NE 6.02 Licensing of radioactive facilities. PR 6.02 /001 Presentation of reports for the licensing of high-sized irradiators. (Regulating Position with specific requirements demanded in CNEN NN 6.01)

CNEN NE 6.05 Management of radioactive wastes in radioactive facilities

CNEN NE 6.06 Selection and choice of locations to store radioactive wastes

CNEN NE 6.09 Acceptance criteria for the disposal of low and medium radiation level radioactive wastes

CNEN NE 5.01 Transport of radioactive materials
PR 5.01 /001 Transport of radioactive by motorcycles in all national territory

CNEN NE 6.04 Operation of industrial X-ray services

CNEN NN 4.01 Radiologic safety and protection requirements for mining-industrial facilities

CNEN NE 3.02 Radio-protection services

CNEN NN 3.05 Radio-protection and safety requirements for nuclear medicine services

CNEN NE 3.06 Radio-protection and safety requirements for radio-therapy services

CNEN NN 3.03 Quality Certification of Radio-protection Supervisors
PR 3.03 / 001 - Working Areas of the Radio-protection Supervisors

CNEN NN 3.01 Basic Guidelines of radiologic protection
PR 3.01 /001 Exclusion, exemption and sparing requirements criteria for radiologic protection
PR 3.01 /002 Ponderation factors for the radiologic protection greatnesses
PR 3.01 /003 Coefficients of dosages for individuals exposed to radiation at work
PR 3.01 /004 Restriction of dosage, occupational reference levels and classification of areas
PR 3.01 /005 Criteria for the calculations of effective dosage arisen from the individual monitoring
PR 3.01 /006 Protection measures and intervention criteria in emergency situations
PR 3.01 /007 Intervention and action levels for chronic exposure
PR 3.01 /008 Environmental radiologic monitoring program
PR 3.01 /009 Model for the elaboration of environmental radiologic monitoring reports
PR 3.01 /010 Dosage levels for the notification of CNEN
PR 3.01 /011 - Dosage Coefficients for Public Exposure

For the management of wastes generated in *health services*, the following complementary resolutions should be taken into account:

- Resolution CONAMA 358 /2005 - Treatment and final disposal of health-care wastes
- Resolution ANVISA /RDC 306 /2004 – Management of health-care wastes

In national extent, the following laws should be taken into account:

- Law 6,453 /1977 Civil Liability Law
- Law 6,938 /1981 Environment National Policy
- Law 6,189 /1974 Law about nuclear issues (alters Law 4,118 /77)
- Law 4,118 /1962 Nuclear Energy National Policy; creates CNEN.

- Law 10,308 /2001 Radioactive Wastes Storage

c. Licensing by CNEN

c.1 General

Every company or institution which intends to use any radioactive material or radioactive source should require a Previous Approval from CNEN for the place proposed for such activity. Once the Previous Approval is granted, request the Authorization so the activity may become effective. The termination of the activity at a place should also be communicated to CNEN, informing the destination foreseen for the wastes, which will require the approval and surveillance of CNEN. Each activity requires a specific License or Authorization.

The frequent administrative acts are:

- Authorization to Purchase Radioactive Material
- Operation Authorization
- Renewal of the Operation Authorization
- Authorization Modification
- Operation Removal

and the demanded documents are the following:

- Authorization Request
- Radiologic Protection Plan
- Wastes Management Plan
- Decommissioning Plan.

c.2 Requirements and procedures for licensing according to the type of facilities and the source

The requirements and procedures for the licensing are in **CNEN NE 6.02,** and were set per type of facilities and the source they will use, being classified as follows:

c.2.1. Facilities which use sealed radioactive sources:

Group I: facilities which use large-sized sealed sources in radiation induced industrial processes.

Group II: facilities which use sealed sources for industrial radio-therapy or X-ray.

Group III: facilities which use sealed sources for other purposes other than those mentioned above.

c.2.2. Facilities which use non-sealed radioactive sources:

Group IV, V or VI: facilities where radionuclide whose classes and total activity limits specified in Table 1 presented in **CNEN NE 6.02** are manipulated, used or stored.

c.2.3. Facilities which use particle accelerators:

Group IX: facilities which use large-sized X-ray machines or particle accelerators.

Group X: facilities which use equipment other than those mentioned in Group IX.

c.3 Licensing process of radioactive facilities

The general licensing process of radioactive facilities involves, as the case may be, the request from the solicitor and the issuance by CNEN, of the following:

c.3.1. For GROUP I facilities:

- Previous Approval
- Construction License
- Authorization to purchase radioactive material
- Operation Authorization

c.3.2. For GROUP II facilities:

- Construction License
- Authorization to purchase radioactive material
- Operation Authorization

c.3.3. For GROUP III facilities:

- Authorization to purchase radioactive material
- Operation Authorization

c.4 Free from the licensing process

Will be **free from the licensing process** set in this Rule, the facilities which comprehend, at any moment:

(a) Specific activity radioactive substances inferior to 0.0027 mCi/g (100 Bq/g) or natural solid radioactive substances of specific activity inferior to 0.014 mCi/g (500 Bq/g);

(b) Radionuclide whose total activities, within each class, do not exceed the following amounts:

Class A	0.1 mCi
Class B	1 mCi
Class C	10 mCi
Class D	100 mCi

(c) Equipment which emit ioning radiation with energy inferior to 5 keV.

In the case of facilities working with radionuclide (other than Th nat and U nat) belonging to different classes, the exemption criteria is decided by means of the calculation of the resulting ioning energy, for which the NE 6.02 provides a formula.

It is important to notice every enterprise or facilities where radiation sources are produced, used, transported or stored are defined as ***radioactive facilities*** – except: a) nuclear facilities (objective of **CNEN NE 1.04**) and b) vehicles which transport radiation sources, when they do not integrate the vehicles.

c.5 Termination of License

The radioactive facilities which decide to **terminate** their activities should request from CNEN the **cancelling of the Authorization** for the operation, by means of a request form followed by at least the information below, besides the fulfillment of determinations contained in specific Rules:

(a) destination to be given to the radioactive material and other sources of radiation;

(b) destination to be given to the records to be kept;

(c) technical and administrative procedures for the total decontamination of the facilities.

The licensing of large-sized facilities for the irradiation of food should follow specific requirements set in **CNEN NE 6.02**.

c.6 Wastes Management Plan

The Wastes Management Plan is highly important and should be formulated according to CNEN NE 6.05, which:

- Sets general criteria and basic requirements concerning the management of radioactive wastes in radioactive facilities;
- Presents in its scope the classification of the wastes with Beta, Gamma and Alpha emitters, both liquid and solid, as well as the general requirements for Wastes Management, i.e., the segregation, stowage and identification;
- Specifies the criteria to be followed as for the transport, provisory storage and elimination of radioactive wastes;
- Presents the limits to be followed concerning the elimination of liquid, solid and gaseous wastes from some facilities, bound to the approval based on the analysis of the pertinent environmental factors.

2.5.3 Selections of the Survey Target Institutions

The records in CNEN of companies and institutions licensed for activities with radioactive sources, shows the following companies located in **Manaus**:

Type	Number of Factories/Institutions
Large-sized Irradiators	1
Nuclear Medicine (with non-sealed sources)	2
Nuclear Measurers - Process Control	5
Research	1
Oil Prospection	1
Radiotherapy	2
Analytical Techniques	2
Total	14

Based on the records of CNEN, the following were selected for visitation and interview with the person in charge:

- Five enterprises located in Industrial District which use sealed sources in their industrial process (nuclear measurers and level controllers):
- Two enterprises located in DI which apply analytical techniques:
- One enterprise out of Industrial District which used non-sealed source (radio- isotope) in image medical diagnosis:

2.5.4 Execution of the Survey

A questionnaire was elaborated to be answered by the people in charge during visitation to the enterprise. The visitations were set by the team in charge of the survey after formal request by SUFRAMA, and took place from 13 July 2009 to 05 August 2009.

The questionnaires were answered during the interviews according to the documents which compose in the Section 2.5.6 of this Report, and the answers are summarized in both charts below:

2.5.5 Results of the Survey and Findings

Analysis of the above survey results was carried out according to the questions found in the questionnaire sheet. The findings by the visit of target institutions are summarized below.

a. Findings by the visit of target institutions

The survey showed all enterprises are properly authorized by CNEN by operation authorization valid for 1 to 3 years, in which the Legal Representative is pointed out, and in almost all of them it is the Radio-protection Supervisor. Nevertheless, the industries use relatively simple sealed sources, mainly for measurement and spectrum, and maybe because of that it has no permanent supervisors, only eventual or periodic ones instead – different to what is set by the rules of CNEN.

CENUSA (Amazonas State Nuclear Medicine and Ultrasonography Center) uses open sources (radioisotope) for medical diagnosis by image, that is why it has a doctor who is at the same time the representative and the professional registered in CNEN for radioactive operations.

It is important to notice the radioactive particles last only for a few hours and the person who receives them will eliminate them in the urine or faeces. The restrooms of CENUSA are located in controlled areas; they show signs concerning hygienic and double flush, according to the rules of CNEN. The non-sealed sources are stored in adequate containers, up to the sufficient decay, when then they become radioactive waste and are disposed.

In all enterprises, the sources operate or are stored in controlled areas, inside the respective equipment, devices or special containers. The sealed sources are replaced at the end of their shelf-life, when they become wastes; they GO to a licensed destination, by the very producer of the product.

b. Summary of Questionnaire Results

- Survey Target

Purpose of use (Type)	Number of target
Nuclear measurers - control of nuclear measuring processes	5
Analytical Techniques	2
Nuclear medicine	1
Total	8

Q.1 Do you have a license of radioactive material use and a control/management document for radioactive material?

Base : Population = 8		
Q1	Answer	%

a. Yes	8	100.0
b. No	0	0.0
Total	8	100.0

Q.2 For what purpose do you use the radioactive material?

Base : Population = 8		
Q2	Answer	%
a. For medical purpose	1	12.5
b. For check of the product of my factory	7	87.5
c. For check of the construction works	0	0.0
d. Others	0	0.0
Total	8	100.0

- The following table shows the specifics as given in the responses.

Answer of Q2	Specify	Answer
a.	Dyagnosis	1
b.	Filling level inspection/ measurement	4
	Measurement of the PVC sailcloth in the process	1
	Products dimension control	1
	B- Verification of the solder	1

Q.3 Information on Radioactive Material Used

Q.3.1 What kind of radioactive material do you use?

Base : Population = 8		
Q3.1	Answer	%
Americium (Am)	3	37.5
Krypton (Kr)	1	12.5
Cesium (Cs)	1	12.5
CRT (uses no radiation)	1	12.5
CRT-Be (Beryllium)	1	12.5
Technetium (Tc)	1	12.5
Total	8	100.0

Q.3.2 Of which radioactivity unit do you use?

Base : Population = 8		
Q3.2	Answer	%
a. Bq	4	50.0
b. Ci	2	25.0
c. MSV	1	12.5
d. not use	1	12.5
Total	8	100.0

Q.3.3 Is the radiation source sealed?

Base : Population = 8		
Q3.3	Answer	%
a. Yes	6	75.0
b. No	1	12.5
c. Others (The Lamp)	1	12.5
Total	8	100.0

Q.3.4 How do you store the radiation source?

Base : Population = 8		
Q3.4	Answer	%
a. It is stored inside of the controlled area with special container.	3	37.5
b. It is stored inside of the controlled area and installed inside of the X-ray equipment.	3	37.5
c. Others	2	25.0
Total	8	100.0

- Specifics of the targets listed as other in the responses are as follows.

*installed in a level measurement device
*installed in a device within the controlled area

Q.3.5 Where is the X-ray equipment used?

Base : Population = 8		
Q3.5	Answer	%
a. In the controlled area.	7	87.5
b. In the open air	0	0.0
c. Others	1	12.5
Total	8	100.0

- Specifics of the targets listed as other in the responses are as follows.

*radio-isotope injected in the patient

Q.4 Do you generate radioactive waste?

Base : Population = 8		
Q4	Answer	%
a. Yes	0	0.0
b. No	8	100.0
Total	8	100.0

<All survey targets responded they have no radioactive waste, so the following questions did not require responses.>

Q.5 What kind of radioactive waste do you generate?

Q.6 How many kilograms of radioactive waste do you generate in a year?

Q.7 How do you treat and dispose the radioactive waste?

Q.8 How do you transport the radioactive waste?

Q.9 How do you dispose the radioactive waste?

2.5.6 Questionnaire of Radioactive Waste Generation Survey

****

Questionnaire to the Radioactive Waste Generation Source

Q.1 Do you have a license of radioactive material use and a control/management document for radioactive material?
a. Yes.
b. No.
If yes, please show us them.

Q.2 For what purpose do you use the radioactive material?
a. For medical purpose
(Please specify :)
b. For check of the product of my factory
(Please specify :)
c. For check of the construction works
(Please specify :)
d. Others
(Please specify :)

Q.3 Information on Radioactive Material Used

Q.3.1 What kind of radioactive material do you use?
(Please specify :)

Q.3.2 Of which radioactivity unit do you use?
a. Bq
b. Ci

Q.3.3 Is the radiation source sealed?
a. Yes
b. No

Q.3.4 How do you store the radiation source?
a. It is stored inside of the controlled area with special container.
b. It is stored inside of the controlled area and installed inside of the X-ray equipment.
c. Others (Specify : .....)

Q.3.5 Where is the X-ray equipment used?
a. In the controlled area
b. In the open air
c. Others (Specify : .....)

Q.4 Do you generate radioactive waste?
a. Yes.
b. No.
If yes, please answer the following questions.

Q.5 What kind of radioactive waste do you generate?
a. Spent radioactive material (Please specify :)
b. Substance contaminated by radioactive material (Please specify :)
c. Others (Please specify :)

Q.6 How many kilograms of radioactive waste do you generate in a year?

a. (Specify : 1. ..... unit : kg/year .....)
b. (Specify : 2. ..... unit : kg/year .....)
c. (Specify : 3. ..... unit : kg/year .....)

Q.7 How do you treat and dispose the radioactive waste?
a. It is stored inside of the controlled area of our compound with special container.
b. It is entrusted to the contractor for disposal outside.
c. Others (Specify : .....)
If the answer is b. or c., please answer the following questions.

Q.8 How do you transport the radioactive waste?
a. We transport it by ourselves.
b. We entrust outside transporter for radioactive waste
c. Others (Specify : .....)

Q.9 How do you dispose the radioactive waste?
a. Final disposal facilities of Federal government.
b. Final disposal facilities of State government.
c. Others (Specify : .....)
d. I don't know.

Radio-protection Supervisor - …..……

Person in charge of the plant - …….....

****

2.5.7 Current Conditions and Issues for Radioactive Waste Management

a. Classification of the Radioactive Wastes

a.1 Classification by CNEN

The rule CNEN NE 6.05 - Management *of radioactive wastes in radioactive facilities* classifies the wastes in categories, as per the **physical state, nature of the radiation, concentration and exposure rate**. They result in **two classes**: wastes with beta or gamma emitters, and wastes with alpha emitters, sub-divided in categories, as seen below:

a.1.1. Wastes with Beta/Gamma Emitters

Liquid Wastes

The liquid wastes containing beta and/or gamma emitters, and in which the eventual alpha emitters have a total concentration inferior to $3.7x10^8$ Bq/m^3 (10^2 Ci/m^3), are classified in the following categories, according to the levels of concentration (Table 1).

Table 2-31: Classification of liquid wastes with beta/gamma emitters

CATEGORY	CONCENTRATION	
	(Bq/m^3)	(Ci/m^3)
Low Radiation Level (LBN)	$c \leq 3,7x10^{10}$	$c \leq 1$
Medium Radiation Level (LMN)	$3,7x10^{10} < c \leq 3,7x10^{13}$	$1 > c \leq 10^3$
High Radiation Level (LAN)	$c > 3,7x10^{13}$	$c > 10^3$

Solid Wastes

The solid wastes containing beta and/or gamma emitters, and in which the eventual alpha emitters have a total concentration inferior to 3.7×10^8 Bq/m^3 (10^2 Ci/m^3), are classified in the following categories, according to the exposure level on the surface of the waste:

Table 2-32: Classification of solid wastes with beta/gamma emitters

CATEGORY	NA RATE EXPOSURE (X) SURFACE	
	µC/kg · h	R/h
Low Radiation Level (SBN)	X ≤ 50	X ≤0,2
Medium Radiation Level (SMN)	50 < X ≤ 500	0,2 < X ≤ 2
High Radiation Level (SAN)	X > 500	X > 2

Gaseous Wastes

The gaseous wastes are classified in the following categories, according to the concentration levels.

Table 2-33: Classification of gaseous wastes with beta/gamma emitters

CATEGORY	CONCENTRATION (c)	
	(Bq/m^3)	(Ci/m^3)
Low Radiation Level (GBN)	c ≤ 3,7	c≤1010
Medium Radiation Level (GMN)	$3,7 < c \leq 3,7x10^4$	$10^{10} > c \leq 10^6$
High Radiation Level (GAN)	$c > 3,7x10^4$	$c > 10^6$

a.1.2. Wastes with Alpha emitters

Liquid Wastes

The liquid wastes containing alpha emitters in concentrations superior to $3.7x10^8$ Bq/m^3 (10^2 Ci/m^3) are classified in the following categories, according to the concentration levels.

Table 2-34: Classification of liquid wastes of alpha emitters

CATEGORY	CONCENTRATION (c)	
	(Bq/m^3)	(Ci/m^3)
Low Radiation Level Alpha (LaBN)	$3,7x10^8$ $c \leq 3,7x10^{10}$	$10^2 < c \leq 1$
Medium Radiation Level Alpha LaMN)	$3,7x10^{10} < c \leq 3,7x10^{13}$	$1 < c \leq 10^3$
High Radiation Level Alpha (LaAN)	$c > 3,7x10^{13}$	$c > 10^3$

Solid Wastes

The solid wastes containing alpha emitters in concentrations superior to $3.7x10^8$ Bq/m^3 (10^2 Ci/m^3) are classified in the following categories, according to the concentration levels.

Table 2-35: Classification of solid wastes of alpha emitters

CATEGORY	CONCENTRATION (c)	
	(Bq/m^3)	(Ci/m^3)
Low Radiation Level Alpha (SaBN)	$3,7x10^8 < c \leq 3,7x10^{11}$	$10^2 < c \leq 10$
Medium Radiation Level Alpha (SaMN)	$3,7x10^{11} < c \leq 3,7x10^{13}$	$10 < c \leq 10^3$
High Radiation Level Alpha (SaAN)	$c > 3,7x10^{13}$	$c > 10^3$

a.2 Classification of the Health Radioactive Wastes

The Resolution of CONAMA n. 358/2005, **does not apply** to **sealed** radioactive sources (Art.1 sole §), but to opened sources and health and research institutions in that area, with their respective equipment and activities.

The radioactive wastes defined by CNEN form the Group C of this Resolution, and should follow the rules of CNEN until the necessary decay takes place so they may go the biologic, chemical or common wastes category and start following the determinations for the group they belong to (Art.23 §2).

The Health-care Wastes Management Plan should forecast all the guidance and attaining procedures.

Resolution RDC 306/2004 of ANVISA – Sanitary Surveillance National Agency reassures and details the definitions of CNEN and CONAMA:

> GROUP C – In this group are the radioactive wastes or the wastes contaminated with radionuclide, coming from clinical analysis laboratories, nuclear medicine and radio-therapy services, according to the resolution of CNEN-6.05.
>
> 12.1.1 – The solid radioactive wastes should be stowed into a container made from a rigid material, internally covered with a resistant plastic bag and identified according to item 12.2.1.
>
> 12.1.2 – The liquid radioactive wastes should be stowed in bottles holding up to two liters or in barrels made from a material compatible with the stored liquid, of plastic always than possible, resistant, rigid and stanching, with a screwed cover, sealed, stowed in an unbreakable material tray and with a depth sufficient to contain, under the due safety rate, the total volume of the waste, and identified according to item 10.2...
>
> 12.1.3 – The piercing and cutting materials contaminated with radionuclide, should be disposed separately, in the place where they were generated, right after use, in stanching containers, rigid, with cover, properly identified, being utterly prohibited to empty such containers to be reused....
>
> 12.2.1 - Group C is represented by the international ioning radiation symbol in yellow background labels with black contour, reading RADIOACTIVE WASTE, indicating the main risk such material presents, beside information about the content, name of the radioactive element, decay time, generation date, name of the generating unit, according to the rules of CNEN NE 6.05 and others CNEN may determine.
>
> 12.2.3 – After the decay of the radioactive element to the elimination level set CNEN NE 6.05, the label RADIOACTIVE WASTE should be removed and replaced with another label, according to the Group of the waste it fits in.

The Resolution guides the on-site treatment and storage, which can be done in the very manipulation room or in a specific room identified as *decay room*. The selection of the storage place, taking into account the half-lives, the activities of the radioactive elements and the volume of waste generates, should be defined in the Facilities Radio-Protection Plan.

Such plan should also inform the preliminary treatment of the excrements, the stowage, identification and conservation of contaminated food, until he decay is completed. That should be done in the controlled manipulation area or in a decay room provided with armored walls or, in that very room, store the wastes in individual armored containers.

There are specific demands for nuclear medicine activities.

The decay room should have controlled access. It should be identified and have restrict access, provided with the means to assure safety conditions against the action of natural phenomena, and comply with the Radio-Protection Plan approved by CNEN for the installation.

b. Radioactive Wastes Management

b.1 General Information

As stated in the Section 2.5.2 *Legislation and Administration*, CNEN has got the exclusive legal competence in Brazil to set guidelines, license, authorize and monitor every activity, installation, equipment, instrument and tool which may use radioactive material or material contaminated with radiation – whether ore, product or waste, national or foreigner. The legislation also grants CNEN the legal competence to produce and commercialize radio-isotope, radioactive substances and nuclear sub-products.

CNEN elaborates and makes available to all, free of charge in the internet, technical rules, instructions for the procedures and licensing, as well as didactical material concerning the issue. Provides the licensed enterprises and registered professionals by means of courses it holds on regular basis for the surveillance or handling of radioactive activities and sources. It is meant to highlight that, in order to facilitate an efficient and current control, the licenses are issued with a validity limited to a short period, expressing in them the Radio-protection Supervisor and the Person in Charge of the activities.

CNEN is the competent entity to receive and dispose the radioactive wastes, even authorizing other institutions to do so under its supervision. Today the authorized entities are, IEN (RJ), IPEN (SP) and CDTN (MG) to store and carry out the elimination of low or medium radiation intensity sealed sources; the authorization also comprises the non-sealed source with long-term decay, which may present difficult practical provisory storage in the enterprise which used it. It may also authorize the re-exports to the foreign vendor. The disposal of radioactive wastes in a place determined by CNEN, without the intention of removing them, is defined as *disposal*.

High radioactivity wastes are generated in nuclear facilities only, where they are stored for elimination out of Brazil.

Radioactive Waste (or simply Waste) is defined as a material resulting from human activities which contain radio-nuclides in quantity superior to the exemption limit specified in *Rule CNEN NE6.02 Licensing of Radioactive Facilities*, and for which the reuse is either improper or not foreseen.

Radioactive Facilities is the enterprise where radiation sources are produced, processed, handled, used, transported or stored, except:

a) the Nuclear Facilities defined in *Rule CNEN NE1.04, Licensing of Nuclear Facilities*; and b) the vehicles which transport radiation sources.

Radioactive Material is the material which contains ioning radiation emitting substances.

The disposal of a radioactive material from a “non sealed source” may be done after the sufficient decay in the sanitary sewer system, if it is liquid, or in a sanitary landfill if it is solid. The time of use plus the provisory storage of the source should be sufficient for the nuclide to decay to a radioactivity level which may not cause harm to living beings, which is equal or inferior to what is ordinarily noticed in nature. That period and the decay rate (or half-life) of the nuclides are presented in tables made available by CNEN.

The rule ***CNEN NE 6.05 – Management of Radioactive Wastes in Radioactive Facilities*** guides the generator of those wastes so it may elaborate its **Radiologic Protection Plan**, which is necessary for the installation licensing and purchasing and use authorization of the material. In it is the **Wastes Management Plan**, which has to do with its management, provisory storage and destination.

Rule NE-6.05:

- Sets general criteria and basic requirements concerning the management of radioactive wastes in radioactive facilities;
- Presents in its scope the classification of the wastes as Beta and Gama emitters and with solid and liquid Alfa emitters, as well as the Wastes Management general requirements, i.e., the segregation and stowage and the identification;
- Specifies the criteria to be followed as for the transportation, provisory storage and the elimination of radioactive wastes;
- Shows the limits to be followed as for the elimination of liquid, solid and gaseous wastes from some facilities, bound to obtaining a report based on the analysis of the pertinent environmental factors.

The Wastes Management Plan shows:

- Storage Area Description
- Procedures for Segregation, Stowage,
- Identification, Storage, Elimination, Transfer
- Training
- Records
- Emergency situations

The Radioactive Wastes Management is defined as the set of administrative activities and techniques involved in the collection, segregation, handling, treatment, stowage, transport, storage, control and disposal of radioactive wastes.

b.2 Management of Radioactive Wastes in the Generation Source

Rule CNEN NE 6.05 sets, among other items -

1. General Requirements

1.1 The wastes should be physically separated from any other materials.

1.2 The wastes initially submitted to segregation which cannot be removed from the facilities, should be placed in proper containers and stored until they may be transferred or eliminated, as per the specific requirements.

1.3 The containers meant both for segregation and collection, transport and storage of wastes should have the international symbol of radiation, in a visible and clear way.

1.4 The place for the provisory storage of waste should be included in the installation project.

2. Segregation

2.1 The segregation of wastes should be done in the same place they are produced, taking the

following characteristics into account:

a) Solid, liquid and gaseous;

b) Short or long shelf-life (T1/2 > 60 days);

c) Compactable or non-compactable;

d) Organic or inorganic;

e) Spoiling or pathogenic, if that is the case;

f) Other hazardous characteristics (exclusivity, combustibility, inflammability, pyreforicity, corrosiveness and chemical toxicity).

2.2 After segregation and **stowage** in proper containers (sub-section 3), the wastes must be **identified** according to Annex A and **classified** according to the 09 categories of Section 4. The **eliminated** wastes must be **registered** (Section 06) according to the form (Annex C).

3. Containers

3.1 The containers for segregation, collection or provisory storage should fulfill the physical, chemical, biological and radiologic characteristics they are meant for.

3.2 The containers for the provisory storage of wastes must have their integrity conditions assured and, if necessary, they should be replaced.

3.3 The containers meant for internal transport should not present external superficial contamination in level superiors to those specified in Annex B.

3.4 The containers meant both for segregation and collection, transport and storage of wastes should be properly sealed and have its content identified (item 2.2) with all data of Annex A.

4. Transport

4.1 The vehicles used for internal transport f wastes should have proper fixation means for the containers so they are not damaged.

4.2 The vehicles, after the internal transport services, should be monitored and, if needed, they should be decontaminated.

4.3 The external transport of wastes is regulated by the current Radioactive Materials Transport Rule.

5. Provisory Storage

The area of the facilities meant for the provisory storage of wastes, as applicable, should:

a) keep the wastes in safety, from the physical and radiologic point of view, **until they can** be removed to a place set by CNEN;
b) have a system which may allow the **control** of the release of radioactive material into the environment;
c) have an area **monitoring** system;
d) be located **far** from the normal working areas, being **fenced** and **identified,** with the **access restricted** to authorized personnel;
e) have waterproof and easily decontaminating walls and floors;
f) have **blindage** for the outside so it may fulfill the radio-protection requirements;
g) have **ventilation**, **exhausting** and **filtering** systems;
h) have means of **avoiding** the **dispersion** of the material **by animals**;
i) present a **clear delimitation** of the restrict areas and, if necessary, areas reserved

for individual monitoring and decontamination;
j) have a **tanks** and floor **drains** systems for the collection of liquids arisen from leakages, decontamination, etc;
k) have means to **avoid the spoiling** of organic materials;
l) provide **safety** against the action of events caused by **natural phenomena**;
m) have **physical barriers** aiming for minimizing the dispersion and migration of radioactive material into the environment;
n) in order to facilitate the handling of the materials and minimize the exposure of workers, have proper **procedures**, always **visible** on walls, notice-boards and other visible areas;
o) have physical protection and radio protection **preliminary plans**, as well as **procedures** for **emergency situations**.

6. Treatment

Any treatment of radioactive wastes is bound to approval of CNEN, in conformity with the specific rules for each type of facilities.

7. Elimination

7.1 The elimination of liquid, solid and/or gaseous wastes from some facilities, following certain limits, is bound to getting an approval from CNEN based on the technical analysis of the pertinent environmental factors.

7.2 The elimination of liquid wastes into the sewer should follow the following requirements:

a) the waste must be promptly soluble or easily absorbed by water;
b) the quantity of each radionuclide released **every day** by the facilities into the sewer should not exceed the highest of the following numbers: the quantity diluted in the average daily sewer volume released by the facilities, should result in an average concentration equal to the limits specified in Table 6, Column 1; ten times the limit specified in Table 6, Column 3;
c) the quantity of each radionuclide released **a month**, when diluted by the average monthly volume of sewer released by the facilities, should have a concentration inferior to the limits specified in Table 6, Column 1;
d) the total **annual** quantity of radionuclide, excluding H3 and C14, released in to the sewer, should not exceed 3.7×10^{10} Bq (lCi);
e) the **annual** quantity of H3 and C14, released into the sewer, should not exceed 18.5×10^{10} Bq (5Ci) and 3.7×10^{10} Bq (1Ci), respectively.

7.3 The elimination of **excrement** of patients submitted to radio isotopic therapy should be done according to the specific instructions set by CNEN.

7.4 The elimination of **solid** wastes **into the domestic waste collection system** should have its specific activity limited to 7.5×10^{4} Bq/kg (2 mCi/kg).

7.5 The elimination of **gaseous** wastes into the atmosphere should be done in concentrations inferior to those specified in Table 6 Column 2, and should be previously authorized by CNEN .

8. Transfer

The transfer of wastes from some facilities is exclusively allowed for a place in the Country determined by CNEN, or with its authorization for another country.

The Rule sets the obligation to keep the updated record and inventory of the wastes, and imposed periodic inspections for each licensed enterprise.

9. Records and Inventories

9.1 In **any** facilities, updated records of all wastes should be kept, describing:

a) identification (2.2) of the waste and location of the container in which it is kept;
b) precedence and destination;
c) external and internal transfer;
d) eliminations, particularizing the released daily activities;
e) other safety information.

9.2 Any **modification** or **correction** done in the data contained in the records should be clearly justified and documented.

9.3 The records, as well as the documents related to the corrections, should be **kept in the** facilities.

9.4 **On regular basis**, as per the determinations contained in the operation authorization, the **inventory variations** control of all radioactive material should be sent to **CNEN**, including the wastes, according to the form (Annex C).

10. Inspections and Auditing

10.1 The facilities should facilitate the access of **inspectors of CNEN or its authorized representatives** so inspections and auditing may be carried out.

10.2 CNEN may, at its own discretion, determine the **suspension or cancelling of the operation authorization**, in the cases of the non-fulfillment of requirements of this or other applicable rules.

Annexes mentioned and contained in Rule NE 6.05 -

Annex A - Form for the identification of wastes contained in each container

Annex B – Maximum allowed levels of removable radioactive contamination in the containers.

Annex C – Variation control of the radionuclide inventory

Annex D - Table 6 of the elimination of radioactive wastes. This table presents three frequent use columns:

Column 01 and Column 03 - concentration and/or maximum allowed activity for the elimination of solid wastes into the sewer (subsection 5.7.2).

Column 02 - maximum allowed concentration for the elimination of gaseous wastes into the atmosphere previously authorization by CNEN.

b.3 Management of Radioactive Wastes out of the Generation Source

The responsibility of the generator of radioactive wastes is up to their total and definitive elimination. It is kept during the external transportation units they are received the collecting company, if that one is licensed by CNEN for the purpose defined in the authorization previously granted by this entity to the generator.

The generator should strictly fulfill the rules fit to it – particularly those concerning the correct classification of the waste, its package and identification, and the transport – and demand from the collector the evidence of its current licensing, as well as the reception and destination certification authorized by CNEN for the waste, whether it is a storage, treatment or elimination.

Every transfer to another place should be registered in the origin, as set in **NE 6.05**

Management of Radioactive Wastes in Radioactive Facilities.

The following rules hold special interest:

CNEN **NE 5.01** Transport of radioactive materials

CNEN **NE 6.09** Criteria for the acceptance for the disposal of low and medium radiation level radioactive wastes

And also concepts set in CNEN **NE 6.06** Selection and choice of local for the storage of radioactive wastes -

Initial storage – temporary storage of radioactive wastes in the facilities which have generated them.

Storage of radioactive wastes – facilities meant for the storage of radioactive wastes.

Final storage – area meant for receiving, following the criteria set by CNEN, the radioactive wastes coming from initial storage, intermediate storage, and provisory storage.

Intermediate storage – area meant for receiving and eventually for the stowage of radioactive wastes, with the objective of using them in the future, or removing them for the final storage, following the acceptance criteria and other rules set by CNEN.
Provisory storage – area meant for receiving radioactive waste coming from an area struck by accidents with radioactive materials up to their transfer, in maximum safety conditions, to another storage area.

Deposition – placement of radioactive waste in places approved by the regulating authorities, without the intention of removing them.

The Wastes Management Plan informs the procedures for packaging, identification, provisory and final storage or eventual treatment, and the consequent transport. It is meant to remind ***CNEN NE 6.05*** defines:

5.6 TREATMENT – Any treatment of radioactive wastes is bound to approval by CNEN, according to specific rules for each type of facilities.

5.7 ELIMINATION -

5.7.1 The elimination of liquid, solid and/or gaseous wastes from some facilities, following certain limits, is bound to obtaining approval from CNEN, based on the technical analysis of the pertinent environmental factors.

5.8 TRANSFER – The transfer of wastes from some facilities is exclusively allowed for a place in the Country determined by CNEN or under its authorization for another country.

On the other hand, ***CNEN-NN-6.09*** adds –

4.17 Identification of the Package – The identification of the package should present no mistakes, be visible and permanent, and it should also assure the correspondence with the documents which may have the information about the product.

4.18 Configuration of the Package – The wastes stowage packages should follow a standard and be compatible with the handling, transport and disposal procedures.

5.3 Package – For means of disposal, no package may be used without previous approval by CNEN.

5.3.1 Disposal package project – The project of any package should be submitted to the

approval of CNEN.

5.3.2 Over package –

5.3.2.1 Whenever needed or recommendable, it will be allowed to place a package inside another one, the so celled over package.

5.3.2.2 The empty spaces between packages and over packages should be filled. The filling procedure and the material to be used should be submitted to the previous approval of CNEN.

5.3.2.3 The over packages will be bound to the same requirements demanded for the packages.

5.4 Packed -

5.4.1 Identification – The packages should present no mistake and be accurately identified and marked in a legible and durable way according to the radiologic characteristics, as well as origin. The identification should also include the weight in such a way it may assure the correspondence with the documents containing the information about the waste.

5.4.2 Records of Packages – All packages should have a documentation registering their physical, chemical, radiologic and mechanic characteristics, as well as their origin. Besides those data, the following information should also be provided, as applicable: a) description of the treatment process; b) degradation 0of the matrix; and other ones described in the rule.

c. Final Remarks

The radioactive wastes deserve a clear and defined attention by only one Regulating Authority, working complementarily only, in its specific extents, the other authorities which deal with the environment, work safety, health care, and the manufacturing and agricultural industries.

That Regulating Authority, CNEN, provides the rules and many didactically organized information, free of charge in the internet, as well as training and professional registration assessments, working not only as technicians in their enterprises, but also as spokespeople of CNEN. The demand for licensing and authorization by the central authority for the implantation and operation of facilities and equipment, as well as deactivation, is the most important safety and monitoring instrument of all the implanted facilities.

Organized as such, the Administration of the radioactive materials, including the wastes, may be relatively simple and safe. Failures may happen more than everything due to the *deceitful* factor the small quantity of generated wastes is, which lead to neglecting the rules fulfillment.

Last but not least, is it meant to notice the radioactive deactivation turns a **refused material** into **waste** to be classified according to its chemical, biologic and physical characteristics – not always inert – when they their management and adequate destination will be decided upon.

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3. Present Generation of Industrial Waste

3 Present Generation of Industrial Waste

3.1 Previous Studies

A number of PIM factories have been submitting a waste inventory (WI) to SUFRAMA since 2002. SUFRAMA subsequently has compiled the WI from 2005 to 2008 as shown in the following table.

Table 3-1: Inquiries and Answers for Waste Inventory

Item	2005	2006	2007	2008
Questionnaires Sent	186	223	229	229
No. of Respondents	102	94	126	110
Ratio of Response (%)	54.8	42.2	55.0	48.0
Did not answer	84	129	103	129

Table 3-2: Generation Rate from Responding Factories

Unit: ton/year

Waste Type	2005	2006	2007	2008
Factories that responded	102	94	126	110
1. Non Industrial Waste	4,286.6	5,950.4	6,581.0	5,268.3
2. Various	37,565.6	35,226.4	38,250.9	41,058.4
3. Rubber and sludge	1,847.2	8,742.4	4,292.0	4,852.2
4. Contaminated waste	338.0	291.3	17,195.0	2,935.7
5. Dangerous residues	6,858.5	2,583.5	2,093.8	2,112.9
6. Metallic waste	9,432.7	43,769.1	33,913.3	30,351.8
7. Liquid waste	1,549.0	6,856.5	662.1	5,658.7
Total	61,877.7	103,419.5	102,988.0	92,238.0

The above attempt to analyze the WI received, shown above, did not clarify the overall generation of waste in PIM in terms of characteristics and quantity, nor the actual conditions of management of those wastes.

3.2 Generation Amount

3.2.1 Factories Surveyed

The following table shows the 134 factories that were surveyed in order to create this report. At present, this is 30.5% of the total number of factories (440) operating in PIM/MFZ.

Table 3-3: Detail on Factories Surveyed

Factory code	Industrial District (DI)			Outside DI			Total number of factory	Surveyed number of factories
	Number of Factory			Number of Factory				
	Part	Part	Sub-	Part	Part	Sub-		

	1	2	total	1	2	total	(A)	Number (B)	% (B/A)
F01	3		3	12		12	15	5	33.3
F02									
F03	6		6	3	7	10	16	6	37.5
F04	64	1	65	51	5	56	121	65	53.7
F05	2		2				2	0	0.0
F06	19		19	9		9	28	17	60.7
F07	23	2	25	19	3	22	47	19	40.4
F08		1	1	2	3	5	6	1	16.7
F09	1		1	3	1	4	5	2	40.0
F10	7		7	6		6	13	7	53.8
F11	2		2	1		1	3	0	0.0
F12				4	9	13	13	3	23.1
F13	13	2	15	15	4	19	34	12	35.3
F14	31	2	33	35	7	42	75	24	32.0
F15				1		1	1	0	0.0
F16				2		2	2	0	0.0
F17	15		15	16	2	18	33	19	57.6
F18		1	1	2	3	5	6	0	0.0
F19	7		7	5	8	13	20	7	35.0
Total	193	9	202	186	52	238	440	187	42.5

a. Responses on the Generation Amount of Industrial Waste

Of the 187 factories surveyed, 170 supplied valid answers to their amount of industrial waste generated (17 factories only answered the general items). The following table shows the answers of 170 factories indicating a total of 1,876 wastes. However, of this number, estimations for the amount of Item B: Health-care Waste and Construction Waste were done in separate surveys, and are therefore excluded. Since the effluent is not included in waste categories in this study, it is also excluded. The amount of effluent generated is as follow:

- Generation amount for target factories: 104,588 m^3 per year/ 286.5 m^3 per day
- Generation amount for all PIM factories: 270,698 m3 per year/ 741.6 m3 per day

Here, items indicated "m^3 per year" were converted to 1 ton/m^3.

Table 3-4: Responses for Industrial Waste Generation Amount

Factory Code	A. Number of Wastes by Responding Factories	B. Eliminated Waste Items (Health-care, Construction, Effluent)	C. No. of Wastes used to estimate waste amount	D. Items showing ton/year from Items in C	E. Items showing m3/year
F01	40	1	39	38	1
F02	0	0	0	0	0
F03	54	1	53	50	3
F04	771	34	737	677	60
F05	0	0	0	0	0
F06	173	8	165	154	11

F07	136	2	134	118	16
F08	23	1	22	22	0
F09	2	0	2	2	0
F10	53	7	46	42	4
F11	0	0	0	0	0
F12	13	0	13	12	1
F13	88	1	87	79	8
F14	203	10	193	173	20
F15	0	0	0	0	0
F16	0	0	0	0	0
F17	221	7	214	197	17
F18	0	0	0	0	0
F19	99	3	96	92	4
Total	**1,876**	**75**	1,801	1,656	145

b. Number of Employees

The number of employees among the 170 factories that provided answers to the amount of industrial waste generated are given, along with the total number of employees at all factories in the study area.

Table 3-5: Number of Employees from Responding Factories and All Factories in Study Area

Factory Code	Factory survey		All factories in study area		Rate (C=A/B x 100)
	Number of Factories	Number of Workers (A)	Number of Factories	Number of Workers (B)	
F01	5	2,127	15	2,975	71.5
F02	-	-	0	0	
F03	6	342	16	843	40.6
F04	60	22,269	121	37,765	59.0
F05	-	-	2	348	
F06	17	4,250	28	5,464	77.8
F07	18	3,651	47	6,003	60.8
F08	1	519	6	698	74.4
F09	2	208	5	445	46.7
F10	6	612	13	1,789	34.2
F11	-	-	3	133	
F12	3	253	13	538	47.0
F13	12	335	34	1,355	24.7
F14	18	5,555	75	9,625	57.7
F15	-	-	1	20	
F16	-	-	2	589	
F17	16	32,383	33	43,937	73.7
F18	-	-	6	440	
F19	6	1,458	20	3,225	45.2
Total	**170**	**73,962**	440	116,192	**63.7**

c. Tabulating the Amount of Industrial Wastes Generated

Responses from 170 factories were used to estimate the total generation amount of industrial waste, and divided into 4 major categories of waste, were then tabulated according to the 19 factory codes and different waste codes.

- Industrial waste generated from a Non-Production Process which is Non-Hazardous: Non-PP / Non-HIW Table 3-6
- Industrial waste generated from a Non-Production Process which is Hazardous: Non-PP / HIW Table 3-7
- Industrial waste generated from a Production Process which is Non-Hazardous: PP / Non-HIW Table 3-8
- Industrial waste generated from a Non-Production Process which is Non-Hazardous: PP / HIW Table 3-9

d. Generation Rate

Using the employees as the base, the generation rate (kg/year/employee), as mentioned above in the tabulation of generation amount for industrial waste of 170 factories, was classified into 4 categories, 19 factory codes and individual waste codes to calculate using Table 3-5: Number of Employees.

- The generation rate for non-production process, non-hazardous wastes (Non-PP / Non-HIW). Table 3-10
- The generation rate for non-production process, hazardous wastes (Non-PP / HIW). Table 3-11
- The generation rate for production process, non-hazardous wastes (PP / Non-HIW). Table 3-12
- The generation rate for production process, hazardous wastes (PP / HIW). Table 3-13

As for the generation rate of the factory code, of which rate this survey could not get, the average generation rate for factory code obtained from all factories was applied.

e. Generation Amount

The generation amount of industrial wastes from PIM/MFZ was calculated by multiplying the number of employees from each factory code by the above mentioned generation rate from industrial wastes generated. The resulting estimation of industrial waste generated from PIM/MFZ is as follows. The details are given in Table 3-14.

1.	Non-PP / Non-HIW:	61,479.0 ton/year, or	168.4 ton/day
2.	Non-PP / HIW:	13,970.0 ton/year, or	38.3 ton/day
3.	PP / Non-HIW:	110,751.6 ton/year, or	303.4 ton/day
4.	PP / HIW:	41,085.4 ton/year, or	112.6 ton/day
	Total	**215,925.5 ton/year,**	**591.5 ton/day**

This generation amount does not greatly conflict with the tabulated results from the SUFRAMA waste inventory.

Table 3-6: Tabulation of Responses for Industrial Waste Generation Amount (Non-PP / Non-HIW)

Non-Production Process – Non HIW (Unit : ton/year)														
Factory code	NH01	NH02	NH03	NH04	NH05	NH06	NH07	NH08	NH09	NH10	NH11	NH12	NH!3	Total
F01	82.6	1,039.0	226.0	81.0	7.0				-	921.0	59.0	233.0	222.0	2,870.6
F02														
F03	3.7		4.3	0.9	0.1	0.1			2.2				17.5	28.8
F04	1,570.7	1,192.3	3,648.6	581.2	3.6	17.5			337.1	83.4	28.7	67.7	3,390.9	10,921.7
F05														
F06	187.1	556.5	832.6	131.8	166.0				23.0	0.8	12.0		458.4	2,368.2
F07	224.1	44.0	769.0	201.2		0.7			243.6	820.6			417.3	2,720.5
F08		57.9	2.6	9.9	4.5					0.4			20.2	95.5
F09														
F10	1,128.1	227.7	60.1	44.2		0.3			5,412.3				153.9	7,026.6
F11														
F12			0.1										-	0.1
F13	18.0		5.7	5.3					0.1	-		0.6	14.9	44.6
F14	101.4	254.4	593.8	24.4		3.3			96.7	3.0		39.0	501.1	1,617.1
F15														
F16														
F17	1,605.4	23.5	428.8	406.1	2.0	0.3	0.1			0.1	29.4		1,952.3	4,448.0
F18														
F19	27.0		55.9	140.2	38.0	2.0							102.4	365.5
Total	4,948.1	3,395.3	6,627.5	1,626.2	221.2	24.2	0.1	-	6,115.0	1,829.3	129.1	340.3	7,250.9	32,507.2

Table 3-7: Tabulation of Responses for Industrial Waste Generation Amount (Non-PP / HIW)

Non-Production Process – HIW (Unit : ton/year)																	
Factory code	HW01	HW02	HW03	HW04	HW05	HW06	HW07	HW08	HW09	HW10	HW11	HW12	HW13	HW14	HW15	HW16	Total
F01			0.1						3.5		13.0				90.6	1.3	108.5
F02																	
F03	0.0						0.1		0.2					2.8		0.2	3.2
F04				0.8			37.2		25.7		736.0				794.8	6.7	1,601.1
F05																	
F06							0.2		0.2		953.6			2.0	12.1	2.5	970.5
F07							0.3		108.8		64.0		199.0	68.0		7.9	447.9
F08																0.9	0.9
F09																	
F10									13.8		16.0				12.1	0.9	42.9
F11																	
F12																	
F13					0.0		0.1		0.1						0.1	0.0	0.3
F14							12.0		1,898.1	0.0	2,024.1			61.1	157.8	514.8	4,667.8
F15																	
F16																	
F17									405.3		32.0			2.0	5.1	0.7	445.2
F18																	
F19									0.0						1.0	0.2	1.3
Total	0.0		0.1	0.8	0.0		49.8		2,455.6	0.0	3,838.7		199.0	135.9	1,073.6	536.0	8,289.6

Table 3-8: Tabulation of Responses for Industrial Waste Generation Amount (PP / Non-HIW)

Production Process – Non HIW (Unit : ton/year)														
Factory code	NH01	NH02	NH03	NH04	NH05	NH06	NH07	NH08	NH09	NH10	NH11	NH12	NH!3	Total
F01	102.8			190.9				117.0	33.0				947.0	1,390.6
F02														
F03			479.3	0.0		0.6			98.0					577.9
F04		720.0	9,631.5	3,489.1	0.4				2,022.8	1,210.0		9.5	878.3	17,961.6
F05														
F06		91.0	522.7	219.7					4,826.2	7.0			1,556.2	7,222.8
F07		440.3	385.8	230.5					9,783.4	0.3	34.0		2.2	10,876.5
F08													436.7	436.7
F09				15.0										15.0
F10		7.2	2,493.8	16.8					2.9				543.4	3,064.2
F11														
F12	2.0	12.2	57.6	67.3					3,328.0				106.6	3,573.6
F13		30.9	27.3	99.8	0.1			27.0	66.3	0.0			109.2	360.6
F14		81.7	712.3	4,119.5	2.1				22.2	0.2		0.3	272.6	5,210.9
F15														
F16														
F17	6.0	1,552.7	3,437.2	1,605.5	18.0		0.5		6,328.8	1.0	327.0	0.5	845.8	14,123.0
F18														
F19		238.1	102.8	57.6	6.0		39.0		130.4				135.3	709.2
Total	110.8	3,174.0	17,850.4	10,111.7	26.6	0.6	39.5	144.0	26,642.0	1,218.6	361.0	10.3	5,833.1	65,522.4

Table 3-9: Tabulation of Responses for Industrial Waste Generation Amount (PP /HIW)

Production Process – HIW (Unit : ton/year)																	
Factory code	HW01	HW02	HW03	HW04	HW05	HW06	HW07	HW08	HW09	HW10	HW11	HW12	HW13	HW14	HW15	HW16	Total
F01							2.0		43.0								45.0
F02																	0.0
F03	0.0		0.0	3.2			2,056.7		2.1					1,052.7	198.3		3,313.1
F04	1.9		3.6	280.1			166.5	40.1	109.8	0.1				25.0	356.2	181.8	1,165.3
F05																	0.0
F06							70.6	3.6	548.4		31.0			123.1	89.5	60.1	926.2
F07							9.1		38.6		15.2		33.0	289.1	371.6	70.0	826.6
F08									1.6								1.6
F09								51.0									51.0
F10							67.0				131.3			65.0	11.0		274.3
F11																	0.0
F12			1.8											59.2			61.0
F13							10.9		1.2	2.3					19.0		33.4
F14					26.2		210.9	49.9	31.6		3.0	0.5		85.1	134.6	47.0	588.7
F15																	0.0
F16																	0.0
F17	56.0			392.0	20.0		1,551.3	78.0	1,447.3		388.0	56.0		6,805.3	574.1	341.2	11,709.2
F18																	0.0
F19							28.3		9.1	0.5	50.0			12.9	207.4	0.1	308.2
Total	58.0		5.5	675.4	46.2		4,173.3	222.5	2,232.7	2.9	618.5	56.5	33.0	8,517.5	1,961.5	700.2	19,303.5

Table 3-10: Generation Rate (Non-PP / Non-HIW)

Generation rate (Non-Production Process – Non HIW) (Unit: kg/year/person)														
Factory code	NH01	NH02	NH03	NH04	NH05	NH06	NH07	NH08	NH09	NH10	NH11	NH12	NH13	Total
F01	38.8	488.5	106.3	38.1	3.3				0.0	433.0	27.7	109.5	104.4	1,349.6
F02	---	---	---	---	---	---	---	---	---	---	---	---	---	---
F03	10.8		12.6	2.6	0.3	0.3			6.4				51.2	84.2
F04	70.5	53.5	163.8	26.1	0.2	0.8			15.1	3.7	1.3	3.0	152.3	490.3
F05*1	66.9	45.9	89.6	22.0	3.0	0.3	0.0		82.7	24.7	1.7	4.6	98.0	439.4
F06	44.0	130.9	195.9	31.0	39.1				5.4	0.2	2.8		107.9	557.2
F07	61.4	12.1	210.6	55.1					66.7	224.8			114.3	745.0
F08	0.0	111.6	5.0	19.1	8.7					0.8			38.9	184.1
F09*1	66.9	45.9	89.6	22.0	3.0	0.3	0.0		82.7	24.7	1.7	4.6	98.0	439.4
F10	1,843.3	372.1	98.2	72.2		0.5			8,843.6				251.5	11,481.4
F11*1	66.9	45.9	89.6	22.0	3.0	0.3	0.0		82.7	24.7	1.7	4.6	98.0	439.4
F12*1			0.4										0.0	0.4
F13	53.7		17.0	15.8					0.3	0.0		1.8	44.5	133.1
F14	18.3	45.8	106.9	4.4		0.6			17.4	0.5		7.0	90.2	291.1
F15*1	66.9	45.9	89.6	22.0	3.0	0.3	0.0		82.7	24.7	1.7	4.6	98.0	439.4
F16*1	66.9	45.9	89.6	22.0	3.0	0.3	0.0		82.7	24.7	1.7	4.6	98.0	439.4
F17	49.6	0.7	13.2	12.5	0.1	0.0	0.0			0.0	0.9		60.3	137.3
F18*1	66.9	45.9	89.6	22.0	3.0	0.3	0.0		82.7	24.7	1.7	4.6	98.0	439.4
F19	18.5		38.3	96.2	26.1	1.4							70.2	250.7
Avg rate: 170 factories	66.9	45.9	89.6	22.0	3.0	0.3	0.0		82.7	24.7	1.7	4.6	98.0	439.4

Note: *1: There are few factories with this factory code, so it was not possible in this study to obtain the generation rate for the amount generated from the Non-PP / Non-HIW category of waste in this table. Therefore, generation rate of these factory codes are calculated by dividing A (total generation amount of each 13 category of waste) by B (number of employees of 127 factories which gave the answers). Also, some items show 0.0 even though there were generation amounts reported, but the generation rate was so small that it is shown as 0.0.

Table 3-11: Generation Rate (Non-PP / HIW)

Non-Production Process – HIW (Unit : ton/year)																	
Factory code	HW01	HW02	HW03	HW04	HW05	HW06	HW07	HW08	HW09	HW10	HW11	HW12	HW13	HW14	HW15	HW16	Total
F01			-						0.5		6.1				11.8	0.6	19.0
F02																	
F03							-		-					5.8		0.6	6.4
F04	-			-			1.7		2.6		37.4			2.6	41.8	0.6	86.7
F05	-			-	-		0.7		33.2	-	51.9		2.7	1.8	14.5	7.2	112.0
F06							-		-		224.4			0.5	2.8	0.6	228.3
F07							0.1		30.5		17.5		54.5	18.6	17.9	2.2	141.3
F08																1.7	1.7
F09	-	-		-	-	-	0.7	-	33.2	-	51.9	-	2.7	1.8	14.5	7.2	112.0
F10									22.5		26.1				19.8	1.5	69.9
F11	-	-	-	-	-	-	0.7	-	33.2	-	51.9	-	2.7	1.8	14.5	7.2	112.0
F12	-	-	-	-	-	-	0.7	-	33.2	-	51.9	-	2.7	1.8	14.5	7.2	112.0
F13					-		0.3		0.3						0.3	-	0.9
F14							2.2		336.0	-	347.1			0.7	3.7	91.6	781.3
F15	-	-	-	-	-	-	0.7	-	33.2	-	51.9	-	2.7	1.8	14.5	7.2	112.0
F16	-	-	-	-	-	-	0.7	-	33.2	-	51.9	-	2.7	1.8	14.5	7.2	112.0
F17									12.5		1.0			0.1	0.2		13.8
F18	-	-	-	-	-	-	0.7	-	33.2	-	51.9	-	2.7	1.8	14.5	7.2	112.0
F19									-						0.7	0.1	0.8
Total	-	-	-	-	-	-	0.7	-	33.2	-	51.9	-	2.7	1.8	14.5	7.2	112.0

Table 3-12: Generation Rate (PP / Non-HIW)

Generation rate (Production Process – Non HIW) (Unit: kg/year/person)														
Factory code	NH01	NH02	NH03	NH04	NH05	NH06	NH07	NH08	NH09	NH10	NH11	NH12	NH13	Total
F01	-			41.3				55.0	15.5				-	111.8
F02														
F03			1,399.7	-		-			286.5					1,686.2
F04		32.3	458.1	235.3	-	-			90.9	54.3		0.4	39.5	910.8
F05*1	1.5	42.9	241.3	136.7	0.4	-	0.5	1.9	360.2	16.5	4.9	0.1	78.9	885.8
F06		21.4	123.0	51.7					1,135.6	1.6			366.2	1,699.5
F07	28.2	120.6	105.7	65.9					2,399.3	0.1	-		260.0	2,979.8
F08	-	-	-	-					-				841.4	841.4
F09*1				72.1										72.1
F10		11.8	4,074.8	27.5					4.7				887.9	5,006.7
F11*1	1.5	42.9	241.3	136.7	0.4	-	0.5	1.9	360.2	16.5	4.9	0.1	78.9	885.8
F12*1	7.9	48.2	227.7	266.0					13,154.2				421.3	14,125.3
F13		92.2	94.3	297.9	0.3			80.6	197.9	-			326.0	1,089.2
F14		14.7	24.7	372.8	0.4				3.3	-		0.1	49.0	465.0
F15*1	1.5	42.9	241.3	136.7	0.4	-	0.5	1.9	360.2	16.5	4.9	0.1	78.9	885.8
F16*1	1.5	42.9	241.3	136.7	0.4	-	0.5	1.9	360.2	16.5	4.9	0.1	78.9	885.8
F17	0.2	47.9	106.1	52.4	0.6		-		227.0	-	11.1	-	26.1	471.4
F18*1	1.5	42.9	241.3	136.7	0.4	-	0.5	1.9	360.2	16.5	4.9	0.1	78.9	885.8
F19		163.3	71.4	243.1	4.1		26.7		90.9				92.8	692.3
Avg rate: 170 factories	1.5	42.9	241.3	136.7	0.4	-	0.5	1.9	360.2	16.5	4.9	0.1	78.9	885.8

Note: *1: There are few factories with this factory code, so it was not possible in this study to obtain the generation rate for the amount generated from the Non-PP / Non-HIW category of waste in this table. Therefore, generation rate of these factory codes are calculated by dividing A (total generation amount of each 13 category of waste) by B (number of employees of 170 factories which gave the answers). Also, some items show 0.0 even though there were generation amounts reported, but the generation rate was so small that it is shown as 0.0.

Table 3-13: Generation Rate (PP /HIW)

Non-Production Process – HIW (Unit : ton/year)																	
Factory code	HW01	HW02	HW03	HW04	HW05	HW06	HW07	HW08	HW09	HW10	HW11	HW12	HW13	HW14	HW15	HW16	Total
F01							0.9		20.2								21.1
F02																	
F03				9.4			299.1		6.1					4.7	579.8		899.1
F04	0.1		0.2	12.6			97.0	1.8	5.2	-				50.2	18.2	10.2	195.5
F05	0.8		0.1	9.1	0.6		56.4	3.0	30.2	-	8.4	0.8	0.4	115.2	26.5	10.9	262.4
F06							16.6	0.8	129.0		7.3			29.0	21.1	39.1	242.9
F07							2.5		3.8		4.2		-	76.0	101.8	19.2	207.5
F08									3.1								3.1
F09								245.2									245.2
F10							109.5				214.5			106.2	18.0		448.2
F11	0.8		0.1	9.1	0.6		56.4	3.0	30.2	-	8.4	0.8	0.4	115.2	26.5	10.9	262.4
F12			7.1											234.0			241.1
F13							32.8		3.6	6.9					56.7	-	100.0
F14					4.7		30.8	9.0	4.5	-	0.5	0.1	-	7.9	13.6	0.4	71.5
F15	0.8		0.1	9.1	0.6		56.4	3.0	30.2	-	8.4	0.8	0.4	115.2	26.5	10.9	262.4
F16	0.8		0.1	9.1	0.6		56.4	3.0	30.2	-	8.4	0.8	0.4	115.2	26.5	10.9	262.4
F17	1.7			12.1	0.6		47.9	2.4	45.5		12.0	1.7	1.0	210.5	17.7	10.5	363.6
F18	0.8		0.1	9.1	0.6		56.4	3.0	30.2	-	8.4	0.8	0.4	115.2	26.5	10.9	262.4
F19							19.3		6.2	0.3	34.3			8.8	149.7		218.6
Total	0.8		0.1	9.1	0.6		56.4	3.0	30.2	-	8.4	0.8	0.4	115.2	26.5	10.9	262.4

Table 3-14: Amount of Industrial Waste Generated from PIM/MFZ

Unit: ton/year

Factory Code	Non production process		Production process		Total
	Non-HIW	HIW	Non-HIW	HIW	
F01	4,015.0	56.5	332.6	62.8	4,466.9
F02	-	-	-	-	-
F03	71.1	5.4	1,421.4	757.9	2,255.8
F04	18,516.2	3,274.3	34,396.2	7,383.1	63,569.8
F05	153.0	38.9	308.2	91.2	591.3
F06	3,044.5	1,247.4	9,286.0	1,327.3	14,905.2
F07	4,472.2	848.4	17,887.8	1,245.6	24,454.0
F08	128.6	1.2	587.3	2.2	719.3
F09	195.5	49.9	32.1	109.1	386.6
F10	20,540.3	125.1	8,957.0	801.8	30,424.2
F11	58.3	14.9	118.0	34.8	226.0
F12	0.2	60.4	7,599.5	129.7	7,789.8
F13	180.3	1.2	1,475.9	135.4	1,792.8
F14	2,801.9	7,506.9	4,475.7	688.2	15,472.7
F15	8.8	2.2	17.6	5.2	33.8
F16	258.8	66.0	521.8	154.7	1,001.3
F17	6,032.6	606.3	20,712.0	15,975.3	43,326.2
F18	193.2	49.3	389.8	115.6	747.9
F19	808.5	2.6	2,232.7	705.0	3,748.8
Total	61,479.0	13,956.9	110,751.6	29,724.9	215,912.4
ton/day	168.4	38.3	303.4	81.4	591.5

f. Flow of Industrial Waste Management

The waste streams for seven types of industrial waste are given below for:

1. All industrial wastes generated from PIM — Figure 3-1
2. Non-HIW generated from PIM — Figure 3-2
3. HIW generated from PIM — Figure 3-3
4. Non-Production Process, Non-Hazardous Industrial Waste: — Figure 3-4
5. Non-Production Process, Hazardous Industrial Waste: — Figure 3-5
6. Production Process, Non-Hazardous Industrial Waste: — Figure 3-6
7. Production Process, Hazardous Industrial Waste: — Figure 3-7

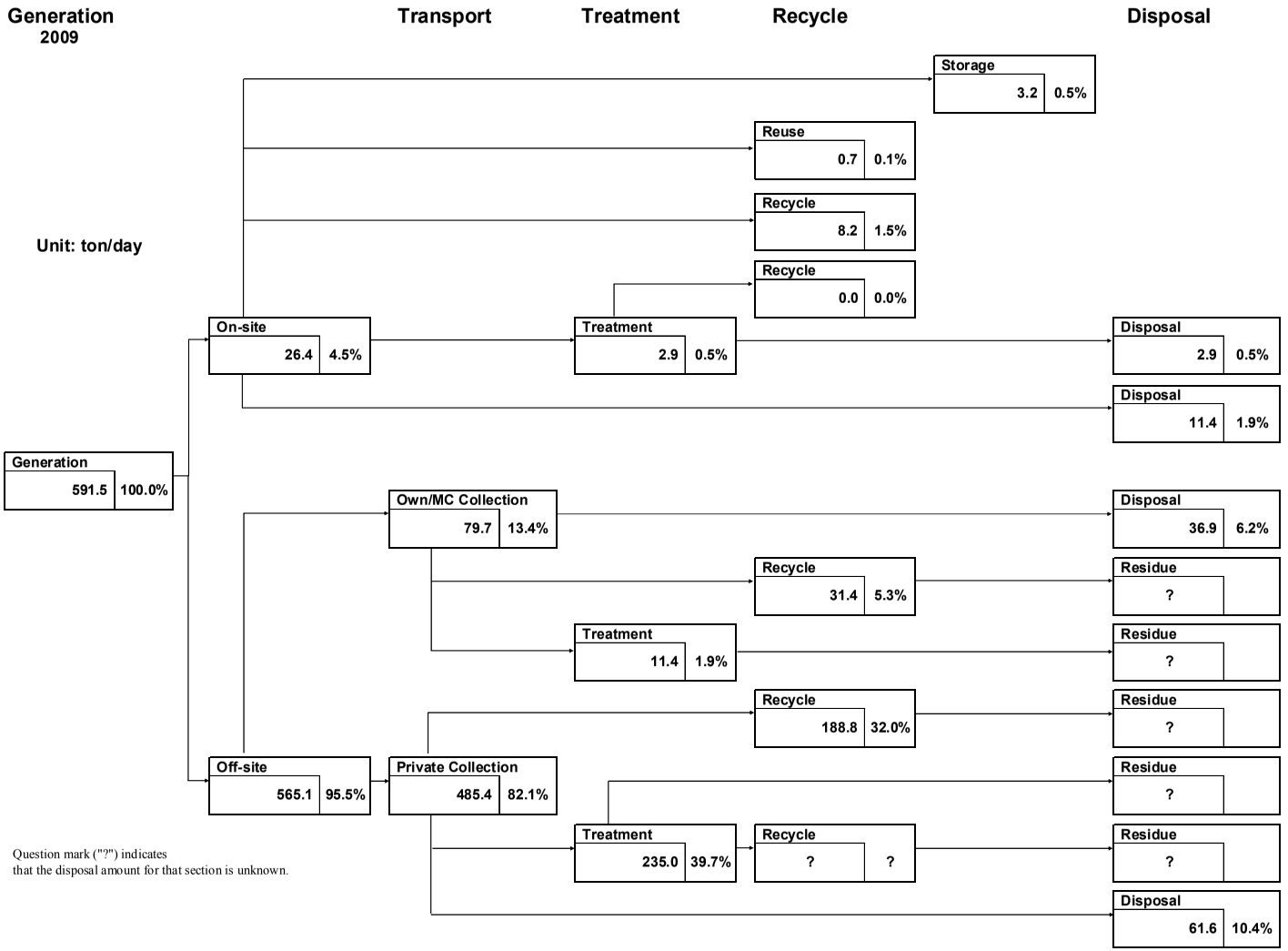


Figure 3-1: Waste Stream for all General industrial wastes generated from PIM

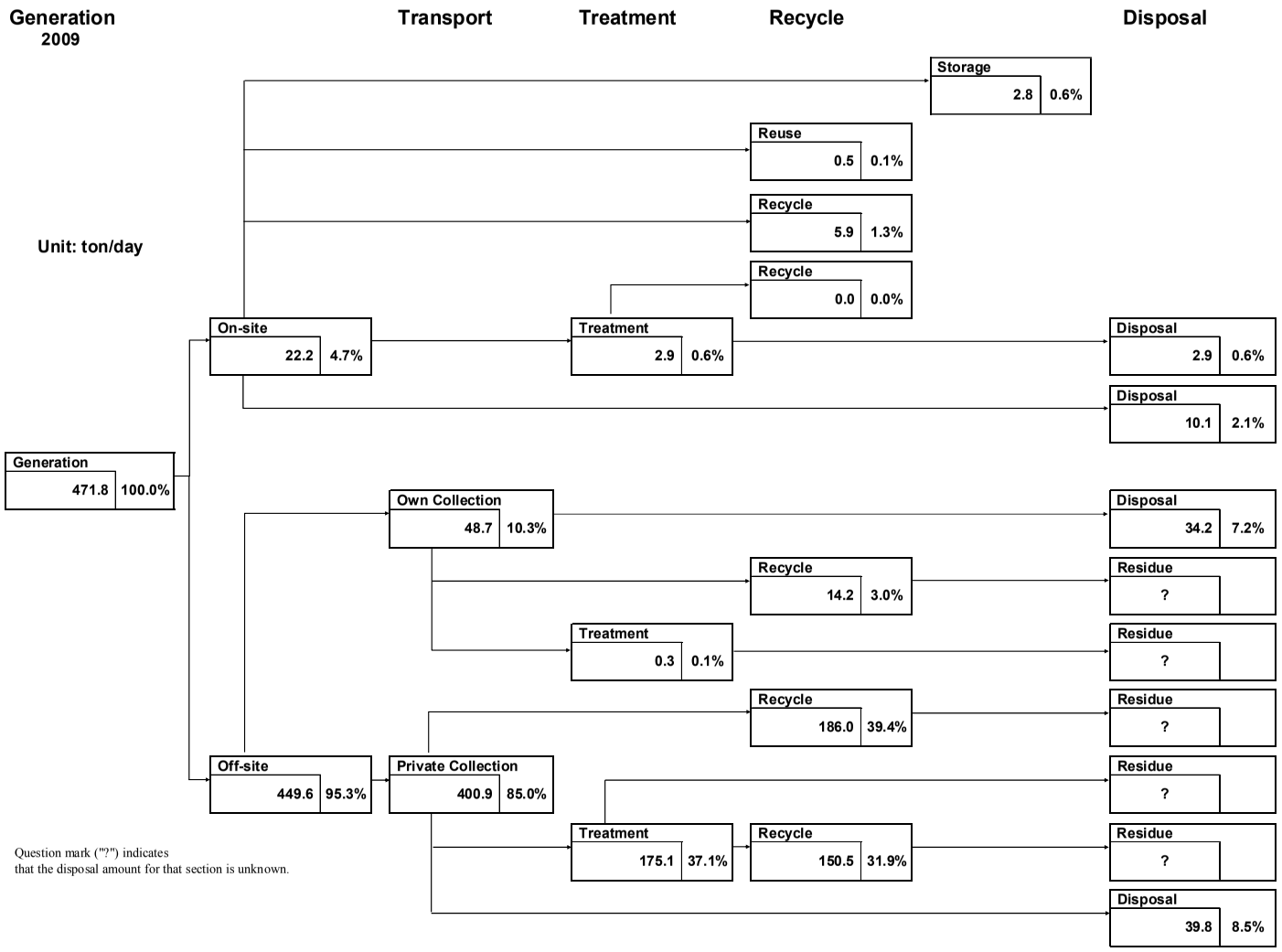


Figure 3-2: Waste Stream for General Non-HIW generated from PIM

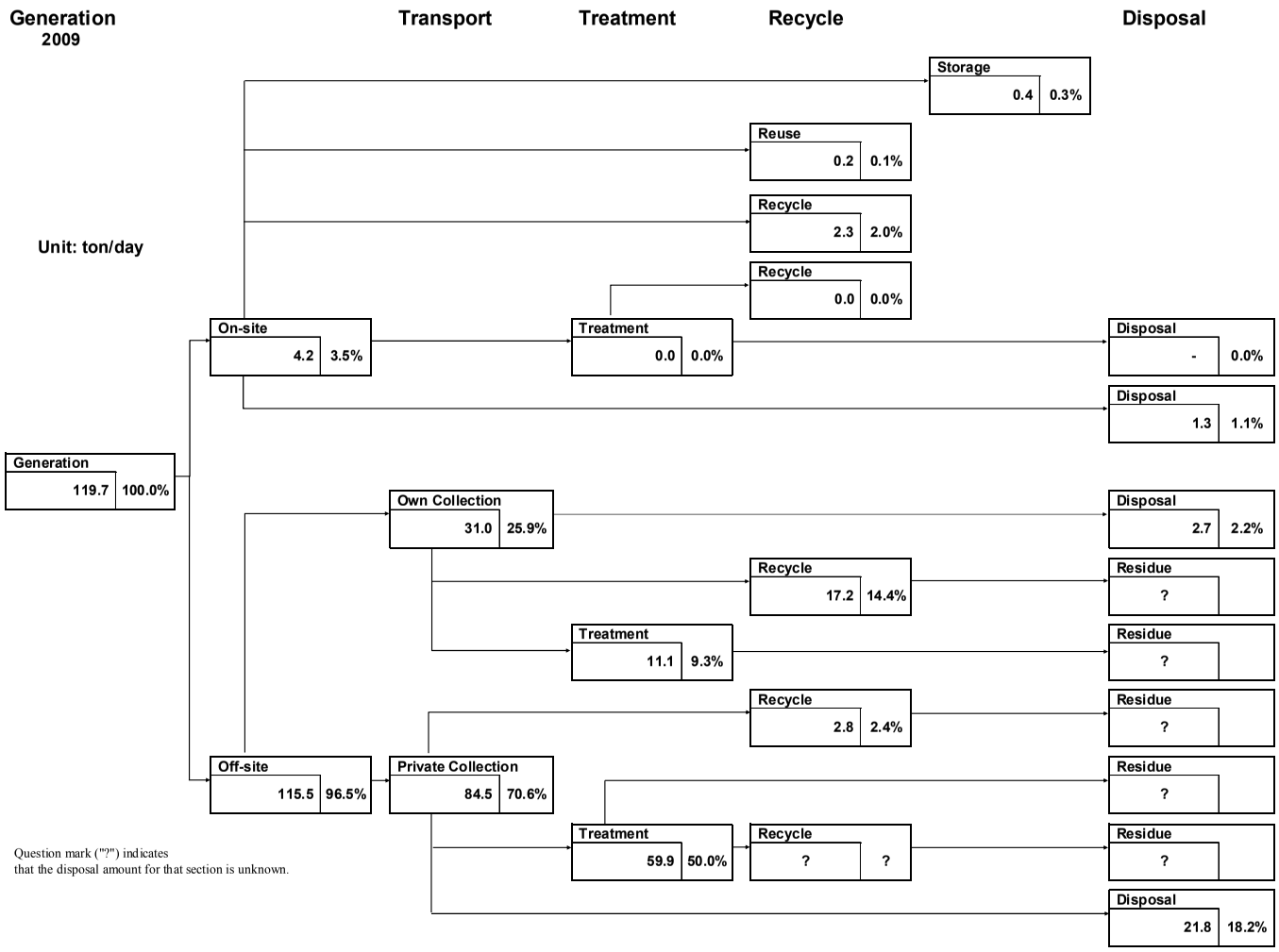


Figure 3-3: Waste Stream for General HIW generated from PIM

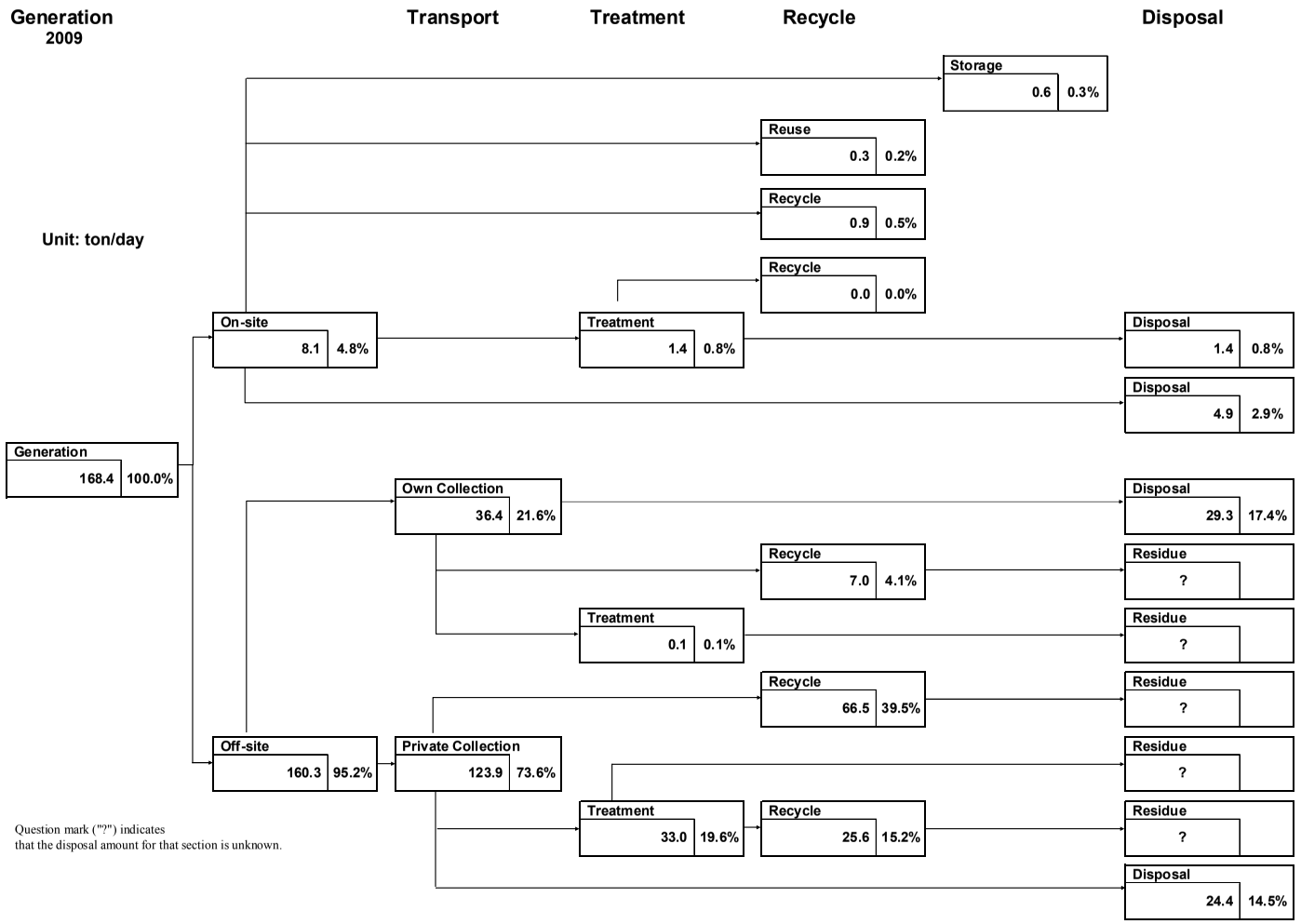


Figure 3-4: General industrial Waste Stream (Non production process – Non HIW)

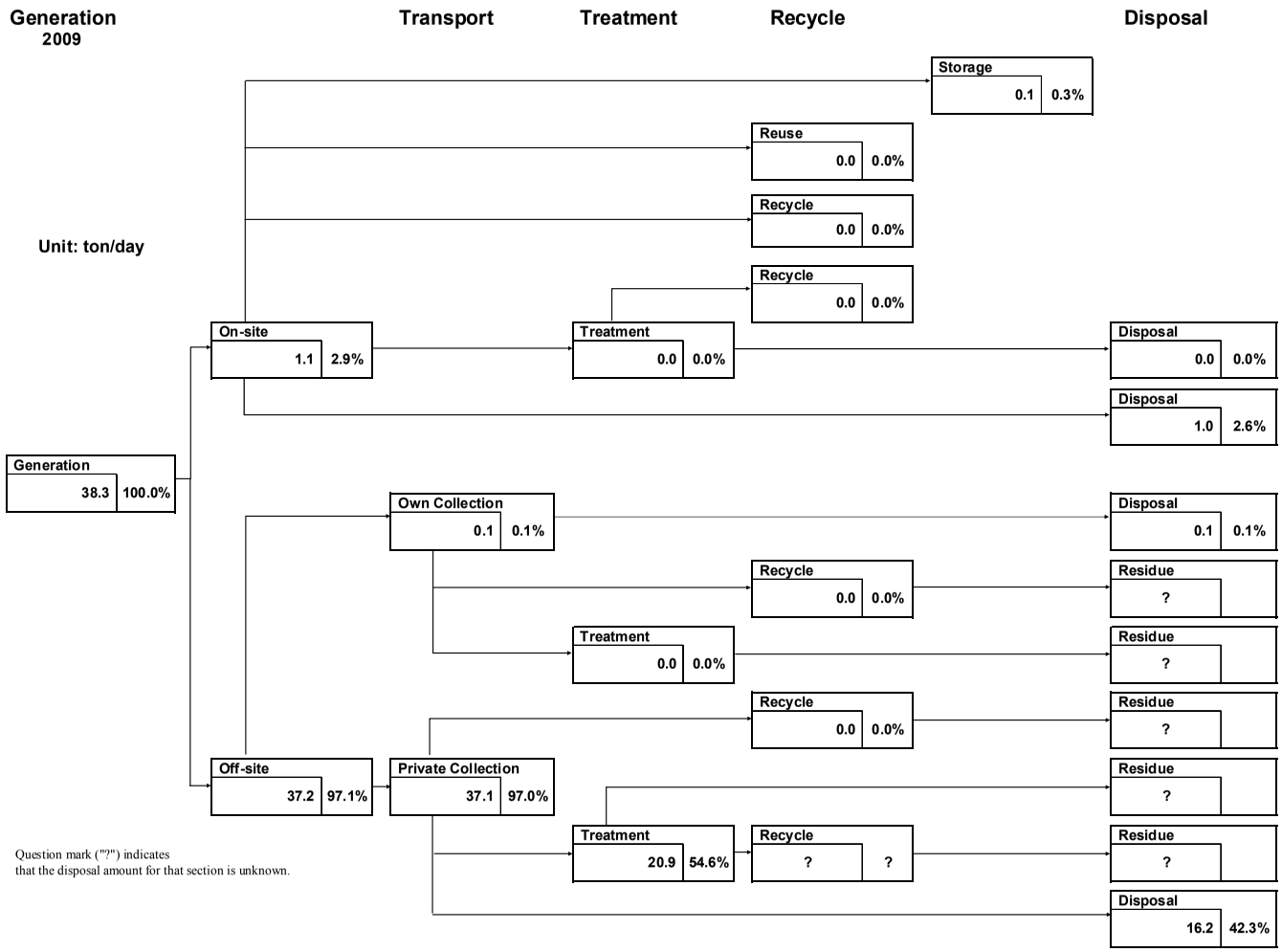


Figure 3-5: General Industrial Waste Stream (Non production process – HIW)

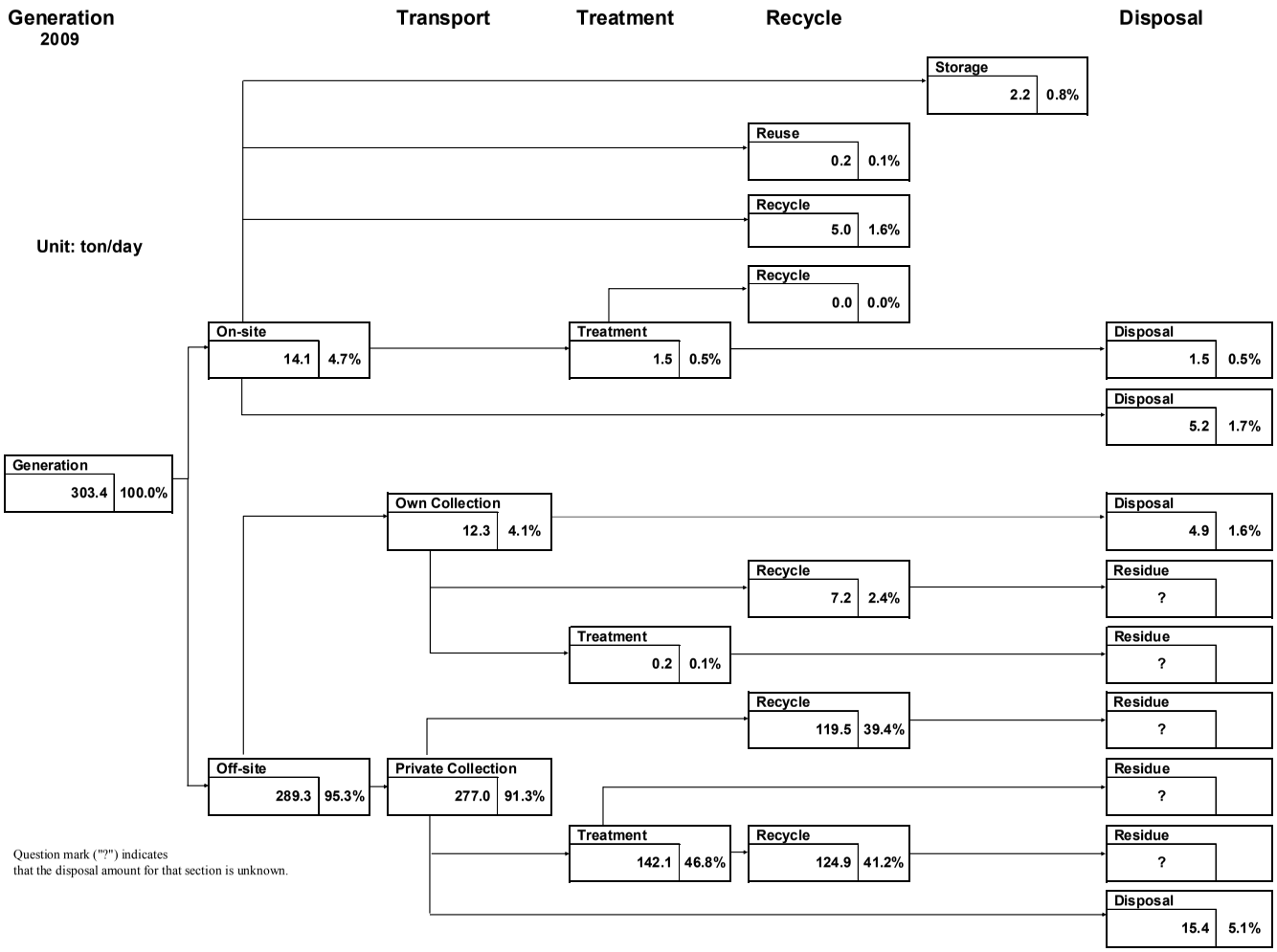


Figure 3-6: General Industrial Waste Stream (Production process – Non HIW)

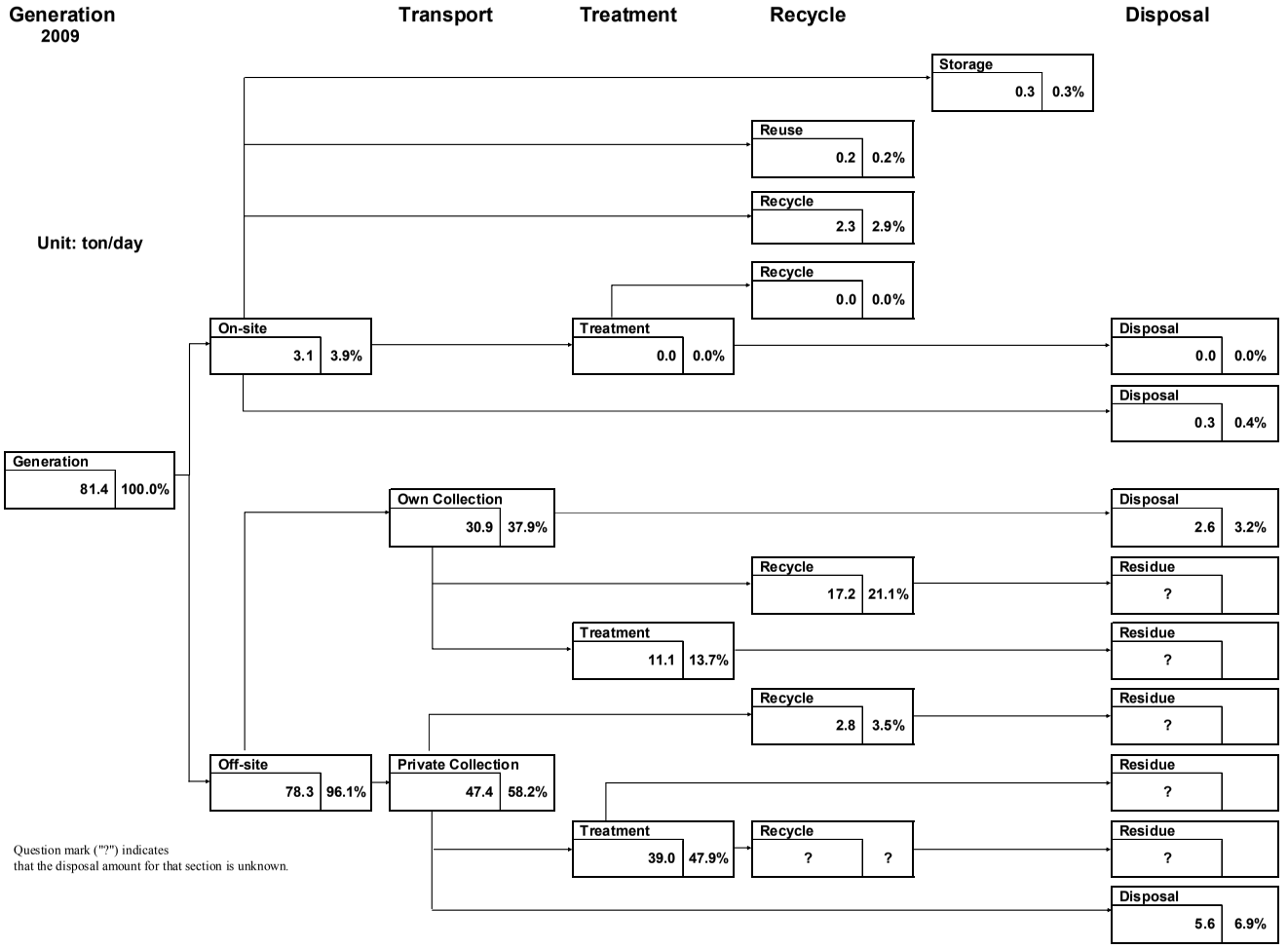


Figure 3-7: General Industrial Waste Stream (Production process – HIW)

3.2.2 Present Generation Amount of Health-care Waste

a. Medical Institutions in the Target Area

There are 475 factories in the factory list provided by SUFRAMA, and of those, 18 factories are located outside the target area, the MFZ. A total of 457 PIM factories in the MFZ area were contacted to confirm whether they had an attached clinic. The following results were found according to their responses.

- Factories that responded by telephone: 334
- Factories that have closed: 17
- Factories that refused to reply: 25
- Factories that could not be reached by telephone: 81

In this survey, it was revealed that 440 factories are PIM factories operating in the MFZ, including those which could not be reached by telephone (which was likely due to a changed phone number, etc.) and excluding the 17 which have closed.

It was found that at least 1/3 of the total (35.3%), or 124 factories, have an attached clinic. Of those 124, nine within the PIM were chosen for direct interview using the prepared survey questionnaire. A summary of these medical facilities, including one general hospital in the PIM, is given below.

Table 3-15: Summary of Medical Facilities

Type	No. Surveyed	No. of Employees*1	No. of Beds	Avg No. of Inpatients/Day	Avg No. of Outpatients/Day
General Hospital	1	439	70	48	900 (*3)
Attached factory clinic	9	4.1 (*2)	1.2 (*2)	No reply	19 *2

Notes: *1: Including part-time employees
*2: Average of 9 clinics
*3: Of this number, 22 were emergency room outpatients

b. Generation Amount of Health-care Waste

The generation amount of health-care waste for the 10 medical institutions is given below.

Table 3-16: Amount of Health-care Waste Generated by Target Medical Institutions

Unit: kg/day

Category of Health-care Waste	General Hospital	Clinics(*1)
Group A	**22.76**	**0.52**
A.1. Biologic	6.01	0.16
A.2. Animals	---	---
A.3 Body part	8.11	0.10
A.4 Patient care etc.	8.64	0.26
A.5 Prions	---	---
Group B: Chemical etc.	**1.67**	**0.27**
Group C: Radioactive	**---**	**---**

Group E: Piercing or Cutting	**3.40**	**0.44**
Total of Group A, B, C and E (Hazardous Waste)	**27.83**	**1.22**
Group D: Common waste	**94.00**	**1.17(*2)**
Total	**121.83**	**2.40**

Note: *1: Average number for 9 clinics

*2: This number is less than the amount of hazardous health-care waste generated. The reason being that it is discharged as non-process, non-hazardous waste from another place within the factory, and the clinic does not that this discharge into consideration. One clinic did not respond.

Based on the survey results given above, it is estimated that the following health-care waste is generated from PIM.

Table 3-17: Amount of Health-care Waste Generated

Category	Whole Factories in PIM (B x 440 /334) (kg/day)	General Hospital (kg/day)	Whole PIM (E = C + D) (kg/day)
Group A	84.8	22.7	107.5
Group B	44.0	1.7	45.7
Group C	0.0	0.0	0.00
Group E	71.7	3.4	75.1
Hazardous Health-care Waste Total	200.5	27.8	228.3
Class D	190.7	94.0	284.7
Health-care Waste Total	391.2	121.8	513.0

Health-care waste generation from factories in PIM excluding a general hospital is as follows:

- Hazardous Health-care waste: 200.5 kg/day
- Non-hazardous Health-care waste: 190.7 kg/day
- Total Health-care waste: 391.2 kg/day

Given the above information, the daily generation amount from the target area (PIM), including the one general hospital, of hazardous and non-hazardous health-care waste is estimated as follows:

- Hazardous Health-care waste: 228.3 kg/day
- Non-hazardous Health-care waste: 284.7 kg/day
- Total Health-care waste: 513.0 kg/day

c. Present Health-care Waste Management Flow

The present health-care waste management flow in PIM, according to the survey of medical institutions, is shown in the following figure.

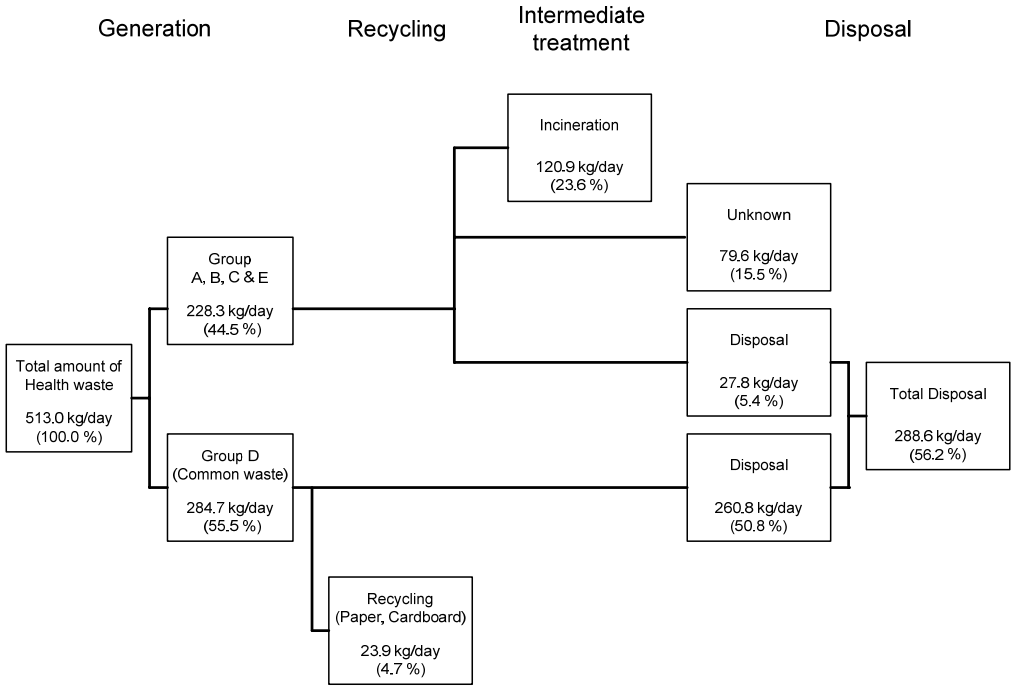


Figure 3-8: Health-care Waste Management Flow in PIM including General Hospital

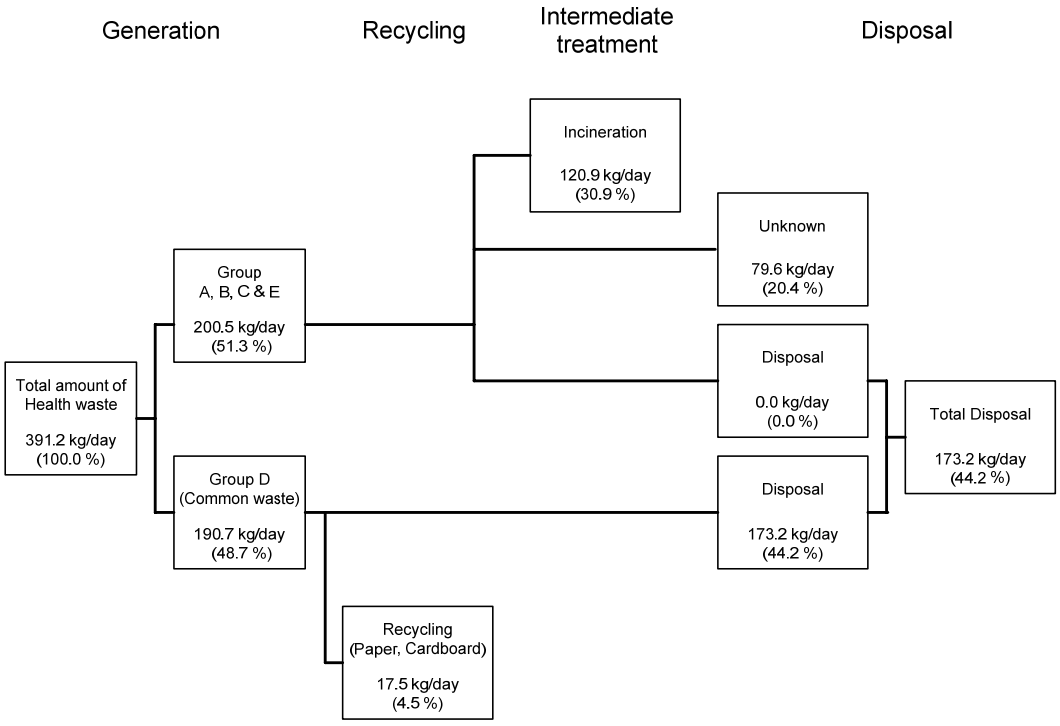


Figure 3-9: Health-care Waste Management Flow in PIM excluding General Hospital

3.2.3 Present Generation Amount of Construction Waste

a. Target Factories

The 457 factories located in the MFZ in the factory list provided by SUFRAMA, were contacted to confirm whether they had conducted any construction projects in the past year, from June 2008 to May 2009. The following results were found according to their responses.

- Factories that responded by telephone: 334
- Factories that have closed: 17
- Factories that refused to reply: 25
- Factories that could not be reached by telephone: 81

In this survey, it was revealed that 440 factories are PIM factories operating in the MFZ, including those which could not be reached by telephone (which was likely due to a changed phone number, etc.) and excluding the 17 which have closed.

It was found that, of the 334 factories, 123 factories, over one-third (36.8%), have conducted construction projects between June 2008 and May 2009. Ten of the 123 factories were chosen at random for direct interview using the prepared survey questionnaire. A summary of these factory construction projects is given below.

Table 3-18: Summary of Construction Projects

Type of Construction Project	No. of Respondents	Ratio (%)
1. New construction	2	20.0
2. Additional construction	0	0.0
3. Demolition	0	0.0
4. Renovation	6	60.0
5. Others *1	2	20.0
Total	10	100.0

Note: *1: In detail,
1. Installation of a waste water treatment facility (WWTF)
2. Construction of a retaining wall and drainage of the rain water.

b. Generation Amount of Construction Waste

In the year from June 2008 to May 2009, the amount of construction waste generated from construction projects at the 10 factories came to a total of 832.7 tons, as shown in column A in the following table. Moreover, the amount generated per day is shown in column B (B = A/365).

Table 3-19: Generation Amount of Construction Waste from Survey of 10 Factories

Waste No	Description of Waste	Total Number of Answer	**A.** Generation Amount (kg)	**B.** Generation Amount (kg/day)	Classification & Generation of Waste by CONAMA Resolution 307 (kg/day)			
					Class A	Class B	Class C	Class D
01	Excavated soil	5	32,985	90.4	90.4			
02	Concrete debris	7	53,830	147.5	147.5			
03	Asphalt debris	1	62,500	171.2	171.2			
04	Brick debris	5	3,015	8.3	8.3			
06	Tile and ceramic	1	10	0.0	0.0			
11	Plastic/vinyl sheet	1	430	1.2		1.2		
12	Iron-bar, steel materials	5	250	0.7	0.4	0.3		
13	Small metal waste	5	571	1.6	0.1	1.5		
17	Plaster boards	1	20	0.1	0.1			
20	Wood debris	3	1,335	3.7	2.8	0.8		
21	Timber form	1	200	0.6		0.6		
22	Scaffolding material	1	1,230	3.4		3.4		

23	Interior timber	3	1,150	3.2	2.9	0.3		
24	Packing (cardboard)	4	960	2.6	0.3	2.3		
29	Machine oil	1	74	0.2	0.2			
33	Ash	2	165	0.5	0.5			
44	Mixed construction waste*1	2	674,000	1,846.6	1,846.6			
	Total	48	832,725	2,281.4	2,271.2	10.3	0.0	0.0

Note: *1) Large-scale construction projects were confirmed at two factories which took place over the course of 6 months and 1 year produced a large amount of construction waste.

Based on the above survey results, the amount of construction waste generated from the PIM/MFZ was calculated. First, the generation rate (GR), which is the average amount of construction waste generated from 10 factories over the course of one year, from June 2008 to May 2009, was calculated. Referring to the above table, this can also be calculated: GR = B/10. Next, the total number of factories (TNF), which is the total number of factories that carried out construction projects in PIM/MFZ during the one year from June 2008 to May 2009. Here, TNF = 440 x 123/334. The total generation amount (TGA) of construction waste in PIM/MFZ is calculated: TGA = GR x TNF. The result of these calculations is as shown in the following table.

Table 3-20: Construction Waste Generation Amount

Unit: ton/day

Waste No	Description of Waste	GR (kg/day)	TGA (ton/day)	Portion (%)
1	Excavated soil	9.04	1.46	4.0
2	Concrete debris	14.75	2.39	6.5
3	Asphalt debris	17.12	2.77	7.5
4	Brick debris	0.83	0.13	0.4
6	Tile and ceramic	0.003	0.00	0.0
11	Plastic/vinyl sheet	0.12	0.02	0.1
12	Iron-bar, steel materials	0.07	0.01	0.0
13	Small metal waste	0.16	0.03	0.1
17	Plaster boards	0.01	0.00	0.0
20	Wood debris	0.37	0.06	0.2
21	Timber form	0.06	0.01	0.0
22	Scaffolding material	0.34	0.06	0.1
23	Interior timber	0.32	0.05	0.1
24	Packing (cardboard)	0.26	0.04	0.1
29	Machine oil	0.02	0.00	0.0
33	Ash	0.05	0.01	0.0
44	Mixed construction waste	184.66	29.92	80.9
	Total	228.18	36.96	100.0

From the above, it was estimated that the daily generation amount of construction waste in the target area (PIM/MFZ) is 37.0 ton/day. The categorization according to CONAMA Resolution 307 for construction waste which is generated is as follows. Note that there was no hazardous construction waste confirmed in this study.

- Class A (reusable or recyclable as aggregate): 36.8 ton/day

- Class B (recyclable as material other than aggregate): 0.2 ton/day
- Class C (not economically feasible for recycling): 0.0 ton/day
- Class D (hazardous): 0.0 ton/day

c. Present Construction Waste Management Flow

Based on the results of the construction waste survey, the flow of construction waste management in PIM was calculated as shown in the following figure.

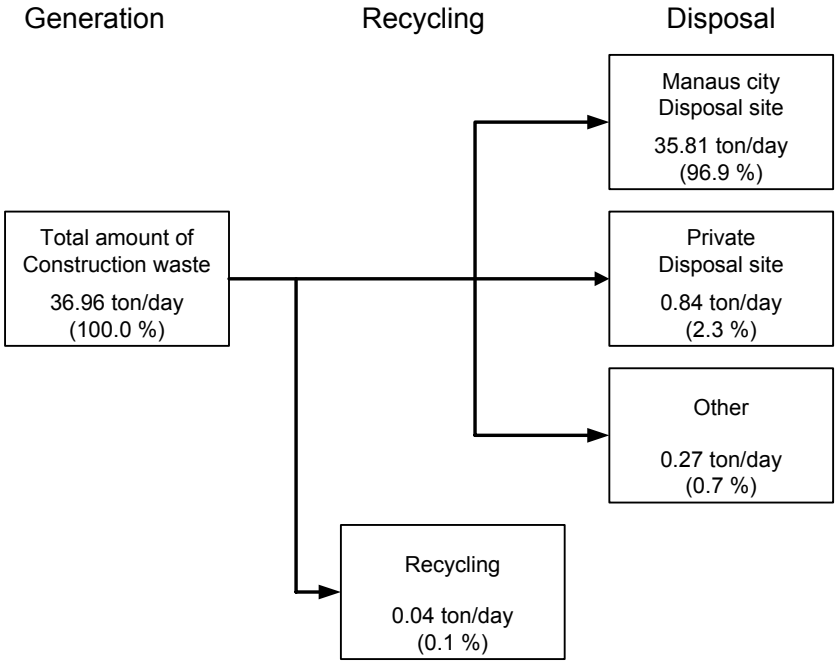


Figure 3-10: Flow of Construction Waste Disposal

4. IWM Master Plan

4 IWM Master Plan

4.1 Future Socio-Economic Framework

4.1.1 Population

IBGE (Brazilian Institute of Geography and Statistics) conducted a long-term population projection between 1980 and 2050 and revised the projected results periodically. Here, the latest revised population projection of IBGE in 2004 is applied for projection of the population in the city of Manaus. According to the latest population data in IBGE, the population in Manaus is 1,738,641 in 2009. Based on this latest population data, the future growth of population in Manaus is projected as follows:

Table 4-1: Population Projection in Manaus (2009-2030)

Unit: thousand

Year	2009	2010	2015	2020	2025	2030
Population (Brazil)	194,370	196,834	208,468	219,078	228,874	237,738
Population (Manaus)	1,739	1,761	1,865	1,960	2,047	2,127

The average annual population growth in the city of Manaus is estimated as 1.09% per year between 2009 and 2020 while it is 0.96% per year between 2009 and 2030.

4.1.2 Economy

According to the latest economic outlook available in the Central Bank of Brazil, the recent trend of GDP growth of Brazil and Manaus is as shown in the table below.

Table 4-2: Recent GDP growth in Brazil and Manaus

Year	2003	2004	2005	2006	2007	2008
Brazil GDP (billion Real)	2,376	2,512	2,591	2,694	2,858	3,005
Real Growth Rate (%)	1.1	5.7	3.2	4.0	6.1	5.1
Manaus GRDP (billion Real)	28.85	32.96	33.30	36.29	NA	NA
Real Growth Rate (%)	NA	14.2	1.0	9.0	NA	NA

According to the announcement of the Finance Minister of Brazil, the real growth rate of GDP in Brazil is estimated as 1.22% in 2009 while it is expected to increase up to 5.8% in 2010. Based on the past trend of economic growth in Brazil, the Study estimated the future economic growth with linear regressions model up until the year 2030. The result of estimation is shown in the next table.

Table 4-3: Estimated Economic Growth of Brazil

Year	2008	2010	2015	2020	2025	2030
Brazil GDP (billion Real)	3,005	3,218	3,794	4,386	4,978	5,570
Growth Rate (%/year)	-	3.5	3.3	2.9	2.6	2.3

On the other hand, the regional GDP of Manaus is only available between 2004 and 2006, by applying the linear regression model, the future economic growth of Manaus is estimated as shown in the table below.

Table 4-4: Estimated Economic Growth of Manaus

Year	2006	2010	2015	2020	2025	2030
Manaus GRDP (billion Real)	36.29	44.17	52.50	60.82	69.15	77.47
Growth Rate (%/year)	-	5.0	3.5	3.0	2.6	2.3

4.1.3 Industry

The framework of future industry growth is the basis of estimating the future industrial waste generation in PIM. The amount of industrial waste generation has the strongest correlation to industrial production although it is not linear considering the improvement of productivity in respective industries.

To estimate the future industrial growth in PIM, the Study utilizes the data of industrial output by types of industry during 2004-2008 available in SUFRAMA, as shown in the table below.

Table 4-5: Trend of Industrial Production Value during 2004-2008

Unit: million $US

Factory Code	Sector	2004	2005	2006	2007	2008
F01	Beverage	152	163	210	84	100
F16	Garment & Footwear	5	12	17	12	21
F03	Printing	35	32	34	36	39
F04	Electrical/Electronics	4,967	6,748	7,840	8,029	8,993
F05	Lumber	21	23	21	25	23
F06	Machinery (Mechanical)	333	475	524	654	788
F07	Metals	393	678	1,068	1,505	2,090
F08	Non-Ferrous Metals	35	51	68	94	151
F09	Furniture	10	15	18	20	27
F10	Paper & Packaging	87	132	158	172	188
F11	Rubber	1.4	1.0	0.5	0.2	1.7
F12	Food Product	59	65	69	52	63
F13	Chemical	1,253	1,584	2,016	2,640	2,987
F14	Plastics	729	1,101	1,279	1,422	1,669
F15	Textiles	5	6	7	7	8

F17	Transportation Equipment	2,353	3,153	4,185	5,948	7,668
F19	Others	3,752	4,676	5,236	4,995	5,359
Total		14,190	18,915	22,750	25,695	30,176

Source: SUFRAMA

With the past industrial output data above, the future industrial growth in Manaus Free Zone is estimated in accordance with the following steps:

STEP 1: Conversion of the industrial output into real output value at 2004 price in Real

The industrial output value during 2004-2008 is converted into real output value at 2004 price in Brazilian Real using deflators and the average currency exchange rate in respective years, as shown in the table below.

Table 4-6: Trend of Industrial Output Value during 2004-2008 at 2004 Price

Unit: million Real

Factory Code	Sector	2004	2005	2006	2007	2008
F01	Beverage	445	370	429	160	178
F16	Garment & Footwear	15	27	35	22	38
F03	Printing	104	72	70	68	70
F04	Electrical/Electronics	14,536	15,270	15,988	15,213	15,974
F05	Lumber	62	53	44	47	41
F06	Machinery (Mechanical)	976	1,075	1,069	1,240	1,399
F07	Metals	1,150	1,535	2,177	2,851	3,712
F08	Non-Ferrous Metals	103	116	139	178	269
F09	Furniture	31	34	37	38	48
F10	Paper & Packaging	255	299	322	327	333
F11	Rubber	4.0	2.3	1.0	0.4	3.0
F12	Food Product	172	146	141	98	111
F13	Chemical	3,667	3,584	4,111	5,001	5,305
F14	Plastics	2,134	2,492	2,607	2,695	3,138
F15	Textiles	15	13	14	13	14
F17	Transportation Equipment	6,886	7,135	8,534	11,270	13,620
F19	Others	10,972	10,578	10,675	9,465	9,347
Total		41,527	42,801	46,393	48,686	53,600

STEP 2: Estimation of the future industrial growth by approximate function analysis for each type of industries

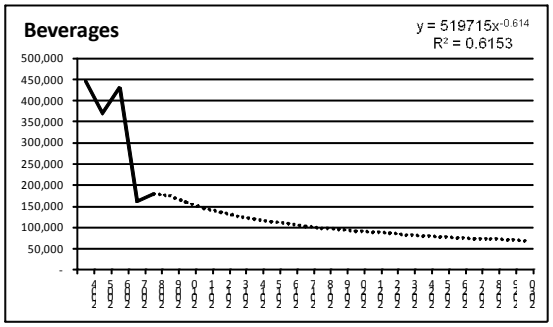
Based on the approximate function analysis of the past trend of industrial growth for each type of industries, the Study estimated the future industrial growth as shown in the table below up until the year 2030.

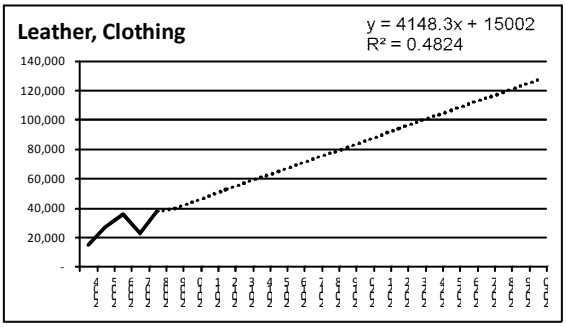
Table 4-7: Estimation of the Future Industrial Growth (2008-2030)

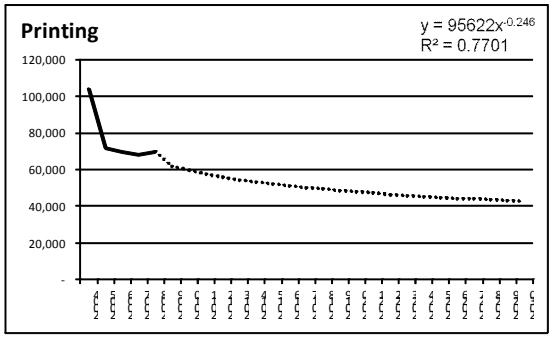
Unit: million Real

Factory Code	Sector	2008	2010	2015	2020	2025	2030
F01	Beverage	178	157	113	91	78	69
F16	Garment & Footwear	38	44	65	86	106	127
F03	Printing	70	59	52	48	45	43
F04	Electrical/Electronics	15,974	16,524	17,934	19,344	20,754	22,164
F05	Lumber	41	38	34	31	29	28
F06	Machinery (Mechanical)	1,399	1,556	2,062	2,568	3,074	3,580
F07	Metals	3,712	4,860	8,079	11,299	14,518	17,738
F08	Non-Ferrous Metals	269	318	515	712	908	1,105
F09	Furniture	48	53	72	92	111	131
F10	Paper & Packaging	333	381	473	565	658	750
F11	Rubber	3.0	0.8	0.5	0.4	0.3	0.3
F12	Food Product	111	96	81	73	67	63
F13	Chemical	5,305	6,211	8,558	10,905	13,251	15,598
F14	Plastics	3,138	3,325	4,257	5,190	6,123	7,055
F15	Textiles	14	13	11	10	8	6
F17	Transportation Equipment	13,620	16,531	25,334	34,136	42,939	51,742
F19	Others	9,347	8,636	6,625	4,612	2,603	590
Total		53,600	58,803	74,265	89,762	105,272	120,789

The Study has to keep in mind that the above estimation of the future industrial growth is made as a so-called 'Business as Usual' scenario in accordance with the statistical analysis of the past trend with the assumption that the past trend will be reflected to the future industrial growth. If SUFRAMA has some plans on future industrial location and/or development of Manaus Free Zone, it should be reflected to improve this estimation. The results of future industrial growth estimation for each type of industries are shown in the figures shown in the following pages.






Printing
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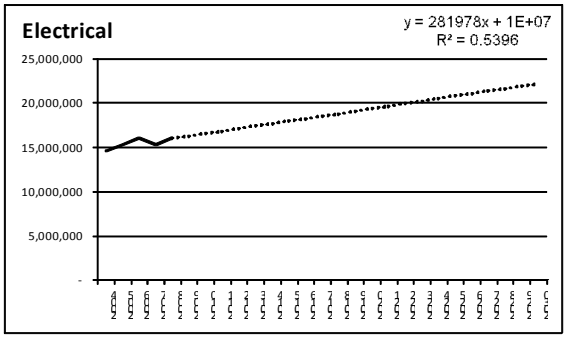
R² = 0.7701


Electrical
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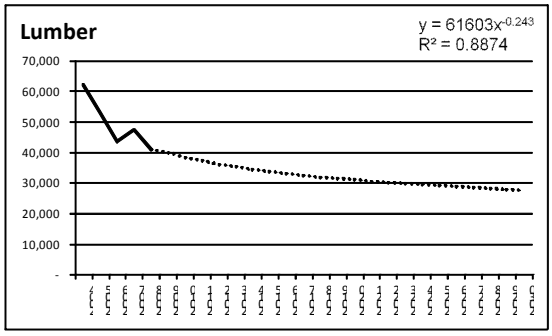
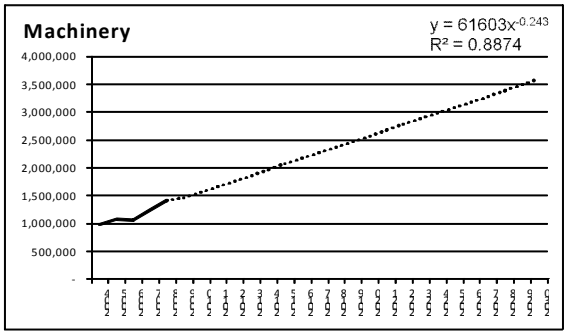
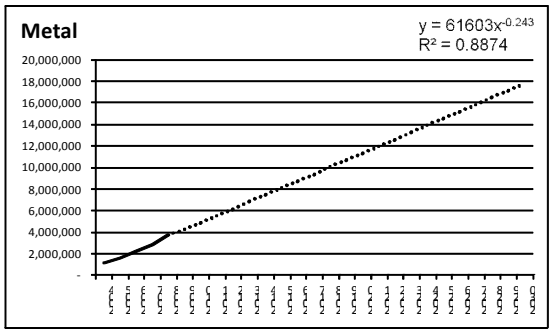
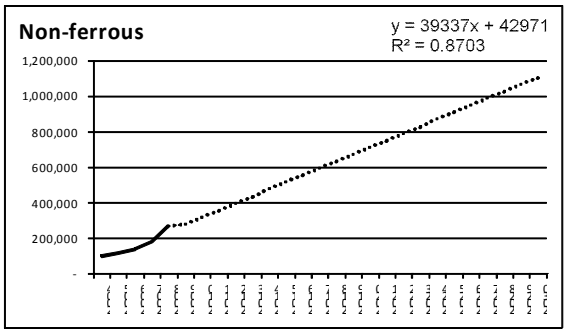
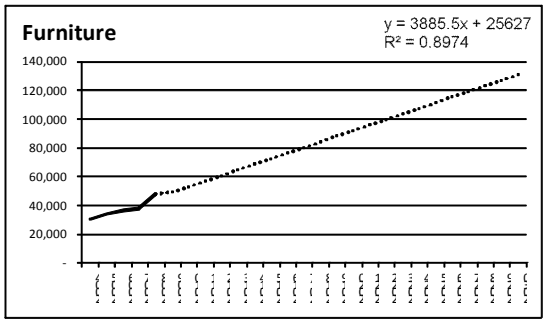
R² = 0.5396

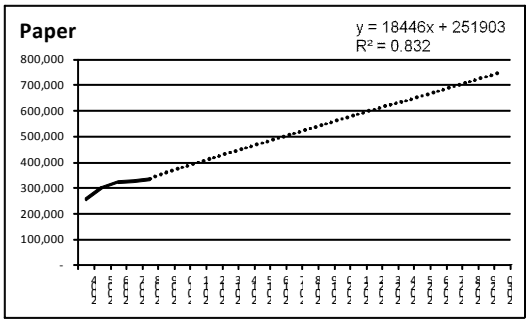

Lumber
y = 61603x-0.243
R² = 0.8874

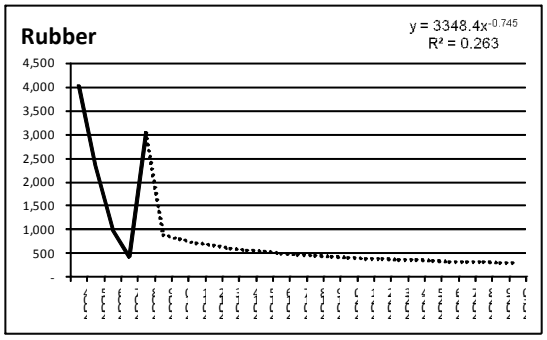

Machinery
y = 61603x-0.243
R² = 0.8874

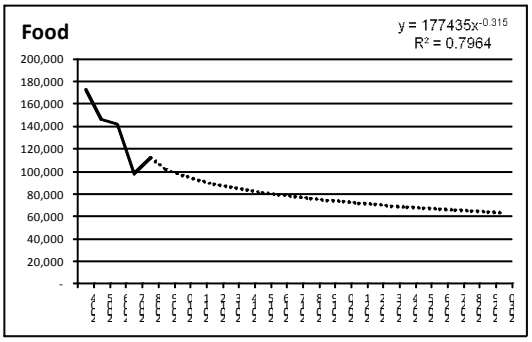

Metal
y = 61603x-0.243
R² = 0.8874


Non-ferrous
y = 39337x + 42971
R² = 0.8703


Furniture
y = 3885.5x + 25627
R² = 0.8974


Paper
y = 18446x + 251903
R² = 0.832


Rubber
y = 3348.4x-0.745
R² = 0.263


Food
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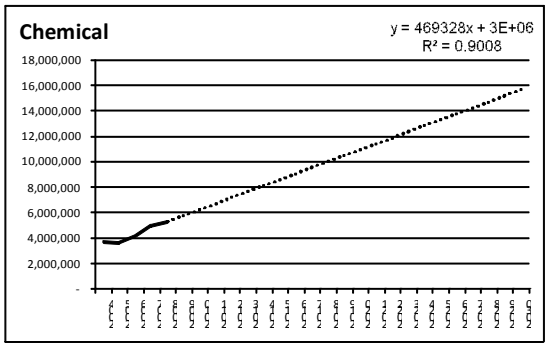
R² = 0.7964


Chemical
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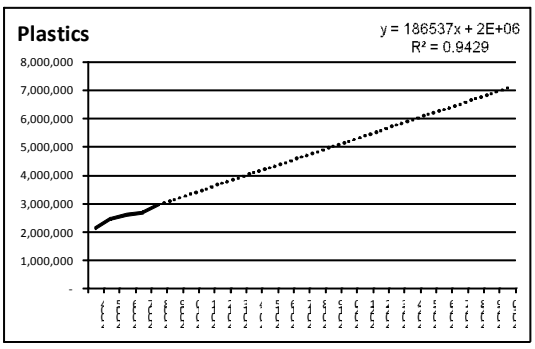
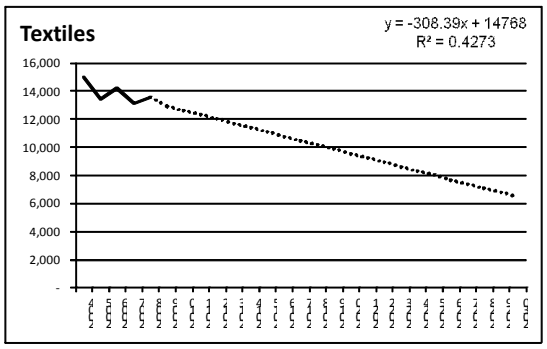
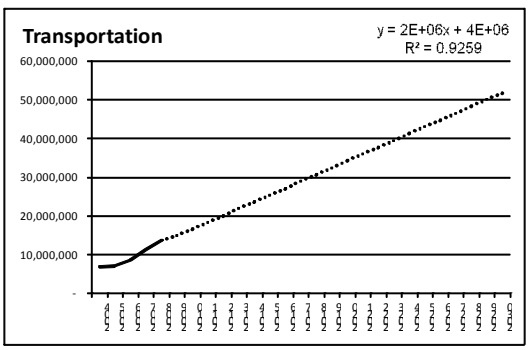
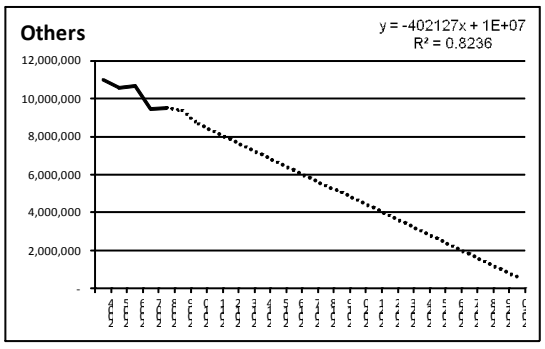
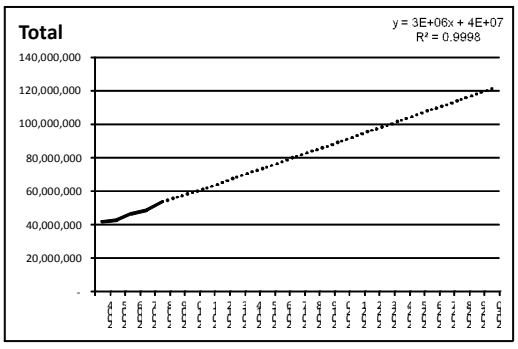
R² = 0.9008


Plastics
y = 186537x + 2E+06
R² = 0.9429


Textiles
y = -308.39x + 14768
R² = 0.4273


Transportation
y = 2E+06x + 4E+06
R² = 0.9259


Others
y = -402127x + 1E+07
R² = 0.8236


Total
y = 3E+06x + 4E+07
R² = 0.9998

4.2 Projection of Future IW Generation

4.2.1 Scope of Projection

a. Target Industry Types

In this report, the following 19 industry classifications used by SUFRAMA for PIM factories were used as the targets for the future estimate of IW generation[1]

Table 4-8: SUFRAMA's Factory Classification

Factory Code	Description of subsector
F01	Beverage (soft drink, alcoholic) and vinegars
F02	Leathers, skins and similar
F03	Printing and graphical company
F04	Electric, electronic and communication materials
	4.1 Components
	4.2 Products (except copy machines)
	4.3 Copy machines and similes
F05	Wood
F06	Mechanical
	6.1 Watch
	6.2 Other mechanical industries
F07	Metallurgy
F08	Non metallic minerals
F09	Furniture
F10	Paper, cardboard, cellulose
F11	Rubber
F12	Food products
F13	Chemical
F14	Plastic material products
F15	Textile
F16	Clothing, fabric and travel goods
F17	Transport material
	17.1 Two wheel
	17.2 Naval
	17.3 Other transport material industry
F18	Construction
F19	Others
	19.1 Optical
	19.2 Toys
	19.3 Devices, equipment, and fotogr. accessories
	19.4 Pens and disposable razors
	19.5 Other several industries

b. Targeted Industrial Waste

The industrial wastes targeted for generation estimates are those required by CONAMA Resolution 313 to be included in a waste inventory. For this report, the following three main categories were used to estimate generation amount.

- General Industrial Waste

[1] Industries (companies) established and producing in western Amazon with full projects approved by SUFRAMA (CGPRI & CGMER/COCAD SUFRAMA , up to 8/2008)

- Health Waste
- Construction Waste

c. Estimation Period for Generation Amount

The estimation period for the generation amount will be until the Master Plan target year 2015.

4.2.2 Methodology of Estimating Future IW Generation

a. Formula used to Estimate the Generation Amount

Estimation of future IW generation amount was made based on the following equation.

$$IWG = \sum_{i=1}^{n} \sum_{j=1}^{m} (Mi \cdot Gij)$$

Basically, the future IW generation amount is calculated using **the generation rate (G)** from each generation source, multiplied by **the number of basic units (M)** from each generation source. The number of basic units (M) can be the production amount, production value, etcetera, but in this study, number of employees was used for reasons given below.

The following table shows how each item of the above formula was established in terms of the previously mentioned 3 types of industrial waste.

Table 4-9: Explanation of Items of Estimation Formula for Future IW Generation Amount

Formula Items	General IW	Health Waste	Construction Waste
IWG	Generation Amount of General IW (ton/year)	Generation Amount of Health Waste (ton/year)	Generation Amount of Construction Waste (ton/year)
i	Factory type	Only one generation rate (GR) is used for all PIM factory	Only one generation rate (GR) is used for all PIM factory
j	Type of general IW	Type of health waste	Type of construction waste
M	Number of employees	Number of employees	Number of employees
G	Waste generation rate (ton/year/person)	Waste generation rate (ton/year/person)	Waste generation rate (ton/year/person)
n	Factory type number (19 types)	Factory type number (only one type)	Factory type number (only one type)
m	Waste type number (29 types)	Waste type number (5 types)	Waste type number (4 types)

b. Setting the Waste Generation Rate (GR)

The waste generation rate (GR) is given for each type of waste for all three types of industrial waste[1]. The GR used is ton per year per person (ton/year/person). The GR was established based on data that the study team gathered when carrying out three surveys: factories, medical institutions, and construction waste. Here, to estimate waste generation amount, it is assumed that until 2015 there is no change in the GR. The table below shows the industry type and generation amount of each type for general industrial waste.

b.1 General Industrial Waste

The tables below show the industry type and generation rate (GR) of each type for general industrial waste. However, Table 5-10 shows the Non-Hazardous and Hazardous industrial waste (Non-HIW and HIW, respectively) according to Non-Production and Production Process in each industry type, whereas Table 5-11 shows the waste generated from Non-Production and Production Process according to Non-HIW and HIW in each industry type. Namely, this is a selection of the generation rates found in the study; the GR of 29 waste types were calculated for each of the 19 types of industry, but the detailed results are given in the Databook.

Table 4-10: Generation Rate for General Industrial Waste by Industry Type

Unit : kg/person/year

Factory Code	Non-Production Process		Production Process	
	Non-HIW	HIW	Non-HIW	HIW
F01	1,349.6	19.0	111.8	21.1
F02*1	---	---	---	---
F03	84.2	6.4	1,686.2	899.1
F04		86.7	910.8	195.5
F05*2				
F06	557.2	228.3	1,699.5	242.9
F07	745.0	141.3	2,979.8	207.5
F08	184.1	1.7	841.4	3.1
F09			72.1	245.2
F10	11,481.4	69.9	5,006.7	448.2
F11*2				
F12	0.4		14,125.3	241.1
F13	133.1	0.9	1,089.2	100.0
F14	291.1	781.3	465.0	71.5
F15*2				
F16*2				
F17	137.3	13.8	471.4	363.6
F18*2				
F19	250.7	0.8	692.3	218.6
All Category	439.4	112.0	885.8	262.4

Note : *1: No factory corresponded to category F02 on the SUFRAMA factory list.
*2 : Listed on the SURAMA factory list and requested for the factory survey, but none of factory of this category was surveyed in this study.

[1] Given for 19 factory types for general IW.

Table 4-11: Generation Rate of General Industrial Waste by Waste Type

Unit : kg/person/year

Waste Code	Non- HIW		Waste Category	HIW	
	Non Process	Process		Non Process	Process
NH01	66.9	1.5	HW01	0.0	0.8
NH02	45.9	42.9	HW02	---*1	---*1
NH03	89.6	241.3	HW03	0.0	0.1
NH04	22.0	136.7	HW04	0.0	9.1
NH05	3.0	0.4	HW05	0.0	0.6
NH06	0.3	0.0	HW06	---*1	---*1
NH07	0.0	0.5	HW07	0.7	56.4
NH08	---*1	1.9	HW08	---*1	3.0
NH09	82.7	360.2	HW09	33.2	30.2
NH10	24.7	16.5	HW10	0.0	0.0
NH11	1.7	4.9	HW11	51.9	8.4
NH12	4.6	0.1	HW12	---*1	0.8
NH13	98.0	78.9	HW13	2.7	0.4
All Category	439.4	885.8	HW14	1.8	115.2
			HW15	14.5	26.5
			HW16	7.2	10.9
			All Category	112.0	262.4

Note: *1: Indicates that corresponding waste was not generated.

b.2 Health Waste

The generation amount of each group of health waste is given in the table below.

Table 4-12: Generation Rate of Health Waste

Waste Category			Clinics		General Hospital
			kg/clinic/day	g/employee/day*1	kg/hospital/day
Group A	A1	Biologic	0.16	0.22	6.01
	A2	Animals	0.00	0.00	0.00
	A3	Body part	0.10	0.14	8.11
	A4	Patient care etc.	0.26	0.36	8.64
	A5	Prions	---	---	---
Group B		Chemical etc.	0.27	0.38	1.7
Group C		Radioactive waste	0.00	0.00	0.0
Group E		Piercing or Cutting	0.44	0.62	3.4
Group D		Common waste	1.17	1.64	94.0
Total			2.40	3.36	121.8

Note: *1: In 2009, there were 116,192 employees.

b.3 Construction Waste

The generation rate was calculated for each class of construction waste, as listed in CONAMA Resolution 307.

Table 4-13: Generation Rate of CONAMA Resolution 307 Construction Wastes

Class	Class A	Class B	Class C	Class D	Total
Generation unit (kg/factory/day)	227.14	1.04	0.00	0.00	228.18

In the survey, the 4 classes of waste as shown in CONAMA Resolution 307 were subdivided into 44 types. The generation rate for each of these 44 types is given below. For those waste codes not listed indicates that generation of such waste was not reported.

Table 4-14: Generation Rate of Construction Waste

Waste No.	Name of Waste	kg/factory/day
01	Excavated soil	9.04
02	Concrete debris	14.75
03	Asphalt debris	17.12
04	Brick debris	0.83
06	Tile and ceramic	0.003
11	Plastic/vinyl sheet	0.12
12	Iron-bar, steel materials	0.07
13	Small metal waste	0.16
17	Plaster boards	0.01
20	Wood debris	0.37
21	Timber form	0.06
22	Scaffolding material	0.34
23	Interior timber	0.32
24	Packing (cardboard)	0.26
29	Machine oil	0.02
33	Ash	0.05
44	Mixed construction waste	184.66
Total		228.18

c. Future estimation for number of employees

The future estimation of number of employees is an important variable when estimating the waste generation amount. The variable for number of employees was selected, particularly, for the following reasons.

1. It is estimated that “the increase in waste generated from factories tends to be closer in relation to growth in number of workers rather than growth in production.”
2. Manufacturers and other industries will increase production according to a rise in demand to expand their profits, but they attempt to control production costs per item as much as possible through improved productivity. These efforts include improving worker productivity, economizing energy use and resources (raw materials).
3. Economizing on energy and resources is, in due course, tied to the reduction of waste generated through production activities. Therefore, assuming such efforts are made, the future amount of waste generated is estimated as a factor in improved productivity included in "growth in number of employees" rather than output growth.

However, the only data available is that for the total number of employees in PIM overall, as the corresponding data for the categories in each of the 19 types of industry does not exist. Accordingly, analysis of the correlation between total number of employees in PIM, 2004 ~ 2008, and estimated industrial growth resulted in an average annual growth in overall PIM production value of 6.6%, thus confirming that average annual growth of direct employment in the same period will remain at 5%.

Based on these results, the forecast for employees in each type of industry was estimated using the following method.

1. The correlation between the change in number of employees in PIM (annual average of 5.0% growth, 2004 ～2008) and change in production value (annual average of 6.6% growth, 2004 ～2008) was estimated, showing that PIM labor productivity will improve 1.5% annually on average.
2. Based on the assumption above, using the 2009 data for number of employees in each of the 19 industry types, and 2009 ~ 2015 estimated industry growth for each industry type, the number of employees in each sector was estimated for 2015 using the following formula:

   Number of Employees (2015) = Number of Employees (2009)× {2015 industrial growth/(2009 industrial growth × $1.015^{(2015-2009)}$)}
3. Results were similarly sought for each of the 19 types of industry.

The forecast for number of employees was estimated using the above conditions with the results as shown in the following table.

Table 4-15: Estimated Forecast for Number of Employees

Factory Code	2009			2015		
	Industrial growth	Number of Employee	Unit Industrial growth	Industrial growth	Number of Employee	Unit Industrial growth
	(mil. Real)	(employee)	(mil. Real /employee)	(mil. Real)	(employee)	(mil. Rea l/employee)
F01	173	2,975	0.058	113	1,794	0.063
F02	---	---	---	---	---	---
F03	62	843	0.074	52	642	0.081
F04	16,242	37,765	0.430	17,934	38,157	0.470
F05	40	348	0.115	34	270	0.126
F06	1,455	5,464	0.266	2,062	7,086	0.291
F07	4,217	6,003	0.702	8,080	10,521	0.768
F08	279	698	0.400	515	1,178	0.437
F09	49	445	0.110	72	600	0.120
F10	363	1,789	0.203	473	2,131	0.222
F11	0.9	133	0.007	0.5	63	0.008
F12	101	538	0.188	81	393	0.206
F13	5,742	1,355	4.238	8,558	1,847	4.634
F14	3,138	9,625	0.326	4,257	11,958	0.356
F15	13	20	0.650	11	15	0.711
F16	40	589	0.068	65	878	0.074

F17	14,771	43,937	0.336	25,334	69,030	0.367
F18	9,355*1	440	21.261	6,623*1	285	23.248
F19		3,225	2.901		2,088	3.172
Total	56,041	116,192	0.482	74,265	148,936	0.527

*1: Statistically, the type of industrial growth for F18 and F19 are the same. Here, in order to calculate the unit industrial growth for each industry, the same industrial growth trends were used.

The value and rate of both total industrial growth and total number of employees were estimated, as shown in the following graph.

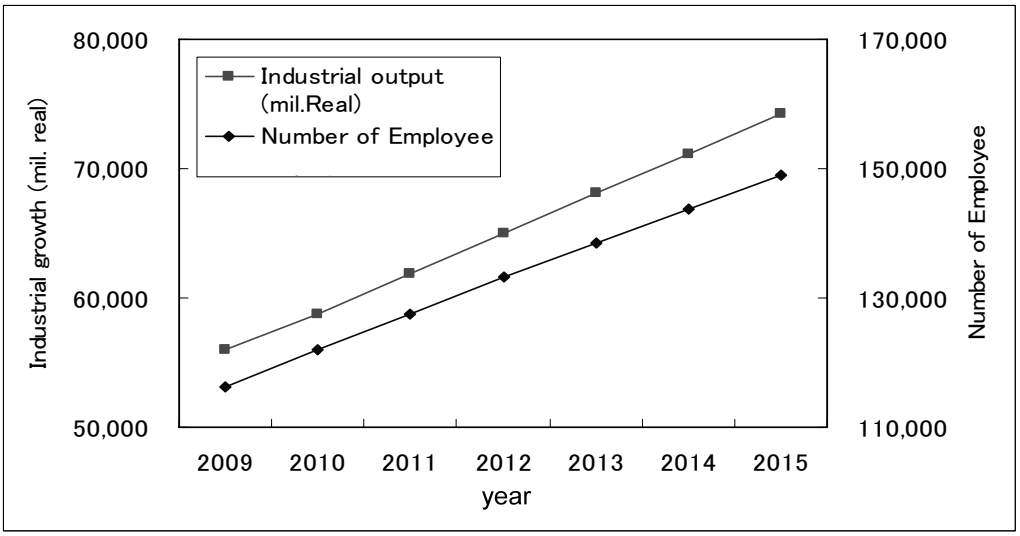


Figure 4-1: Estimated Results for Total Industrial Growth and Total Number of Employees (Forecast)

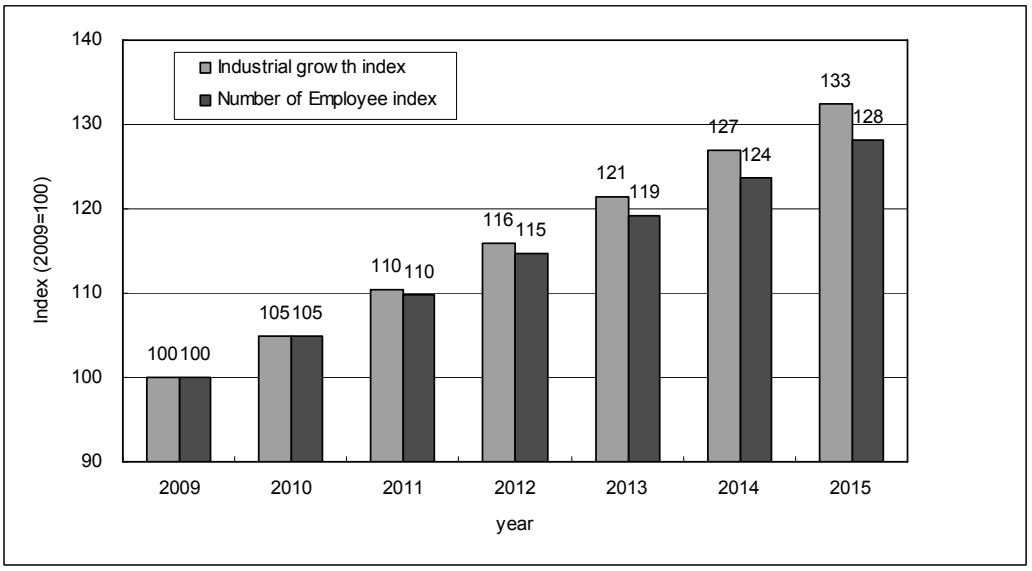


Figure 4-2: Estimated Results for Total Industrial Growth and Total Number of Employees (Rate)

4.2.3 Estimation of Future IW Generation Amount

Future IW generation rate is the product of the above-mentioned generation rate of industry/industrial waste by type (general IW, health waste, construction waste) and the number of employees by industry. The results are as follows.

a. General Industrial Waste Generation

The generation amount of general industrial waste in the entire target area of the study may be calculated by multiplying a GR of a general IW by the number of employees of each year. Below, Non-HIW and HIW generated from Non-Production and Production Processes was calculated for 2015.

The generation amount of general IW in 2009 was estimated at 591.5 ton/day. Further, the 2015 general industrial waste amount generated was estimated by multiplying each type of waste in each sector (Factory Category) by the future index 737.7 ton/day. It is estimated that in 2015 there will be about 1.3 times the present amount of general IW.

Table 4-16: Forecast Generation Amount of General IW by Factory Category (2015)

Factory Category		Non-Production		Production Process		All Process	
		Non-HIW	HIW	Non-HIW	HIW	2009	2015
F01	Beverages	6.6	0.1	0.5	0.1	12.2	7.3
F02	Leather	-	-	-	-	-	-
F03	Printing	0.1	-	3.0	1.6	6.2	4.7
F04	Electrical	51.3	9.1	95.2	20.4	174.1	176.0
F05	Lumber	0.3	0.1	0.7	0.2	1.7	1.3
F06	Machinery	10.8	4.4	33.0	4.7	40.9	52.9
F07	Metal	21.5	4.1	85.9	6.0	67.0	117.5
F08	Nonferrous Metal	0.6	-	2.7	-	2.0	3.3
F09	Furniture	0.7	0.2	0.1	0.4	1.0	1.4
F10	Paper	67.1	0.4	29.2	2.7	83.3	99.4
F11	Rubber	0.1	-	0.2	-	0.6	0.3
F12	Food	-	0.1	15.2	0.3	21.3	15.6
F13	Chemical	0.7	-	5.5	0.5	4.9	6.7
F14	Plastic	9.5	25.6	15.2	2.3	42.4	52.6
F15	Textiles	-	-	-	-	0.1	0.1
F16	Clothing	1.1	0.3	2.1	0.6	2.7	4.1
F17	Transportation	26.0	2.6	89.2	68.8	118.8	186.5
F18	Construction	0.3	0.1	0.7	0.2	2.1	1.3
F19	Other	1.4	-	4.0	1.3	10.2	6.7
Total		198.1	47.1	382.4	110.1	591.5	737.7

As shown in the table above, 93% of the total general IW will be generated in the following 6 factory's categories:

Factory Code	Type of Industry	Waste Generation in 2009 (ton/day)	Waste Generation in 2015 (ton/day)	Increase Rate (%)
F04	Electrical industry	174.1	176.0	1.1

F17	Transport Machinery	118.8	186.6	57.0
F10	Paper industry	83.3	99.4	19.3
F07	Metal industry	67.0	117.5	75.3
F14	Plastic Industry	42.4	52.6	24.1
F06	Machinery	40.9	52.9	29.3
Total		526.5	685.0	30.1

Among the 6 large generation sources the highest increase rate is F07: Metal Industry, 75.3%, followed by F17: Transport Machinery, 57.0%.

The following two tables show forecast of generation amount of general Non-HIW and HIW in 2015, respectively:

Table 4-17: Forecast Generation Amount of General Non-HIW by Type of Waste (2015)

Unit: ton/day

Waste Code	Description of Non-HIW	Generation Amount	
		2009	2015
NH01	Kitchen waste (include waste from animal such as bone, skin, hair)	26.0	32.8
NH02	Wood	29.2	34.0
NH03	Paper	120.0	137.2
NH04	Plastic or polymers and resins	54.5	62.8
NH05	Textile and fiber	1.0	1.1
NH06	Animal oil, Vegetable oil	0.1	0.1
NH07	Rubbers and Leather	0.2	0.2
NH08	Ash/dust from coal-fired power plants, etc.	0.7	0.7
NH09	Metals and metal alloys such as aluminum, copper, bronze	163.6	218.0
NH10	Ceramic & Glasses	13.4	14.8
NH11	Stone, sand or material that have composition of soil such as tile, brick, gypsum, cement	1.7	2.6
NH12	Mixed waste (This code shall be applied in case wastes are discharged without separation.)	1.5	1.1
NH13	Others	59.9	75.1
Total		**471.8**	**580.5**

Table 4-18: Forecast Generation Amount of General HIW by Type of Waste (2015)

Unit: ton/day

Waste Code	Description of Non-HIW	Generation Amount	
		2009	2015
HW01	Inorganic acid	0.2	0.3
HW02	Organic acid	-	-
HW03	Alkalis	-	-
HW04	Toxic Compounds	2.8	3.6
HW05	Inorganic Compounds	0.2	0.3
HW06	Other Inorganic	-	-
HW07	Organic Compounds	18.9	22.5
HW08	Polymeric Materials	1.0	1.4

HW09	Fuel, Oil and Grease	20.0	27.0
HW10	Fine Chemicals and Biocides	-	-
HW11	Treatment Sludge	20.6	24.9
HW12	Ash from incinerator	0.2	0.3
HW13	Dust and Air pollution control (APC) products	1.0	1.8
HW14	Other Hazardous substance (besides HW01-HW13)	34.4	50.7
HW15	Mixed Waste	14.7	16.9
HW16	Hazardous materials from Non-production process	5.7	7.5
Total		**119.7**	**157.2**

As shown in the Table 4-17, 72% of the general Non-HIW will be main 3 types of waste, i.e. NH09: Metal Scrap, NH03: Waste Papers and NH04: Waste Plastics. Among the 3 main types of general Non-HIW the highest increase rate is NH09: Metal Scrap, 33.3%, followed by NH04: Waste Plastics, 15.2%.

Factory Code	Type of Industry	Waste Generation in 2009 (ton/day)	Waste Generation in 2015 (ton/day)	Increase Rate (%)
NH09	Metal Scrap	163.6	218.0	33.3
NH03	Waste Papers	120.0	137.2	14.3
NH04	Waste Plastics	54.5	62.8	15.2
	Other than the above 3 Types of Waste	133.7	162.5	21.5
	Total	471.8	580.5	23.1

As shown in the Table 4-18, 47.3% of the general HIW will be main 3 types of waste, i.e. HW09: Fuel, Oil and Grease, HW11: Treatment Sludge and HW07: Organic Compounds. Among the 3 main types of general HIW the highest increase rate is HW09: Fuel, Oil and Grease, 353%, followed by HW11: Treatment Sludge, 20.9%.

Factory Code	Type of Industry	Waste Generation in 2009 (ton/day)	Waste Generation in 2015 (ton/day)	Increase Rate (%)
HW09	Fuel, Oil and Grease	20.0	27.0	35.0
HW11	Treatment Sludge	20.6	24.9	20.9
HW07	Organic Compounds	18.9	22.5	19.0
	Other than the above 3 Types of Waste	60.2	82.8	37.5
	Total	119.7	157.2	31.3

b. Health Waste

The generation amount of health waste in the entire target study area is calculated by multiplying the generation rate per employee by the number of employees in each year. The results for each type of waste are shown below.

The generation amount of health waste in 2009 and 2015 is estimated at 391.2 kg/day and 500.5 kg/day, respectively. Health waste in 2015 will be generated at 1.3 times the current amount.

Table 4-19: Forecast Amount of Health Waste

Waste Category		Generation Rate	Generation amount	
		g/employee/day	2009	2015
			kg/day	kg/day
Group A	A.1	0.22	26.1	32.8
	A.2	0.00	0.0	0.0
	A.3	0.14	16.3	20.9
	A.4	0.36	42.4	53.6
	A.5	---	---	0.0
Group B		0.38	44.0	56.6
Group C		0.00	0.0	0.0
Group E		0.62	71.7	92.3
Group D		1.64	190.7	244.3
Total		3.36	391.2	500.5

c. Construction Waste

The amount of construction waste generated according to each class as shown in CONAMA Resolution 307 is calculated by multiplying the generation rate per employee for each waste by the number of employees each year. The results estimated for each type of waste are shown below.

The amount of construction waste generated in 2009 and 2015 is estimated at 36.96 ton/day and 47.54 ton/day, respectively. The amount of construction waste generated in 2015 is estimated to be about 1.3 times the current amount.

Table 4-20: Generation Amount of Construction Waste according to CONAMA Resolution 307

Class	Class A	Class B	Class C	Class D	Total
Construction Waste Generation in 2009	36.79	0.17	0.00	0.00	36.96
Construction Waste Generation in 2015	47.28	0.26	0.00	0.00	47.54

The study surveyed 44 types of waste according to the 4 classes as shown in CONAMA Resolution 307. The generation rate of these 44 types of wastes is shown below. For those waste codes not listed indicates that generation of such waste was not reported.

Table 4-21: Forecast Amount of Construction Waste

Waste No.	Name of Waste	Generation Rate	Generation amount	
			2009	2015
		kg/employee/day	ton/day	ton/day
01	Excavated soil	0.013	1.46	1.94
02	Concrete debris	0.021	2.39	3.13
03	Asphalt debris	0.024	2.77	3.57

04	Brick debris	0.001	0.13	0.15
06	Tile and ceramic	0.000	0.00	0.00
11	Plastic/vinyl sheet	0.000	0.02	0.02
12	Iron-bar, steel materials	0.000	0.01	0.01
13	Small metal waste	0.000	0.03	0.03
17	Plaster boards	0.000	0.00	0.00
20	Wood debris	0.001	0.06	0.16
21	Timber form	0.000	0.01	0.01
22	Scaffolding material	0.001	0.06	0.15
23	Interior timber	0.000	0.05	0.04
24	Packing (cardboard)	0.000	0.04	0.04
29	Machine oil	0.000	0.00	0.00
33	Ash	0.000	0.01	0.01
44	Mixed construction waste	0.257	29.92	38.28
Total		0.318	36.96	47.54

d. Total Amount of Industrial Waste Generated and IWM Flow in 2015

From the above results, it is estimated that the total generation amount for industrial waste in PIM in 2015 will be 785.7 ton/day.

If current IWM is continued in 2015, IWM flow chart will be shown in the following figure.

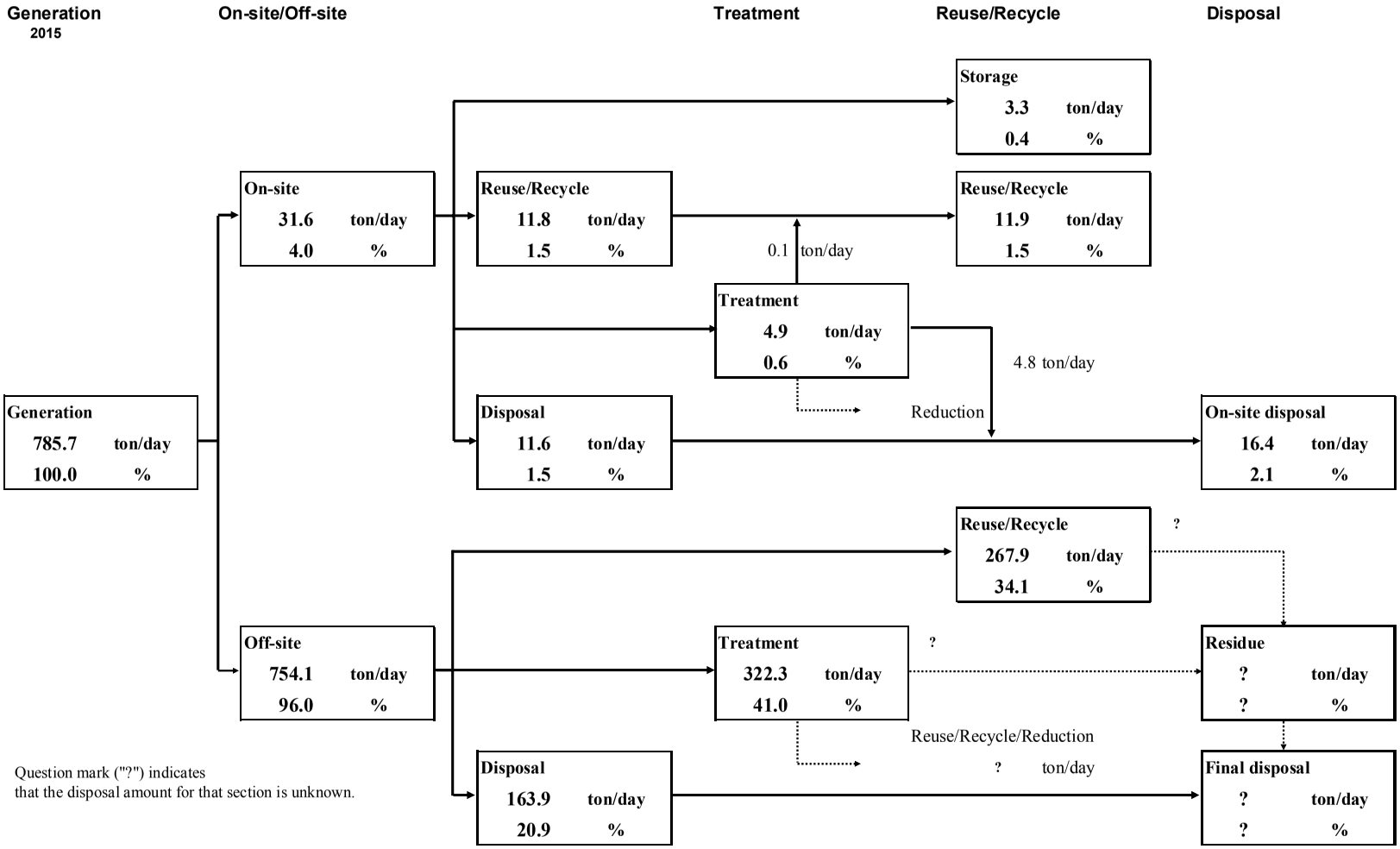


Figure 4-3: Industrial Waste Treatment and Disposal Flow in 2015

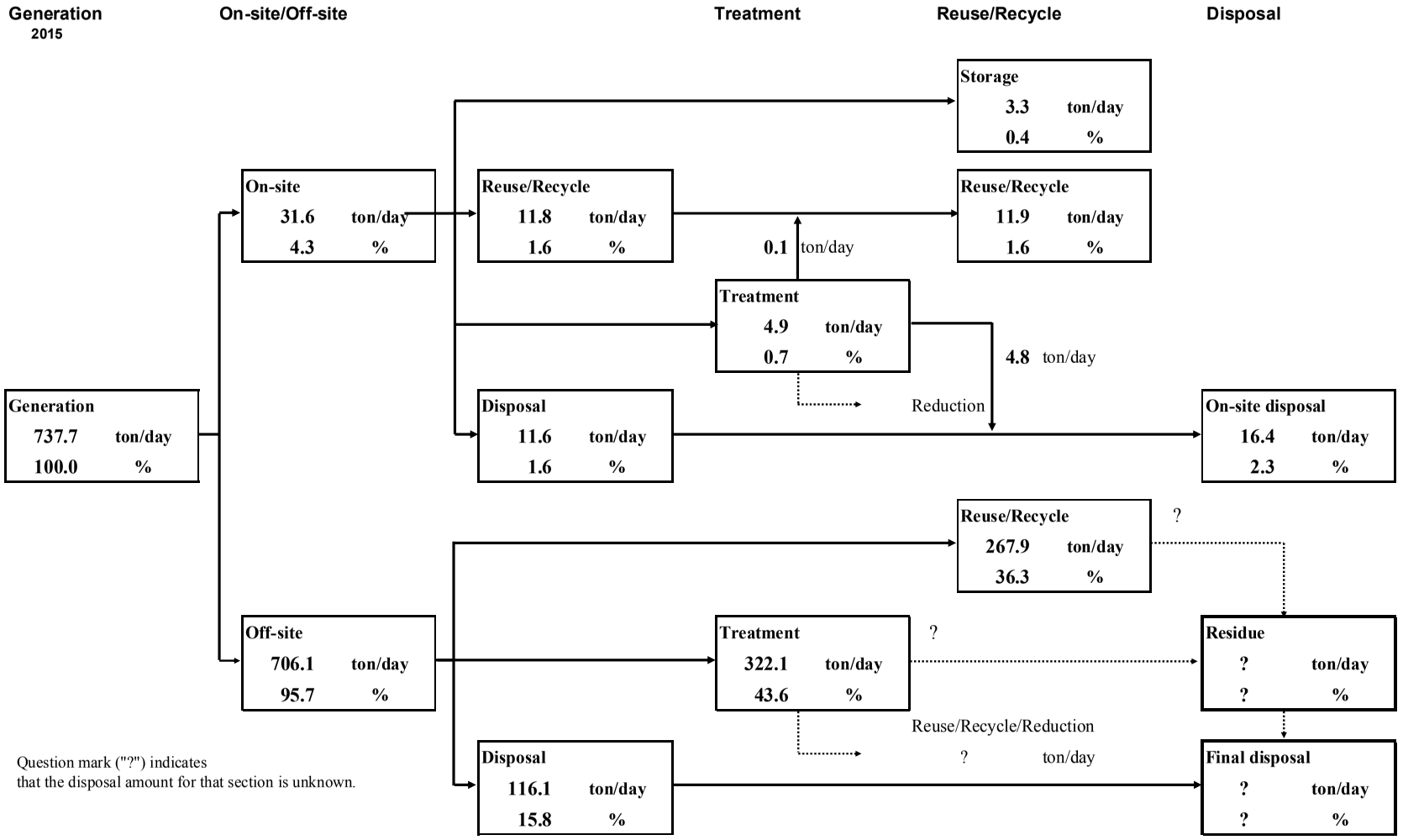


Figure 4-4: Waste Flow for all General industrial wastes generated from PIM in 2015

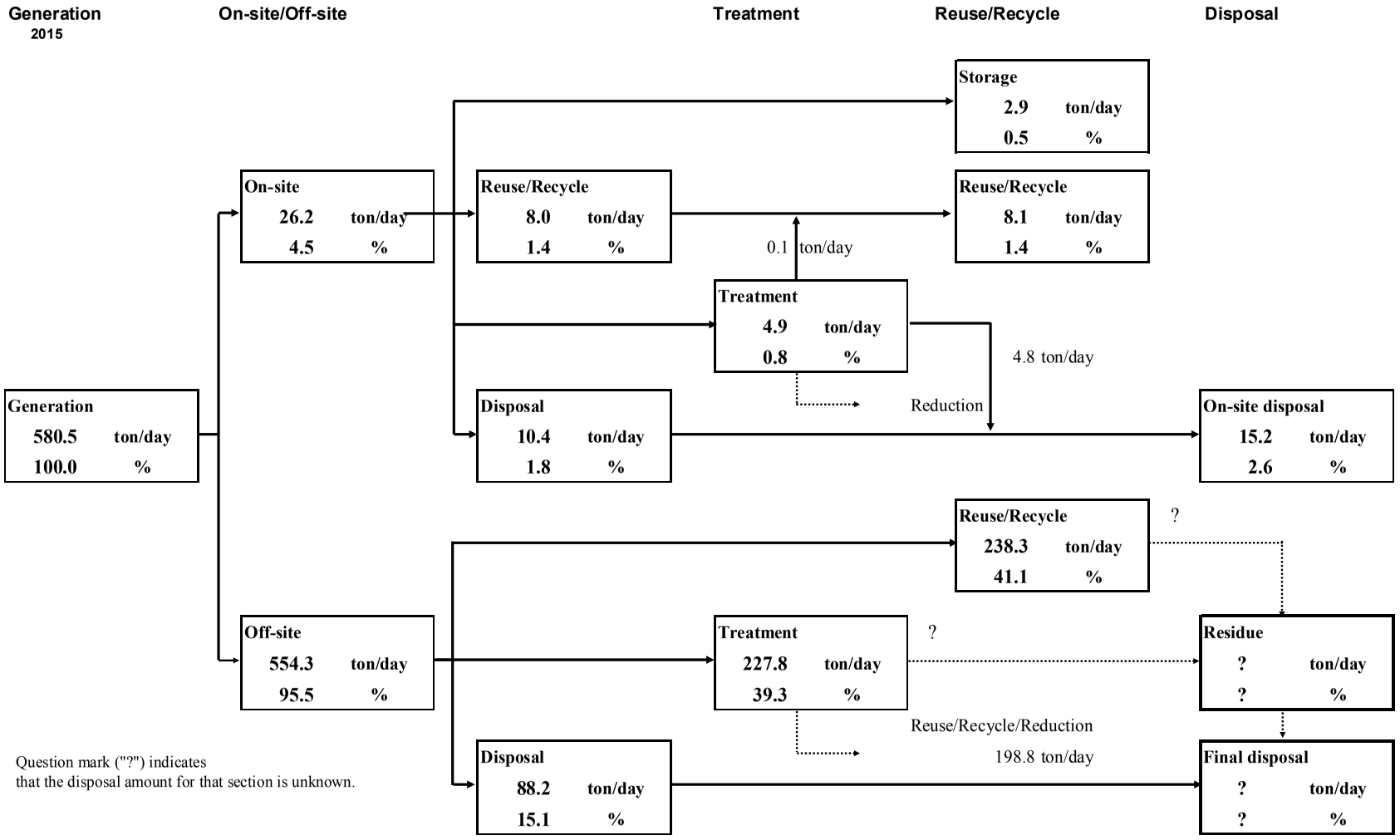


Figure 4-5: Waste Flow for General Non-HIW generated from PIM in 2015

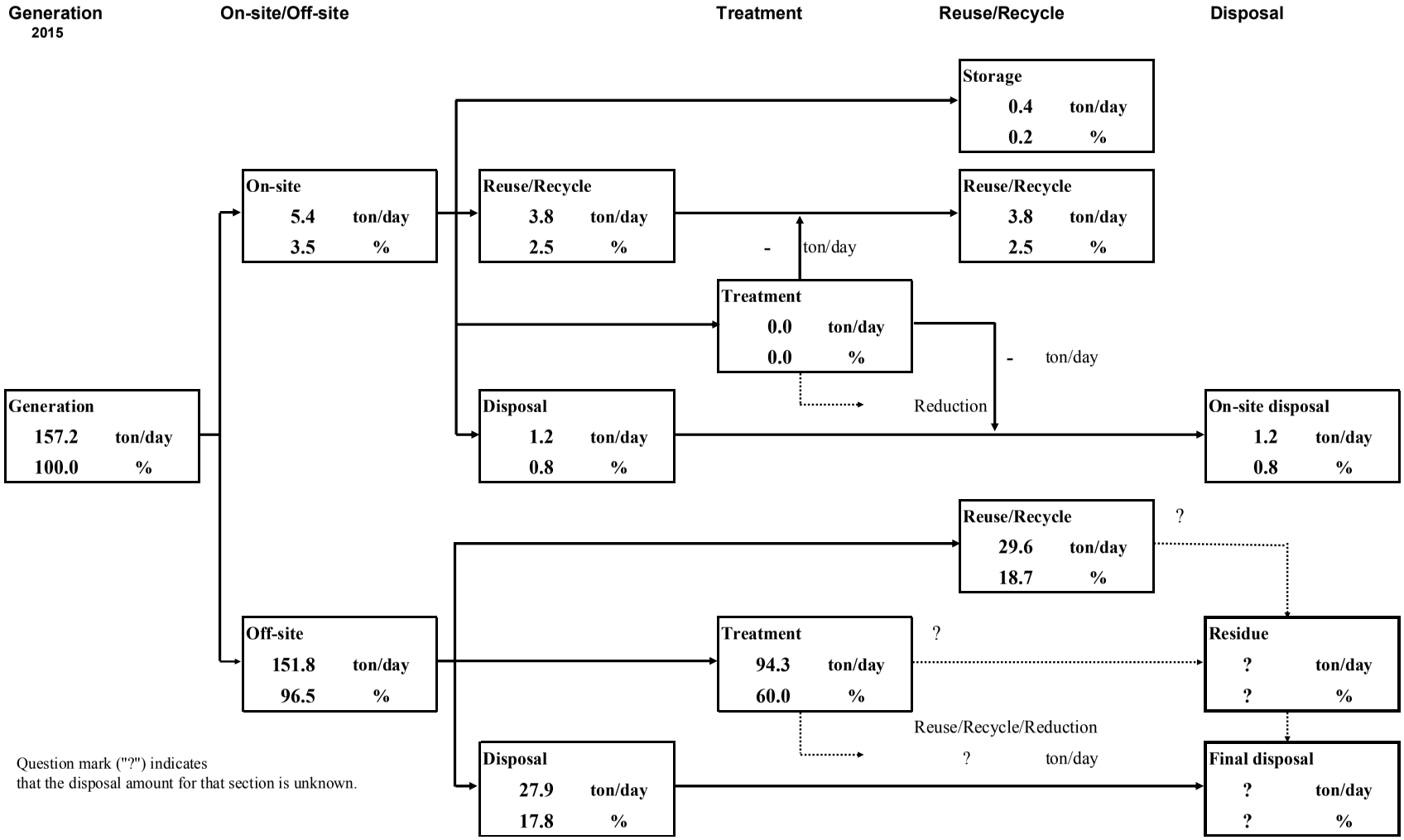


Figure 4-6: Waste Flow for General HIW generated from PIM in 2015

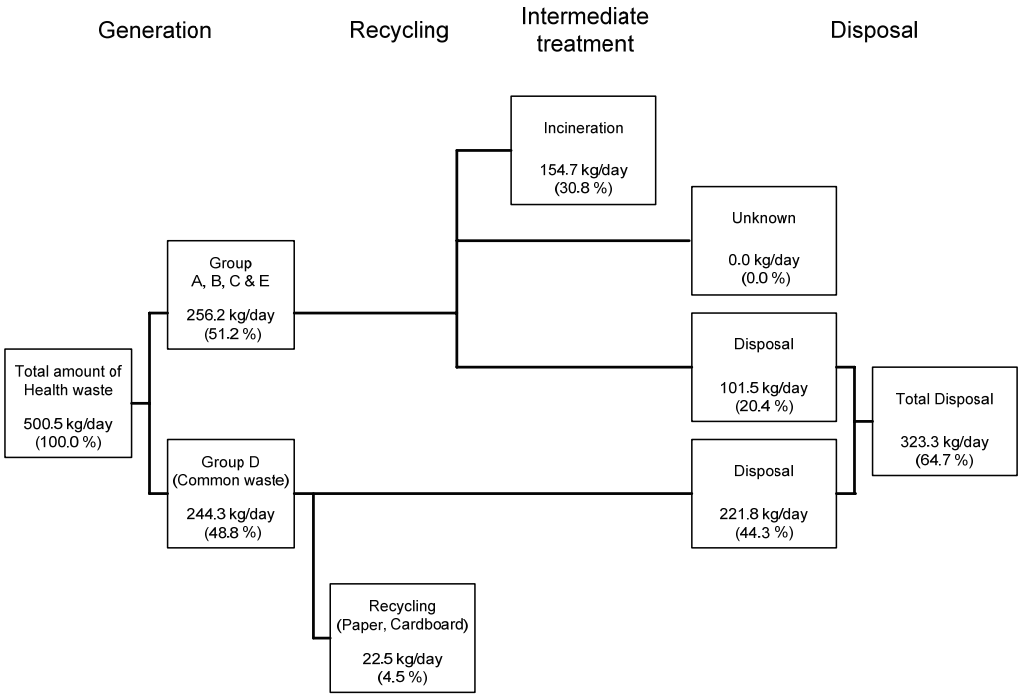


Figure 4-7: Health Waste Management Flow in PIM excluding General Hospital in 2015

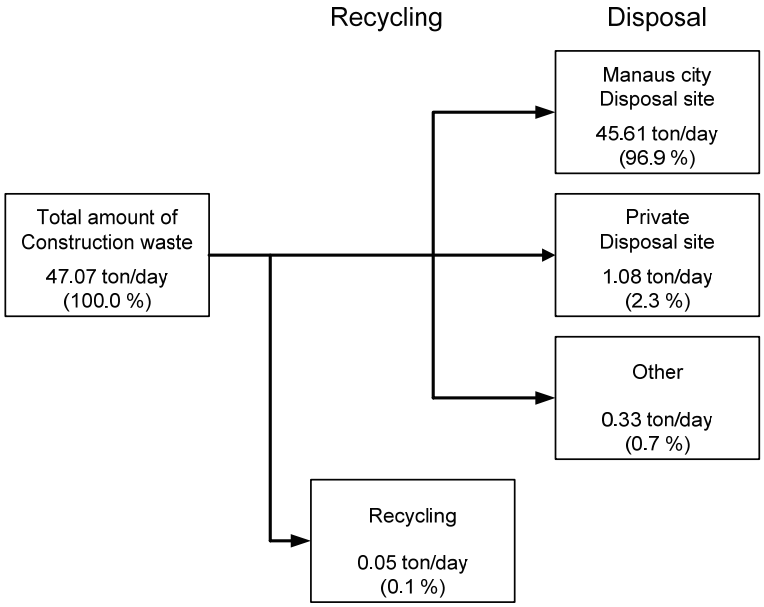


Figure 4-8: Construction Management Flow in PIM in 2015

5. Guidelines to Improve Industrial Waste Management in PIM