Waste Transportation Tracking and Monitoring Service Using Satellite Communications

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1. Introduction

Speculation is abounding about environmental pollution due to the illegal dumping of industrial waste. In response, the National Police Agency has ordered a strict crackdown on acts that harm the environment as "environmental crimes." A movement toward clarifying waste-emitting companies' responsibility for violations, such as the commissioning of waste-disposal to unauthorized enterprises, is growing in intensity day by day.

Meanwhile, the problem of general waste being illegally transported to low-cost trash incineration plants in other municipalities is becoming increasingly serious. The municipality that receives the waste is forced to bear a large amount of the disposal cost, and the result imposes an economic burden on the residents. Moreover, as in the case of deadly poisonous dioxin, serious health and environment problems can also arise.

To improve and modernize the waste-disposal industry, NISSCOM Inc. started commercialization of the "Industrial Waste's Electronic Manifest Data Management System" in September 1997. Fuji Electric entered into a business tie-up with NISSCOM Inc. in 1998, and based on the system, developed a new application system. Now, both companies are jointly promoting their environmental information service, "SCM (satellite communications management) Information Service", which utilizes the new system. This paper introduces that service.
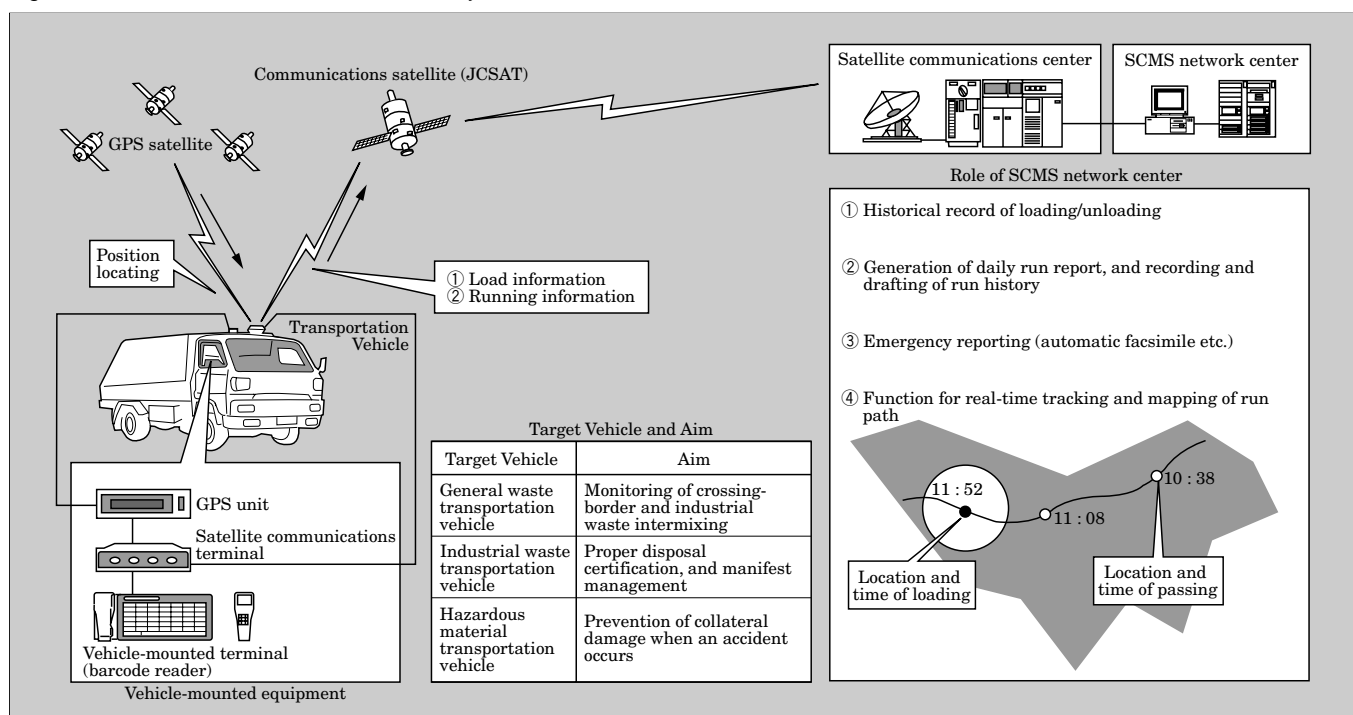
2. Overview of SCM Information Service

Figure 1 shows an overview of the SCM information service system.

(1) Overview of the service

Using the GPS (global positioning system) and a

Fig.1 Overview of SCM information service system

communications satellite and acting on behalf of the user, this service tracks and monitors the movement of transportation vehicles and the waste loaded on them to verify that the waste is properly treated. Further, this service provides users with various types of information.

(2) Telecommunications infrastructure

The telecommunications infrastructure used in the service is based on the "OmniTRACS" truck operation management system developed by Qualcomm Inc., a major U.S. telecommunications corporation. The infrastructure has been applied to waste management systems. Moreover, the service uses the "JCSAT" communications satellite, which is stationed southeast of Japan at an altitude of 36,000 km.

(3) Vehicle-mounted equipment

Each transporting vehicle is equipped with a satellite communications controller, an antenna, a GPS locating unit, a barcode reader, and a dedicated terminal.

(4) Features of the service

(a) The service area covers the entire country

Because satellite communications is utilized, the service can be used anywhere in Japan, including illegal waste dumpsites in mountainous regions or local areas.

(b) The service provides a system scaled to the user's needs

To obtain the service, collection/transportation enterprises just need to rent the necessary number of vehicle-mounted devices, corresponding to their own scale.

(c) The service promotes modernization of business operations systems

Office cost and time can be extensively reduced by modernizing business operations for waste disposal.

The waste transportation vehicle tracking and monitoring service is one practical example of the SCM information service. Waste is broadly divided into industrial waste and general waste. The service for each type of waste will be introduced below.

3. Application to Industrial Waste

3.1 Problems of industrial waste disposal

(1) Manifest management system

The waste disposal and clean-up law obligates industrial waste to be operated with the "Manifest System" (industrial waste-disposal voucher system) that controls the waste disposal flow with vouchers. The system regulates the following: the entry of required items in the so-called manifest vouchers, such as the waste classification, name, and handling precautions; the conveyance of necessary information from waste-emitting companies to transportation and disposal companies; and verification and recording that the waste has been properly transported and disposed,

based on reference to the manifests retrieved from the final disposal companies.

However, forged manifests are appearing in some areas and the system is being somewhat enforced in name only.

(2) Greater responsibility for waste-emitting companies

The recently revised waste disposal and clean-up law obligates waste-emitting companies to take responsibility for their waste, until the final disposal stage. This requires the waste-emitting companies themselves to verify that the waste is indeed brought to a disposal plant and disposed.

3.2 Industrial waste transportation tracking and monitoring service

To solve the above-mentioned problems, the service, acting on behalf of a waste-emitting company, manages the manifest vouchers and monitors whether the waste itself is properly transported and disposed.

(1) Operation method (Fig. 2)

(a) Task of waste-emitting company (Fig. 2 ①)

The waste-emitting company buys special stickers (hazard labels) each with a barcode that contains data of the emitted waste classification, name of company division that is emitting waste, etc. Then, the company affixes the hazard labels for each waste-emitting company division on conventional dedicated waste containers or collection/transportation vehicles.

(b) Task of collection/transportation enterprise (Fig. 2 ②)

When collecting waste, the collection/transportation enterprise uses a vehicle-mounted barcode reader to read the hazard labels affixed by the waste-emitting company and the barcodes printed on received manifest vouchers. Then, the collection/transportation enterprise transmits that information via a communications satellite.

(c) Task of disposal plant (Fig. 2 ③, ④)

The disposal plant reads the barcodes printed on the hazard labels using a ground terminal installed at the plant, and transmits that information via the communications satellite.

(2) Service description

Through the above operations, various information is aggregated at the system network center via the communications satellite. The information includes the classification and mass of waste emitted from businesses, the historical records of a collection vehicle's run track, and the classes and masses of waste brought into waste treatment plants. The data obtained for waste collection is instantaneously compared with that obtained for the waste received at waste treatment plants. Any discrepancies are reported to the waste-emitting companies and the collection/transportation enterprises. In some cases, reporting to the supervising administrative agencies enables acci-

Fig.2 Operation of industrial waste transportation tracking and monitoring service
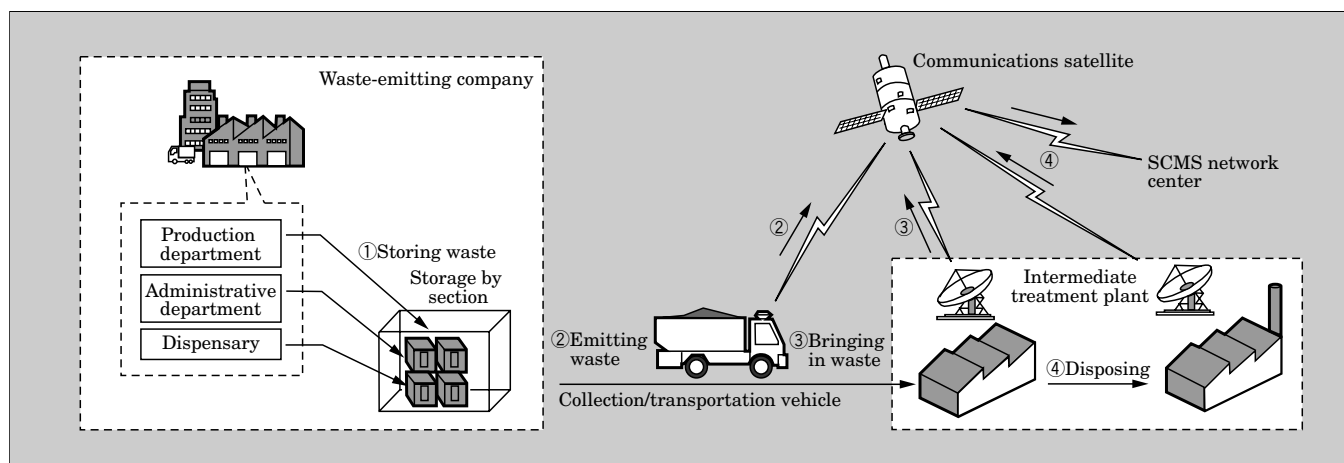
dents to be prevented and facilitates a rapid tracking down of the cause of the discrepancy (accidents including missing or illegal dumping of waste).

Waste-emitting companies, collection/transportation enterprises, and disposal plants are each obligated to submit disposal reports to the administrative agencies. The information service also includes means to prepare these reports by proxy.

(3) Effects of introducing the service

By tracking and monitoring the manifest vouchers, waste, and transportation vehicles, the waste-emitting companies can more efficiently implement manifest management and can reliably certify that proper waste-treatment is being performed.

The collection/transportation enterprises can achieve improved vehicle operating efficiency and can more efficiently implement manifest management with the service acting on behalf of the enterprise to manage operation of each vehicle's operation and automatically generate daily run reports.

3.3 Linkage with sectional aggregate management system

The SCM information service is used to verify and certify that waste from emitting companies has been properly disposed. Meanwhile, waste-emitting companies are struggling to initiate recycling activities and reduce trash through sectional metering management of the waste (including valuable substances) generated from their own places of business. The sectional metering management system described in this section proposes a solution for the above-mentioned needs.

(1) Sectional waste-emissions management system

In this system, a bar-coded label on which is printed the waste item and the emitting section name is affixed to each sorted small waste bag emitted from the various sections, as shown in Fig. 3. At a block collection site, each barcode is read and, at the same time, the mass of each bag is automatically measured. One general server controls the collected data in a uniform way, aggregating the data monthly by section and item, and supports information disclosure to each

section's client.

(2) Manifest management linkage system

This system supports printing of the manifest vouchers and the hazard labels required when collected and sorted waste is commissioned to a collection/transportation enterprise. This allows a seamless link with the SCM information service. Moreover, the system can manage and distinguish collected waste commissioned this time from that postponed until next time. Furthermore, it prepares reports to submit to the administrative agencies based on the information from the manifest vouchers issued or retrieved.

4. Application to General Waste

4.1 Problems of general waste

Unlike industrial waste, each municipality is responsible for disposing of general waste. General waste is disposed in the trash incineration plant operated by each municipality. The inflow of waste into the plant is managed by allowing plant access only to authorized waste transportation vehicles.

However, many problems have been reported in the mass media, including the so-called "crossing-border waste problem" in which some general waste collection/transportation enterprises authorized by more than one municipality bring other municipalities' waste into low-cost municipal treatment plants, and the "industrial waste intermixing problem" in which industrial waste collected in transit storage yards or intermediate treatment facilities is mixed with general waste and brought into a municipal incineration plant.

4.2 General waste transportation tracking and monitoring service

Figure 4 shows an overview of the general waste transportation tracking and monitoring service.

(1) Operation method

In addition to the GPS and the satellite communications equipment, each waste-collecting vehicle is equipped with a sensor that detects the start of

Fig.3 Overview of sectional aggregate management system
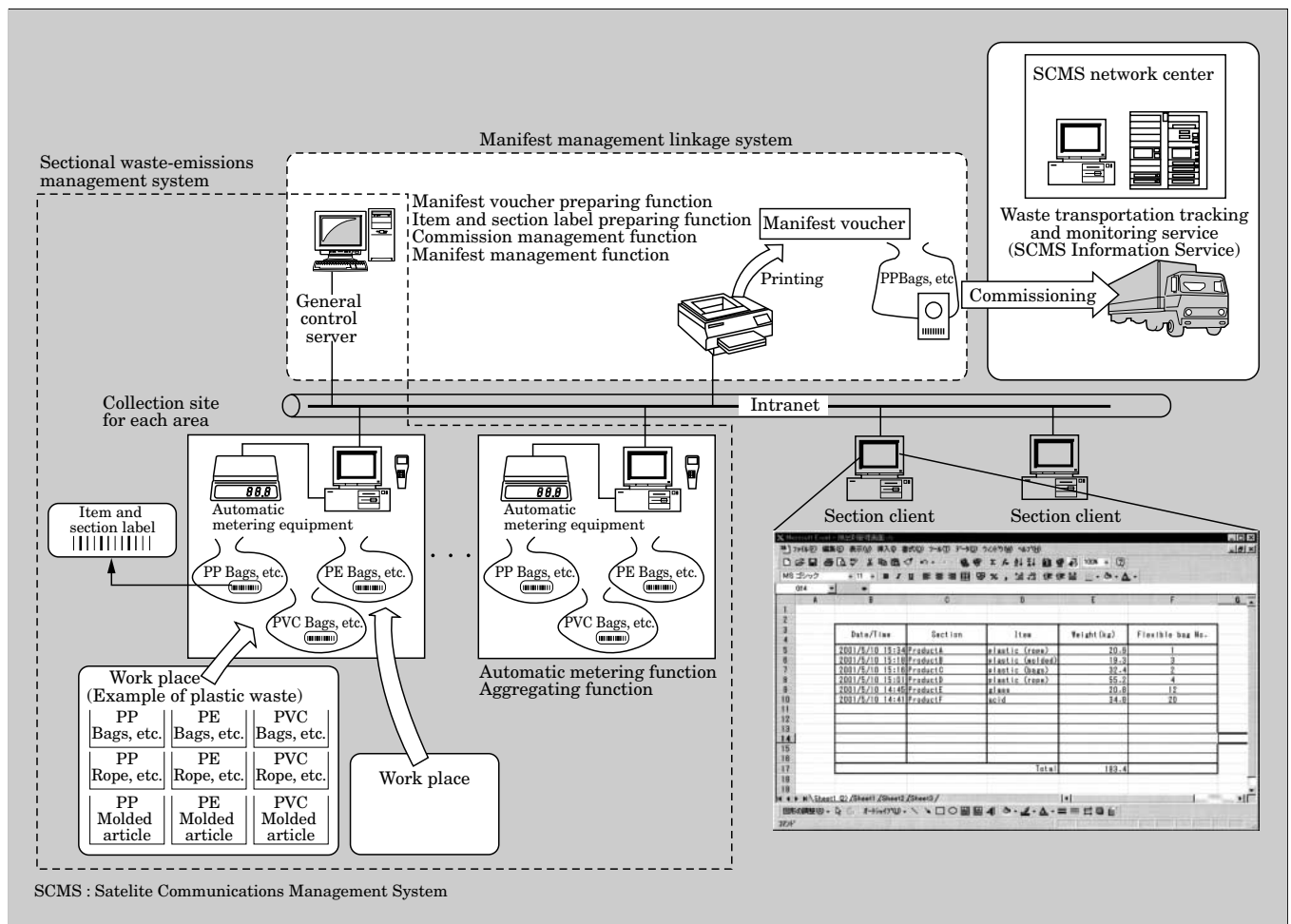
operation of waste loading equipment (packer) and a sensor that detects the dumping operation to emit waste. When either sensor detects operation, that information, together with GPS position data (latitude and longitude information), is transmitted to the system network center via the communications satellite.

Based on the received information, the system network center grasps where and in which municipality the waste was collected and to which plant it was transported. The center manages all of the data, and checks whether any violation exists. If a violation occurs, the center provides the trash incineration plants with the information described below in advance and prevents illegal waste from being brought in.

(2) Service description

　(a) Crossing-border waste notification service

　From GPS position data (latitude and longitude) at the time when the packer first began operation, the service determines the municipality in which the concerned vehicle works.

　Next, the service investigates the location in detail every time the packer starts, and constantly checks whether the vehicle loads waste at any location other than in the municipality where the work is authorized. If a violation is detected, the service faxes the car number, together with notice of the loading in other municipalities, to the trash incineration plant.

　(b) Industrial waste intermixing notification service

　The service registers the transit storage yards for industrial waste as areas to be monitored. Then, once the service detects that industrial waste has been loaded at these areas, it faxes the car number, together with notice of the illegal loading, to the trash incineration plant.

5. Conclusion

This paper has introduced an application of the SCM information service to waste transportation vehicles. In addition, another information service is now under development for crisis management use; if vehicles transporting dangerous or deadly toxins are involved in an accident, the system will rapidly report the load information, its treatment method, and medical countermeasures if an individual is exposed to the toxin. The system aims to save lives and prevent

Fig.4 Operation of general waste (business-owned) transportation tracking and monitoring service
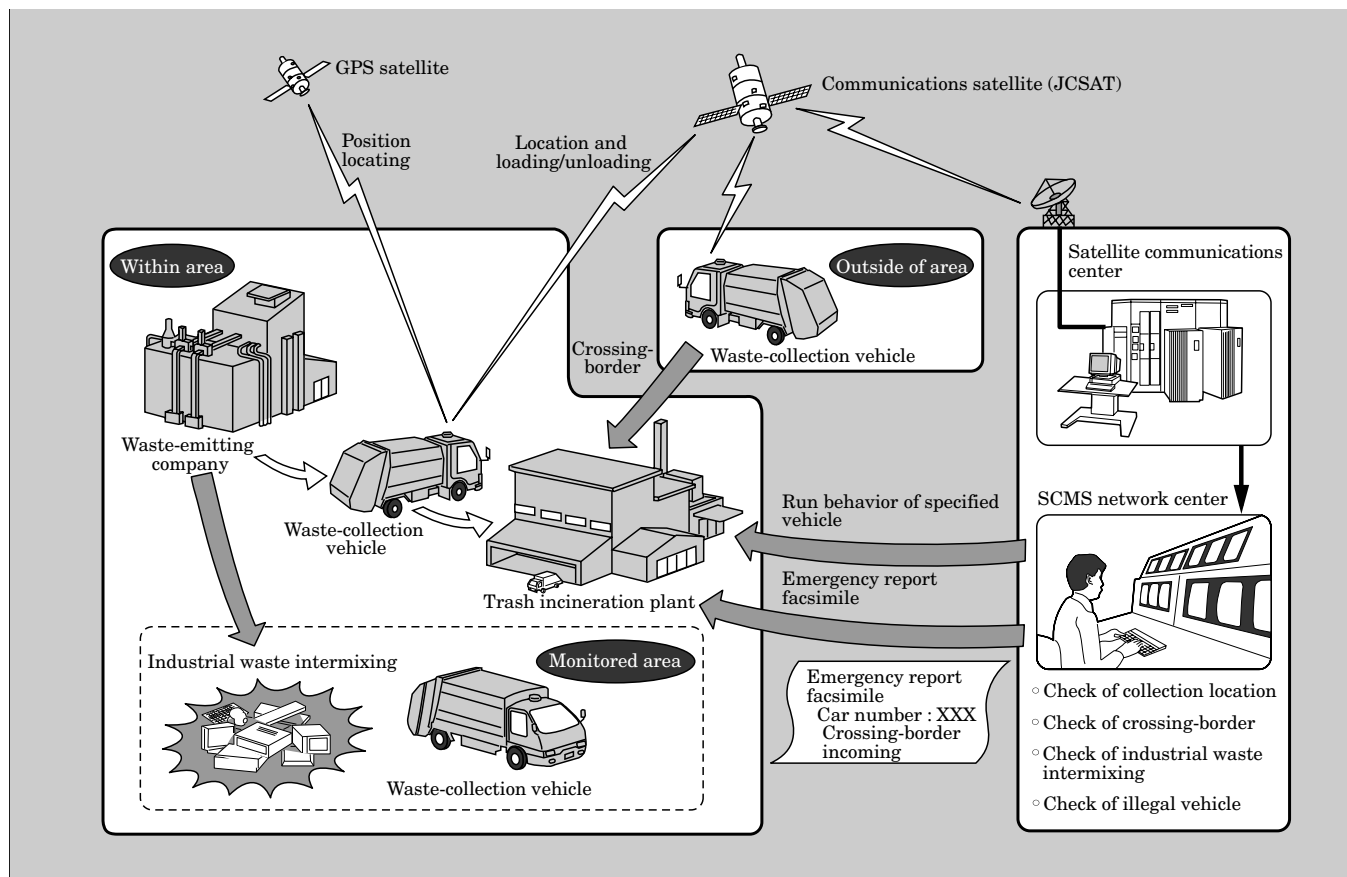
disposal accidents without delay, and also to prevent collateral damage and to keep neighboring residents safe.

Fuji Electric continues striving to solve users'

problems through extending applicability of the SCM information service toward a comprehensive environmental information service.

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