STUDIES ON THE IMPACT OF CLOSED-SYSTEM DISPOSAL SITES ON THE OUTSIDE ENVIRONMENT

Masahiro IDO[1], Katsuhiko HAYASHI[2], Yoshijirou SHIMOMURA[3]
Environmental Evaluation Working Group, Research Committee for Closed-System Disposal Facilities
Chateau Takanawa 401, 3-23-14 Takanawa, Minato-ku, Tokyo, 108-0074 Japan
[1] Kokusai Kogyo Co., Ltd.; [2] Maeda Corporation; [3] Pacific Consultants Ltd.

Masataka HANASHIMA, Tohru FURUICHI
Research Committee for Closed-System Disposal Facilities
Chateau Takanawa 401, 3-23-14 Takanawa, Minato-ku, Tokyo, 108-0074 Japan

ABSTRACT

The majority of final disposal sites in Japan are the open type; however, in consideration of the impact on the surrounding environment, many “indoor” sites that are either covered or completely enclosed are being constructed. At present, 44 facilities are in operation or under construction. Moreover, seminars have been held on the development of closed-system disposal sites since 1989, and extensive research has been carried out to popularize such facilities. This report summarizes the results of studies on the impact of closed-system disposal sites on the outside environment, conducted by the Environment Evaluation Working Group (hereinafter called the “WG") from 2002–2004.

The WG investigated actual conditions of closed-system disposal sites, believing that this system is kinder to the surrounding environment compared to the open site, and that in an environmental impact study, a reduction in investigation items could be expected. The results revealed an interesting situation concerning the noise and fine particles. The WG proposes conducting environmental impact assessments on the development of such facilities in the future, estimating the pollution load based on the facility structure, landfill items, landfill method, etc.

INTRODUCTION

A number of small-scale, closed-system disposal sites have been constructed, and studies are being conducted to determine their impact on the living environment. It was considered that closed-system sites, being covered structures, would have less impact on the outside environment, and that environmental impact assessment items could be simplified. Therefore, the difference in environmental impact between closed and open systems was examined, and dust and noise were selected as items that could potentially be simplified. The current situation concerning these items was investigated at several closed-system disposal sites and they were examined as environmental impact assessment items.

This paper describes the situation of dust and noise generation at closed-system disposal sites and makes recommendations on factors impacting the living environment and environmental impact assessment items, considering facility structure and operation and maintenance aspects.

OUTLINE

Objective

Field surveys on dust and noise at closed-system disposal sites were carried out with the purpose of making recommendations on environmental impact assessment items, supposing that the items could be simplified in the case of a closed-system facility.

Target facilities

In order to study dust and noise during landfill operations (waste unloading, spreading/compacting), we selected facilities with landfills in progress. The target facilities and survey items are shown in Table 1. Primary studies were conducted at two facilities in 2003 and secondary studies were conducted at four facilities in 2004.

Table 1 Facilities for investigation

Facilities for investigation	Investigation date	Investigation item		Completion year
		Dust	Noise	
Final disposal site in Y village	2003.10.9	○	○	1998. 3
Final disposal site in S town	2003.10.8	○	○	1998. 7
Final disposal site in N town	2004.10.5	○	—	2002.11
Final disposal site in K town	2004.10.6	○	—	2002.11
Final disposal site in KZ town	2004.10.12	○	—	2003. 3
Final disposal site in Y town	2004.10.28	○	—	2001. 3

Content of study

Dust survey

(1) Measurement of dust concentration

1) Study items and quantity

Gravimetric method

: 6 facilities, one point both indoors and outdoors

Digital dust meter

: 6 facilities, total of 4–6 points indoors and outdoors

2) Study points

At each facility, measurements were taken near the generation source, near the vent, and at impact points and control points set up outside the facility. The impact points were points likely to be affected and the control points were points unlikely to be affected.

(2) Measurement of heavy metals in accumulated dust

1) Study items and quantity

Analyzed items

: Cd, Pb, Cu, As, Hg, SiO_2, moisture; 6 facilities, 1 sample each

2) Study points

At each final disposal site, accumulated dust on the roof's steel frame and railing was collected at a random point.

Noise survey

(1) Noise level

1) Study items and quantity

Noise meter: 6 facilities, 8 points

2) Study points

At each facility, the noise level was measured at 4 points both indoors and outdoors.

Facility details

Details of the facilities are shown in Tables 2 and 3. Conditions during waste unloading and spreading/ compacting operations are shown in Photos 1 to 8.

STUDY RESULTS

Dust survey

Dust concentration

① Final disposal site in Y village

At this site, water spraying was seldom conducted and at the time of the study, simulated waste unloading and spreading/compacting operations were carried out. As a result, indoor dust concentration rose above normal conditions to approximately ten times higher than the control point. Furthermore, peak concentration at the point near the work area appeared immediately, and a reduction in concentration was seen relatively soon after the completion of operations. This is presumably due to the walls having many slit-shaped vents with three-way shutters that were left open during operations to allow the air to vent easily. Also, dust concentration near the shutter openings was found to be close to the indoor concentration.

Table 2 Details of facilities (First investigation)

Institution name			Final disposal site in Y village	Final disposal site in S town
Reclaiming material			Incinerator residue, Nonflammable crushed waste	Crushed nonflammable residue
Landfill operation term			1998 to 2006 (Eight years)	1998 to 2003 (Five years)
Scale of facilities	Maintained area		5,951 m^2	36,000 m^2
	Reclaiming area		800 m^2	950 m^2
	Reclaiming capacity		2,660 m^3	7,100 m^3
	Average height of landfill		5.0 m	7.5 m
Scale of facilities	Method of feeding waste		Feeding from the feeding stage (Head 2 m)	Feeding from the feeding stage (Head 5 m)
	Method of covering with soil		None	None
	Watering	Frequency	None	When waste is turned on, Others
		Volume of water	0 m^3/d	Average amount of daily precipitation during year (5m^3/d)

② Final disposal site in S town

At this site, water spraying was conducted during waste unloading, and at the time of the study normal unloading and spreading/compacting operations were carried out. However, the concentration at the indoor points was 50 to 100 times higher than at the control point, and the concentration outside the ventilation fan was 5 times higher than the control point. In addition, peak dust concentration was detected during waste unloading operations in the lower portion of the facility, although not in the upper portion. This could be due to the small number of openings in the facility. The dust generated in the lower portion could not be quickly discharged through the ventilation system in the upper portion. Afterwards, dust generated during spreading/ compacting operations gradually reached the upper portion of the facility and peak concentration was later detected there.

③ Final disposal site in N town

At this site, dust concentration was low during both unloading and spreading/compacting operations, and no significant difference was found between concentrations at the impact point and control point outside the facility. In the behavior check on smoke from the preliminary smoke candle, smoke discharged from the roof fan spreads on the roof, so the impact is presumably less than from smoke discharged from the sides.

④ Final disposal site in K town

At this final disposal site, dust concentration during waste unloading was high and as a result, high concentration was also found at the impact point outside the facility. Also, because waste was unloaded from a height of 4.5 m in the unloading operations, dust concentration was momentarily high, but then quickly decreased. An increase in dust concentration was also found during spreading/compacting operations. However, the concentration was comparatively low and only a slight increase in concentration was found at the impact point.

⑤ Final disposal site in KZ town

At this site, dust concentration was low during unloading and spreading/compacting operations. Outside the facility, a slight increase in concentration was found at the impact point during loading operations, but no difference was found during spreading/compacting operations. Furthermore, a difference of 10–20 min was found in peak dust concentration near the generation source and near the vent. This is presumably due to the large interior spatial capacity of the facility.

Table 3 Details of facilities (Second investigation)

Item		Final disposal site in N town	Final disposal site in K town	Final disposal site in KZ town	Final disposal site in Y town
Reclaiming area		1,000 m^2	590 m^2	5,813 m^2	2,300 m^2
Reclaiming capacity		4,500 m^3	1,994 m^3	24,860 m^3	13,500 m^3
Reclaiming material		Incinerator residue, Crushed remainder	Incinerator residue, Noncombustible matter	Incinerator residue, Noncombustible matter	Incinerator residue, Crushed remainder
Method of feeding waste (At investigation)	Kinds of waste	Crushed remainder	Noncombustible matter	Noncombustible matter	Crushed remainder
	Method	The waste is packed in flexible containers, carried to the landfill by a vehicle fitted with a crane, and then removed from the flexible containers.	Waste in the Collection vehicle is fed from the feeding stage. (Head 4.5 m)	Waste in the Collection vehicle travels down the road from the hall, and is unloaded into the landfill bottom. (Head 1 m)	Waste at the recycling center is carried by belt conveyer, and falls from the duct into the landfill.
Method of covering with soil		None	Occasionally (Almost every time)	Once a year	None
Watering	Frequency	Twice/day	Once/day	Twice/day	None
	Volume of water	4.2 m^3/d	2 m^3/d	15 m^3/d	0 m^3/d
Moisture conditions of reclamation material		Overall watering in the morning and evening. Moist conditions were observed.	Overall watering every morning. Moist conditions were observed.	Watering according to reclamation material. Moist conditions were observed.	No watering. Dry conditions were observed.
Capacity of ventilated air (including capacity of reclamation)		12,954 m^3	6,035 m^3	66,860 m^3	37,000 m^3
Ventilator (Exhaust fan)	Number	φ900×5	φ600×4	φ600×10	φ600×9 φ400×3
	Amount of wind	1,150 m^3/min	480 m^3/min	1,200 m^3/min	1,400 m^3/min
	Position	Top part: 5 (GL + 8.9 m)	Side (both sides): Each 2 (GL + 5 m)	Side (one side): 10 (GL+ 3.3 m)	Side (one side): 12 (GL + 14 m)
	Filter	None	None	None	Fiber filter 1×2 m (for φ600) 1×1 m (for φ300)
	Remarks	—	—	Ten inspiratory side ports are on the other side. (GL + 3.3 m)	The device used for ventilating the hall is mainly a louver type, although a suction type is used in the landfill layer.

⑥ Final disposal site in Y town

At this site, indoor dust concentration was very high during both unloading and spreading/compacting operations. An increase in concentration was also found at the impact points and control points outside the facility. The

【During unloading operations】			
			
Photo 1 (N town)	Photo 2 (K town)	Photo 3 (KZ town)	Photo 4 (Y town)
【During spreading/compacting operations】			
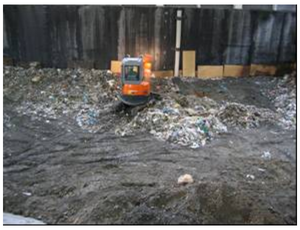			
Photo 5 (N town)	Photo 6 (K town)	Photo 7 (KZ town)	Photo 8 (Y town)

spreading/compacting operations conducted at the time of the study generated more dust than normal so the concentration was extremely high. However, the concentration at the impact point was lower than that during unloading operations. This could be because the wind direction changed during the study, eliminating the dust impact. In addition, a 10-min difference was found between the peak dust concentration near the generation source and near the vent, due to the large interior spatial capacity of the facility.

Heavy metals in accumulated dust

Accumulated dust consists of scattered particles from the landfilled waste and is, therefore, considered to have almost the same components as normal scattered dust. The heavy metals in the accumulated dust were evaluated using "Environmental Standards for Soil Contamination" and "Specified Standards for Specified Areas Based on the Soil Contamination Countermeasures Law" as a reference.

As a result, the following conditions were found at the various facilities:

① At the final disposal site in Y village, copper exceeded the reference value.

② At the final disposal site in S town, lead, mercury and copper exceeded the reference values.

③ At the final disposal site in N town, lead and copper exceeded the reference values.

④ At the final disposal site in K town, lead and copper exceeded the reference values.

⑤ At the final disposal site in KZ town, lead, mercury and copper exceeded the reference values.

⑥ At the final disposal site in Y town, lead, mercury and copper exceeded the reference value, and the mercury concentration was high.

<u>Noise survey</u>

① Final disposal site in Y village

This site does not generate loud noise, apart from the spreading/compacting operations carried out after unloading. During the spreading/compacting operations, the noise level within the facility boundaries did not exceed the standard value of noise regulations for specified construction works, which were used as a reference. However, the noise level at a point 13.5 m from the opening exceeded the environmental standard values.

② Final disposal site in S town

At the final disposal site in S town, the sound of the ventilation fan that runs during indoor operations is a source of loud noise. The spreading/compacting operations also generate noise. However, in each case, the noise generated did not exceed the standard value of noise regulations for specified construction works. On the other hand, noise levels at a point 8.8 m from the opening exceeded environmental standard values, regardless of whether or not spreading/compacting operations were being conducted. At this facility, only one of the four walls has a large opening, and that wall is installed with two large-sized ventilation fans. Because the operating sound of the fan was greater then the noise generated from the spreading/ compacting operations, the noise level was the same regardless of whether or not spreading/compacting operations were being carried out.

Based on the above, although the covering has a great effect on noise control, consideration must be given to the operating sound of the ventilation fan and the noise from the opening during spreading/ compacting operations.

CONSIDERATIONS

Equipment at the disposal site

Ventilation system

Depending on the structure of the ventilation system, the dust generated indoors is discharged in a concentrated manner and the operating sound of the ventilation fan is greater than the noise of the landfill operation. Therefore, when installing the ventilation system, the structure and position of installation should be selected in consideration of the waste type, the landfill construction method, and the surrounding environment.

Unloading system

The unloading operation is a large factor in dust and noise generation. Therefore, when selecting the structure and method of the unloading system, it is necessary to assess various aspects such as the shape and moisture conditions of the landfill waste, the amount of dust generated during unloading operations, operating efficiency, etc.

Water spraying system

Water spraying not only reduces dust but also plays an important role in promoting the stabilization of waste. Therefore, the structure of a water spraying system for the overall facility should be determined from the viewpoint of promoting waste stabilization, and a local water spraying system should be a separate installation for securing the work environment during unloading and spreading/compacting operations and reducing the environmental impact that accompanies indoor ventilation.

Operation and maintenance of final disposal site

Method of transporting waste

The dust generation conditions change depending on the drop unloading condition, the vehicle approach to the landfill site, the use of flexible containers and the ducting, etc. The moisture conditions of the waste and whether or not water spraying is carried out during unloading are also important factors. Therefore, when selecting the method of transport, it is necessary to consider its suitability to the type of waste to be landfilled in order not to generate dust. Furthermore, when unloading waste, facility openings should be closed whenever possible.

Spreading/compacting operation

A lot of dust is generated when spreading waste and the concentration of dust is greatly affected by the spreading method and moisture conditions of the waste. Therefore, efforts should be made to conduct operations that do not generate dust, based on the type and moisture conditions of the waste, while carrying out adequate water spraying. When conducting spreading operations, it is also necessary to close the facility openings.

Ventilation to reduce dust accumulation

We observed facilities that quickly reduced dust concentrations and those that did not, depending on the capacity and structure of the ventilation system. Therefore, it is necessary to consider installing additional ventilation according to the height of the completed landfill surface, which changes from day to day. Furthermore, the analysis results on heavy metals in accumulated dust showed large quantities of heavy metals. Therefore, facility operation and maintenance should include structural improvement such as putting filters on the ventilation openings.

Attire for working indoors

In this study, the accumulated dust was found to contain heavy metals. Therefore, on-site workers should be sure to wear a dust mask and clothing that fits snugly at the neck, wrist, and ankles. It is also necessary to conduct studies on the heavy metals contained in the dust and based on the results, examine the issue of indoor work clothes, referring to the "Work Manual for the Dismantling of Waste Incinerators", not leaving the facility in the indoor work clothes, the installation of an air shower, etc.

Relocation of roof

In this study, the dust that accumulates on the roof's steel frame and railings was found to contain heavy metals. Therefore, it is necessary to consider the environmental impact of relocating the roof. If the roof is reused, it is necessary to ensure that there is no health hazard by conducting a preliminary study, referring to the "Work Manual for the Dismantling of Waste Incinerators" and eliminating the accumulated dust prior to relocating the roof.

RECOMMENDATIONS ON ENVIRONMENTAL IMPACT ASSESSMENT ITEMS FOR CLOSED-SYSTEM FINAL DISPOSAL SITES

At a final disposal site, it is compulsory to examine the impact on the living environment that occurs from the disposal of waste. In the case of a closed-system disposal site, there is less impact on the living environment compared with an open-system disposal site, and it is believed that environmental impact assessment items can be simplified. Dust and noise

Table 4 Living environment impact factors and investigation items in closed-system final disposal sites (Proposal)

Matters for investigation	Life environment impact factor / Life environment impact investigation item	Discharge of processing water from leachate treatment facilities	Operation of facilities (Ventilation equipment and leachate treatment facilities)	Reclamation work	Stench generation from facilities (Landfill site)	Running of waste transportation vehicle
Air pollution	Dust, etc.			◎★		◎★
	Nitrogen dioxide (NO_2)					◎☆
	Suspended particulate matter (SPM)					◎☆
Water pollution	Biochemical oxygen demand (BOD)	◎☆				
	Chemical oxygen demand (COD)	◎☆				
	Suspended solids (SS)	◎☆				
	Total nitrogen (T-N)	◎☆				
	Total phosphorus (T-P)	◎☆				
Noise	Level of noise		◎★	◎★		◎★
Vibration	Level of vibration		◎☆	◎☆		◎☆
Stench	Density of specific malodorous substance				◎☆	
	Stench density				◎☆	

Note) Open (management) system: ◎; Closed system: ☆; ★ (Investigated this time) were selected as items that could potentially be simplified, and field surveys were conducted to investigate them as environmental impact assessment items.

As a result, it was found that even with a closed-system disposal site, it is necessary to conduct environmental impact studies on the same items as an open system. However, it is possible to simplify the contents, depending on the study item.

Based on the above, the recommended environmental impact assessment items for closed-system final disposal sites are as shown in Table 4.

CONCLUSION

In this study, it was believed that environmental impact assessment items for closed-system disposal sites could be simplified compared with open-system disposal sites. Field surveys on dust and noise were conducted and environmental impact assessment items were investigated.

The results were as follows:

① Regarding dust, it was found that the concentration increased outside the ventilation fan and that the concentration outside the facility openings was about the same as that indoors. The concentration of heavy metals in the accumulated dust was also found to be high.

② Regarding noise, although the covering had a large effect on noise control, its benefit was reduced when landfill operations were carried out with the openings left open. The operating sound of the ventilation fan was also found to be a source of noise.

Based on the above, although the factors that impact the environment differ between open and closed systems, the environmental impact assessment items for closed systems need to be the same as those for open systems.

ACKNOWLEDGEMENTS

We express our sincere appreciation to Mr. Nobuyuki Maeda (Hazama Corporation), Mr. Tadashi Takase (JDC Corporation), and Mr. Tatsuya Kametani (Towakagaku Ltd.) for their cooperation and assistance.

REFERENCES

・Ministry of Health, Labor and Welfare, Work Manual for the Dismantling of Waste Incinerators, Japan Safety Appliances Association, published June 7, 2001