[Environmental Technology Verification]

Summary of Verification Report for FY 2004

Treatment Technologies for Human Waste in Mountain District

Ministry of the Environment of Japan

Contents

I. Introduction

1. What is the Pilot Project for Environmental Technology Verification?

Advanced environmental technologies, even though they are commercial-ready and seem to be useful, have not necessarily been pervasive widely since the users such as local governments, companies and citizens, cannot make selection of those technologies because of the lack in objective assessments, concerning the performance in environmental conservation.

The expectations through this project are as follows;

- ❖ dissemination of the technologies verified in this project developed by venture companies etc. will be promoted,
- ❖ environmental conservation would be achieved,
- ❖ economic activity, such as those in the regional environmental industries would be stimulated,
- ❖ suitable method and system of ETV would be established.

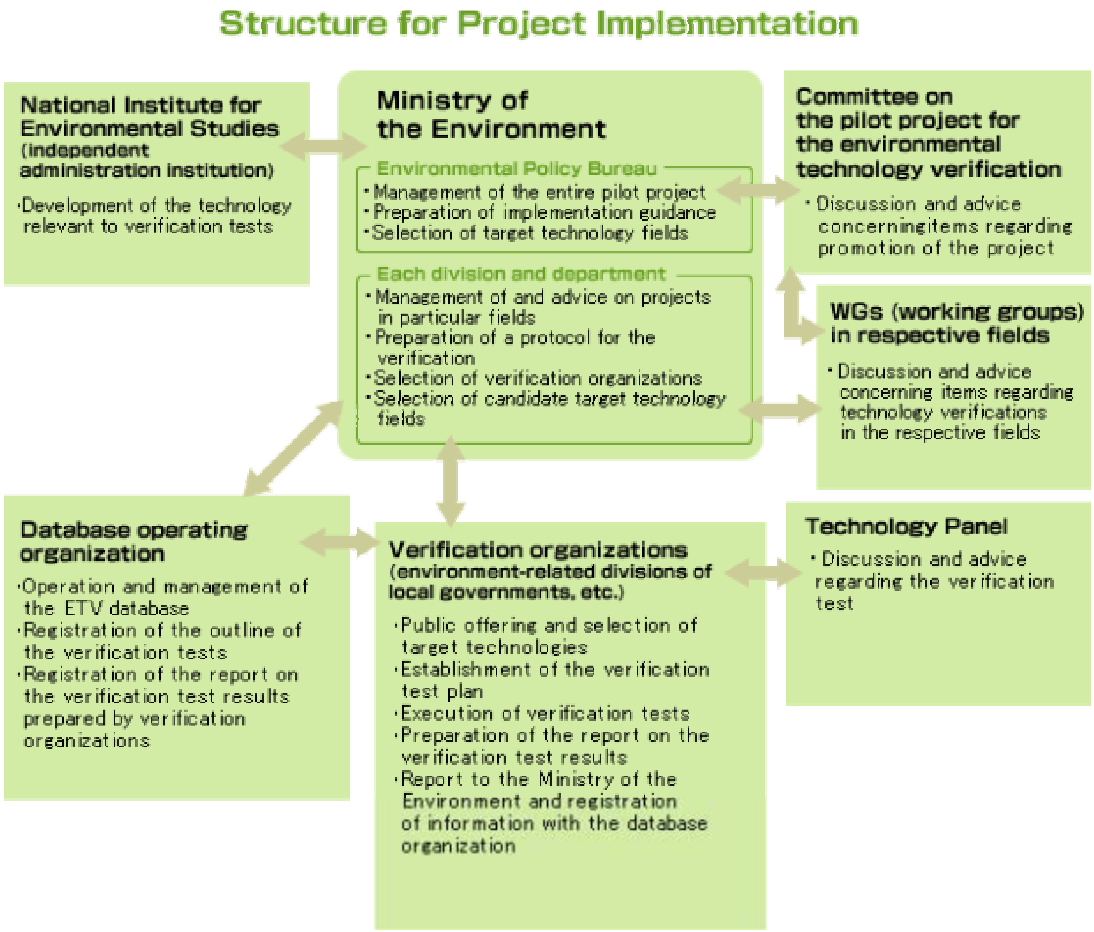


Figure 1: Structure for Project Implementation

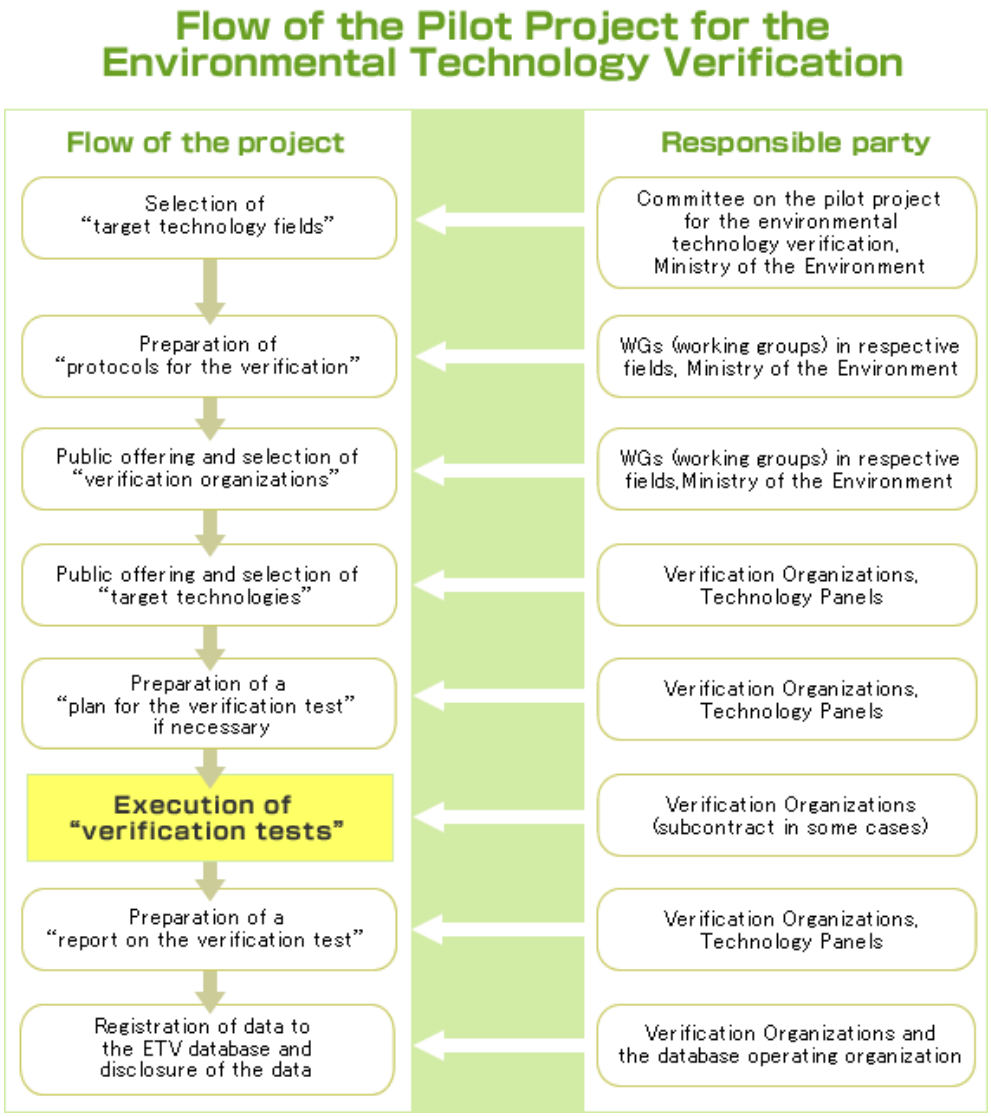


Figure 2: Flow of the Pilot Project for Environmental Technology Verification

2. Selection of target verification technology fields

In the implementation guidance for the Pilot Project for the Environmental Technology Verification in 2003, the scope of the selection of target technology fields was defined as follows:

- ○ Technology field whose developers and users (such as local governments, consumers) require verification.
- ○ Technology field for which technology verification is effective to promote their dissemination.
- ○ Technology field for which verification system such as technology certification, has not been implemented by other conventional systems.
- ○ Technology field for which verification is possible because;

  a. Verification is possible in terms of budget and implementation system.

  b. Verification test procedures can be established properly.

After discussions in the committee on the pilot project for environmental technology verification, the following target technical fields were selected in FY 2003 and 2004.

[FY 2003]

- Ethylene-oxide treatment technologies
- Organic-wastewater treatment technologies for small-scale establishments
- Treatment technologies for human waste in mountainous districts

[FY 2004]

- Ethylene-oxide treatment technologies
- Organic-wastewater treatment technologies for small-scale establishments
- Treatment technologies for human waste in mountainous districts
- Simplified analysis technologies for the monitoring of chemical substances
- Heat-island mitigation technologies
- VOC treatment technologies

3. Contents of this report

This report summarizes the results of verification tests conducted in FY 2003 and 2004 for the technical field of organic wastewater treatment technologies for small-scale establishments. It contains the following contents.

- Summary of target technical fields
- Summary of the target technologies and results of verification tests conducted in FY 2003 and 2004

The verification test results described in this report are only summaries. Details of the results for each technology are available in separate reports (in Japanese only, see the database described below). Please contact each manufacturer for more information.

4. Database of the Pilot Project for Environmental Technology Verification

The database of the Pilot Project for Environmental Technology Verification has been created at the website (URL http://etv-j.eic.or.jp), in order to provide information on the progress and results of the project, including reports on the verification tests. The following information is available at the website:

(1) List of verified technologies

The technologies verified in the pilot project and the verification results thereof, such as those for environmental-protection efficiency (reports on the verification test, etc.).

(2) Protocols of the verifications/Plan for the verification tests

The " protocols of the verifications," which specifies the basic concept, test conditions and methods, and the like in conducting verification tests, and the " plan for the verification tests," which specifies detailed experimental conditions and the like for each target technology based on a protocols of the verifications.

(3) Information on public offering for verification organizations and target verification technologies

Information on public offering including when applications for verification organizations or target verification technologies are invited publicly

(4) Information on the relevant committee and working groups

Documents delivered in and summaries of the meetings of the committee on the pilot project and its working groups, in which plans for implementing the pilot project are discussed.

II. Treatment technologies for human waste in mountainous districts

1. General description

The treatment technology for human waste in mountainous districts specified for this pilot project refers to those technologies for treating human waste in natural surroundings such as mountainous districts where environmental conservation is given priority and where infrastructure such as water supply and sewerage systems, electricity (commercial power source), roads, and the like are unavailable.

The methods for human-waste treatment may be classified into biological treatment methods, chemical treatment methods, physical treatment methods, and combinations of these treatment methods. Table 1 presents the categories of the treatment technologies for toilets in mountainous districts. The “Others” category indicates methods that do not fall under any of the five categories preceding it. For combined treatment methods, the method will be classified according to the treatment method that is considered to be the most characteristic.

What differentiates the technologies presented here from human-waste treatment technologies in general is the fact that rinse water and wastewater containing treated human waste are not released or discharged into public waters. As these non-discharge treatment methods do not require septic tanks, they correspond to the drop-and-store toilets defined in Cabinet Order No. 29 under Article 31 of the Building Standard Law. However, the structures, performance, and maintenance of these toilets differ significantly from those of conventional drop-and-store toilets, so new legislation concerning these technologies is expected to be introduced in the future.

Table 1 Classification of Human-Waste Treatment Technologies in Mountainous Districts

No	Treatment method	Description
1	Biological treatment	Method of biologically treating waste using microbes
2	Physicochemical treatment	Method of physicochemically treating waste
3	Soil treatment	Method for disposing of human waste in the surrounding soil through an underground sprinkler system after pretreatment
4	Dry and combustion treatment	Method for removing moisture in human waste by drying and combustion to convert it into powder form
5	Composting treatment	Method for decomposing human waste using microbes by blending and mixing it into cedar chips and sawdust
6	Others	Methods other than the above 1-5

Figure 3 presents an example of the flow of human-waste treatment in mountainous districts.

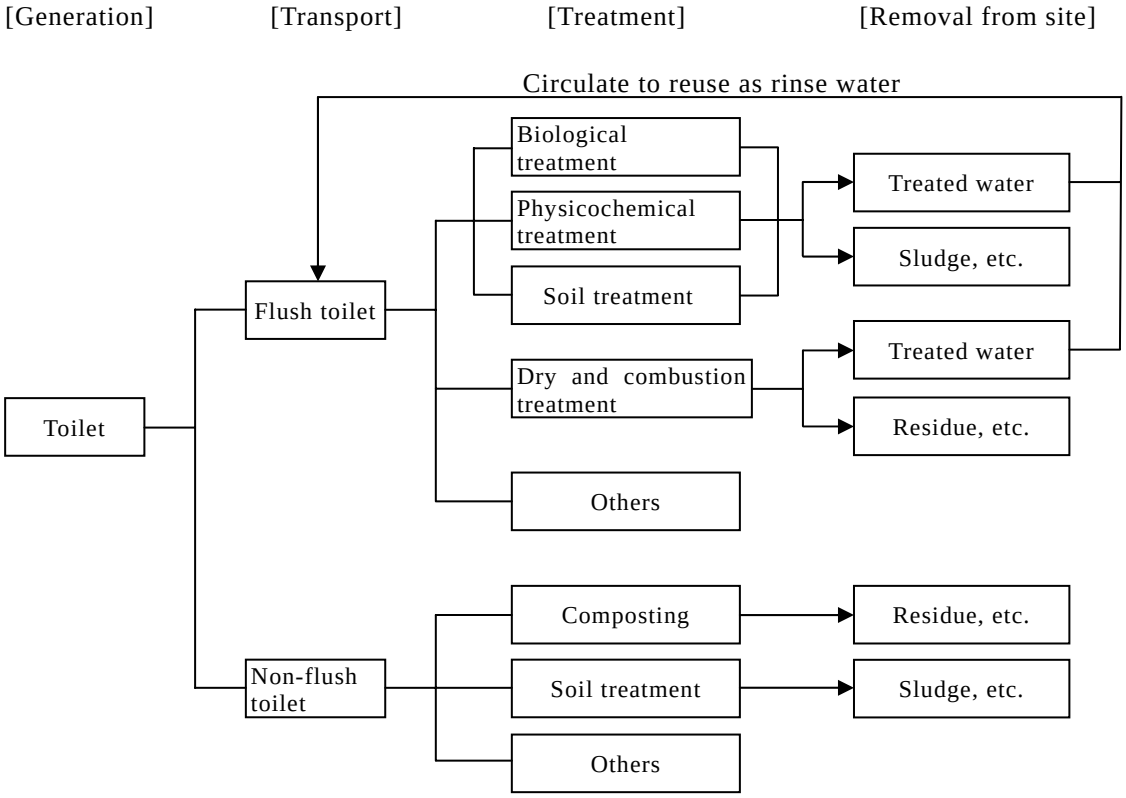


Figure 3 Example of the flow of human-waste treatment in mountainous districts

● Article 31 of the Building Standards Law
(Toilets)
All toilets installed within the regions specified in Article 2-8 of the Sewage Water Law (Article 79 of the 1958 Law) must be flush toilets (restricted to those types in which the waste pipes are connected to public sewage systems as defined in Article 2-3 of the Sewage Water Law).

2. Septic tanks must be installed when waste is to be discharged from the toilets into systems other than public sewage systems having a terminal waste-treatment facility as defined in Article 2-6 of the Sewage Water Law. The structure of the septic tank must conform to the technological standards stipulated by cabinet order regarding the waste-treatment capacity (capacity required by a septic tank to properly treat discharged human waste so as to prevent any negative effects on sanitary conditions), and must be that specified or approved by the Minister of Land, Infrastructure, and Transportation.

● Cabinet Order No. 29 of the Building Standard Law
(Structure of drop-and-store toilets)
The structure of a drop-and-store toilet must conform to the following standards, and must be that specified or approved by the Minister of Land, Infrastructure, and Transportation.
1. The parts coming into contact with human waste must be sealed so as to prevent the leakage of water.
2. The odor from human waste (excluding odor inevitably released from toilet bowls or due to design) may not pass into other parts of the building (excluding the area under the floor of the restroom).
3. Rainwater and soil and sand must be prevented from entering the waste tank.

2. Why was the treatment technology field for human waste in mountainous districts selected as the target verification field?

Mountainous districts normally lack adequate power sources and water supplies for normal flush toilets, and conditions such as low water and air temperatures prevent the installation of septic tanks. Therefore, conventional toilet facilities in mountainous districts were pits dug in the ground for storing waste, which was allowed to permeate through to the surrounding soil. In areas where no toilet facilities were available, people simply relieved themselves outdoors. Although some regions carried human waste out using helicopters or the like, such options were unavailable for most areas due to the high cost involved.

The recent rise in popularity of mountain climbing among middle-aged people has caused concerns that the resulting increase in the human waste released may have adverse effects on the water quality of public water systems and vegetation. These concerns have driven many mountain lodge businesses and local governments to take measures to improve the condition of human waste treatment in their region. The Ministry of the Environment has also been involved in promoting measures to realize improved human-waste treatment, such as by establishing grants for mountain lodge businesses since FY 1999. In light of these events, there has been an increasing number of technologies being developed and commercialized within these past few years for non-discharge of human waste treatment facilities that may be installed in settings where previously septic tanks could not be installed.

In FY 2001, a survey was conducted on mountain lodges in Japan (approximately 300) with insufficient infrastructure, and it was found that only 30% of the owners of the lodges believed the human-waste treatment systems to be “satisfactory in their current state.” Thus, it was concluded that at most mountain lodges there was a need for improved human-waste treatment systems.
What seemed to concern the lodge owners most regarding the introduction of a new type of waste treatment equipment was the risk of “problems such as the failure to achieve the design performance or unsatisfactory operation of the equipment in consideration of the high cost of installation,” as the available information was limited to that provided by the developer of the equipment. Therefore, we have concluded that appropriate steps must be taken by the government to provide information on these new technologies.

Thus, we have selected the technological field of human-waste treatment in mountainous districts for the pilot project for environmental-technology verification, and have conducted verification tests on human-waste treatment technologies in mountainous districts to provide objective information on their environmental-conservation capacities in order to promote environmental conservation in the mountainous districts, as well as to promote the widespread use of appropriate human-waste treatment equipment by mountain lodge businesses.

III.Verification-Test Methods

1. Summary of Verification Test

The Verification Test in this pilot project will verify the following items based on the “Protocol,” which has been prepared for all technologies in the field of human-waste treatment technologies for mountainous districts.

- Range of operational conditions for proper operation, energy consumption, fuel, and types and volumes of consumables
- Operating conditions and contents of operations and maintenance (O&M)
- Conditions inside the cubicle
- Effects on the surrounding environment
- Human-waste processing capacity

The verification test will primarily be conducted according to the steps specified below.

(1) Planning

The plan for the verification test (hereinafter referred to as the “Test Plan”) will be prepared for each target verification technology according to the Verification Test Protocol before the test is conducted. The Test Plan will be prepared by a Verification Organization in cooperation with an environmental technology developer.

(2) Verification testing process

In this stage, a verification test will be conducted according to the Test Plan described above. The verification test verifies the conformity of a target verification apparatus with its objectives specified in the planning stage. The Verification Organization may, if necessary, subcontract part of the verification test to external test organizations.

(3) Data assessment and reporting

In the final stage, all data collected will be analyzed for verification, and a report on the verification test (hereinafter referred to as the “Verification Report”) will be compiled. The Verification Organization will be responsible for analysis of the data and reporting. To accelerate the above process, the Verification Organization may subcontract an external organization to prepare a draft of the Verification Report.

The Verification Report will be submitted by the Verification Organization to the Ministry of the Environment. In the report, the suitability of the verification tests will be discussed by the working group on the ethylene oxide treatment technology (hereinafter referred to as the “Working Group”) of the committee on the pilot project for the environmental technology verification. After its approval by the Ministry of the Environment, the report will be returned to the Verification Organization. The approved Verification Report will then be issued by the Verification Organization to the environmental technology developer and simultaneously disclosed to the public.

2. Verification Organization

The protocol stipulates that the Verification Organization performs the following duties: public offering of target technologies to businesses developing relevant technologies; selection of target technologies; preparation of the Test Plan if necessary; verification of the technology (conduct Verification Test and prepare Verification Reports); and submission of the Verification Report to the Ministry of the Environment and registration to the ETV Database operating organization. In FY 2003, a public offering was made for the selection of Verification Organizations from local governments (of prefectures and government-decreed cities) for each environmental technology field.

Furthermore, in FY 2004, public offerings were made to local governments (of prefectures and government-decreed cities), public-interest corporations founded based on Article 34 of the Civil Law, and specified non-profit organizations. The following local governments and NPOs were selected as the Verification Organizations for the human-waste treatment technologies in mountainous districts in FY 2003 and FY 2004:

- Toyama prefecture
- Nagano prefecture
- Kanagawa prefecture
- Shizuoka prefecture
- NPO “Yama no ECHO”

3. Target Technologies

The target technologies will be selected based on the information obtained from the application form submitted by the business possessing the target technologies. The Verification Organization will make a comprehensive judgment on the technology based on the contents of the application form, and obtain approval from the Ministry of the Environment.

(1) Technical requirements

a. Does the applied technology fall under the category of the target verification technology field?

b. Is the technology in a commercialization stage?

c. Is this the first time the technology will be subjected to technological evaluations, evaluations by verification businesses, or other forms of verification?

(2) Feasibility of verification

a. Is it possible to complete the verification from cost and organizational standpoints?

b. Can a suitable Test Plan be established?

c. Is there a specific candidate for the Test Site for conducting the Verification Test?

d. Can the facility be installed without difficulty at the Test Site?

e. Are the installation conditions at the Test Site within the range of conditions for proper operation of the technology?

f. Has the approval of the owner or manager of the mountain lodge that is to be the Test Site been obtained?

(3) Environmental conservation effect, etc.

a. Is it possible to provide a scientific explanation of the principle and mechanism of the technology?

b. Is there any possibility of the technology causing environmental issues?

c. Can a high environmental-protection effect be expected?

d. Is it an innovative technology?

4. Determination of Verification Items

The considerations in verification of the human-waste treatment technologies in mountainous districts can be largely classified into the following five groups: a) operational conditions and status; b) O&M performance; c) indoor conditions; d) environmental impact; and e) treatment performance. The classification items and verification items corresponding to each verification point are shown in Tables 2-7.

Table 2. Points of verification

	Considerations	Description
a	Operational conditions and status	Verify the requirements and preconditions for proper operation
b	O&M performance	Verify the ease of daily and specialized O&M
c	Indoor conditions	Verify the comfort level inside the cubicles
d	Environmental impact	Verify the impact on the surrounding environment
e	Treatment performance	Verify the treatment performance

Table 3. a) Major verification items regarding operational conditions and status

No	Classification items	Verification items
1	Number of users	Number of people using the facility per day
2	Water	Initial volume required
3		Replenished volume
4		Consumed volume
5	Electric power	Electric-power consumption, maximum electric-power consumption
6	Fuel	Type, volume, etc. of fuel consumed
7	Consumables	Types, cost, and volume of consumed materials
8	Temperature	Temperature at the installation site
9	Weather	Weather at the installation site

Table 4. b) Major verification items regarding O&M performance

No	Classification items	Verification items
1	Routine maintenance procedures	Contents of O&M procedures and the number of operators, time required, workability, etc.
2	Specialized maintenance procedures	
3	Procedures for on- and off-season preparations	
4	Transportation, processing, and disposal of refuse	
5	Troubleshooting procedures	
6	Reliability	Legibility, clarity, and accuracy

Table 5. c) Major verification items regarding indoor conditions

No	Verification items	
1	Temperature	
2	Humidity	
3	Allowable range	Comfort level
4		Operability

Table 6. d) Major verification items regarding impact on the surrounding environment

No	Classification items	Verification items
1	Conditions of soil alteration	Surface area of installation, change in ground morphology, felling and clearing of area, earthwork, etc.
2	Surrounding soil	Nitrogen in nitric form, chloride ions

Of the considerations in verification, the treatment performance will be used not only to verify the human-waste processing capacity of the target apparatus, but also to verify its safety. The Verification Organization shall determine the verification items regarding the treatment performance based on information such as advice from the technology developer, the technical specifications of the target apparatus, operational conditions, and status at the Test Site, in order to make a complete characterization of the target technology. The major verification items are shown in Table 7.

Table 7. e) Major verification items regarding Treatment Performance

Major verification items	Description
pH	An index representing the degree of acidity or alkalinity. When the pH is 7, the substance is neutral; the higher the pH level the more alkaline the substance, and the lower the pH level the more acidic the substance. Generally, human waste displays weak acidity immediately after excretion, but gradually turns into a weak alkaline over time due to hydrolysis.
BOD: Biochemical Oxygen Demand (mg/L)	One of the major indexes of the quality of the treated water; refers to the amount of oxygen that would be consumed if all of the organic material contained in a liter of water were decomposed by microbes. When the water is polluted and contains large amounts of organic substances that may be decomposed biologically, it will display a high BOD value. Generally, 1 liter of collected human waste will contain approximately 13,000 mg of BOD.
TOC: Total Organic Carbon (mg/L)	Represents the amount of carbon in organic matter. Polluted water with a high organic-substance content will display high TOC values. While 5 days are required to analyze BOD, TOC can be measured in a short time through the use of an analysis instrument.
SS: Suspended Solids (mg/L)	Of the components that make water turbid, solid particles that are less than 2 mm in diameter and are not dissolved. It is an important index along with BOD. More turbid and polluted waters display high SS values. BOD values will decrease when SS is removed through treatment. Generally, human waste contains up to approximately 18,000 mg of SS per liter.
TS: Total solids (mg/L)	Solids that remain after the evaporation of water by heating and drying. Represents the total amount of solids contained in water. Water containing large amounts of solid material will display high TS values.
IL (VS): Ignition loss (Volatile Solids) (mg/L)	Represents the amount of material lost by evaporation when residual solids are incinerated at high temperatures. As organic materials are the main components of the volatile solids, the IL (VS) values will be high for samples containing large amounts of organic materials.
Total Coliform Group (groups/mL)	Coliform is a generic name given to *E. coli* bacteria and bacteria having similar characteristics. As *E. coli* bacteria exists in abundance in the intestines of humans and animals, water containing the coliform groups are likely to be contaminated by feces and other pathogens. Generally, 1 ml of collected human waste contains over 1,000,000 coliform groups.
Cl^-: Chloride ion (mg/L)	Represents the amount of ionized chlorine in water. As normal biological treatment processes will not remove chloride ions, this can be used to estimate the rate of dilution by wash water or the concentration rate. Generally, 1 liter of collected urine will contain approximately 3,800 mg of chloride ion.
EC: Electrical conductivity (S/m)	The ability of an aqueous solution to conduct electricity. Can be used as an indicator of the total amount of ions dissolved in water, or as an indicator for salt accumulation. Pure water displays EC of nearly 0, while water containing large amounts of impurities will display high EC values.

Details on the verification items are given in the “Protocol,” which defines the basic principles, the test conditions, and the methods for the Verification Tests, and in the “Test Plan,” which lays down the detailed test conditions based on the Protocol. These can be viewed at our website (http://etv-j.eic.or.jp/).

IV. Verification-Test Results

1. Verification Report

The results of the Verification Test will be submitted in the form of a Verification Report. All data, including that on the operational conditions and status, the results of the verification test, all actions taken for O&M, and any changes in the test results for verification items concerning water quality throughout the test period shall be described in the Verification Report.

The Verification Organization will prepare a draft of the Verification Report, which, after examination by the Technology Panel, will be compiled as a final report. The Verification Report will be submitted to the Ministry of the Environment and discussed by the Working Groups before approval is given by the Ministry of the Environment.

2. Summary of the Target Technologies

The following are the target technologies for the present Verification Tests.

	Verification Organization	Verification applicant (technology developer)	Treatment method (name of treatment apparatus)	Test period (inclusion or exclusion of wintering test*)	Page #
FY 2003	Toyama Prefecture	Reinforce Co., Ltd.	Soil treatment (Sunlet)	Oct. 15, 2003 – Oct. 5, 2004 (includes wintering test)	P14
		Takahashikikan Co., Ltd. (Seiwa Denko Co., Ltd.)	Composting treatment (Bio-Lux)	July 24, 2004 – ongoing (includes wintering test)	---
FY 2004	NPO "Yamano ECHO"	Orient Ecology Co., Ltd.	Physicochemical treatment (steady-circulation-type human-waste treatment system "Seseragi")	Aug. 11, 2004 - Dec. 13, 2004 (no wintering test, as this system is not affected by winter conditions)	P20
	Kanagawa Prefecture	Reinforce Co., Ltd.	Soil treatment (Sunlet)	Sept. 2, 2004 – ongoing (no wintering test, as this system will operate year-round)	---
	Nagano Prefecture	Daiichi Kogai Plant Co., Ltd.	Soil treatment (AbicFB-type human-waste treatment apparatus)	Aug. 3, 2004 – ongoing (includes wintering test)	---
	Shizuoka Prefecture	Yamashiro Kizai Co., Ltd.	Biological treatment (Above-ground installation and low-floor-type Double Clean)	July 27, 2004 – ongoing (includes wintering test)	---

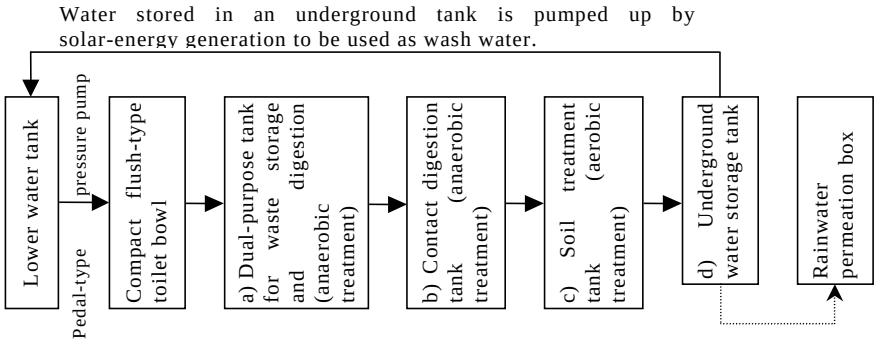
* Note) In the wintering test, the apparatus will be shut down and closed temporarily during the winter season to obtain data on the startup of the apparatus at the beginning of the next season.

V. Summary of the Verification Reports

1. Toyama Prefecture

Human-waste treatment (See Note)	Soil treatment method
Verification Organization	Nature Conservation Section, Living Environment Division, Toyama Prefecture TEL: int-81-76-444-3399FAX: int-81-76-444-4430
Verification applicant /Environment technology developer	Reinforce Co., Ltd. TEL: int-81-467-33-0500 FAX: int-81-467-33-0501

Note) Enter the category name of the human-waste treatment method defined in the Protocol that corresponds to the present technology.

(1) Summary of the Verification Apparatus	
Features of the apparatus	・ The present apparatus processes wastewater through the adsorption and filtering effect of soil particles, and through the metabolism of microbes in the soil. Under appropriate conditions, this apparatus will remove not only organic materials but also nitrogen and phosphorus. ・ The compact toilet bowl adopted for this system uses 250 cc of water each time it is flushed. ・ An enzyme additive will liquefy solid waste in order to enhance biological decomposition. ・ To prevent the mixing of rainwater and soil-treated water, rainwater is directed to a rainwater permeation box, which transports and releases the rainwater beneath the ground outside the system by permeation. ・ This facility may be installed where no commercial power sources are available, as it uses a unique system in which treated water is circulated by pressure-type foot pedals.
Flow of human-waste treatment and description	 (1) Enzyme is added to the dual-purpose tank in order to liquefy solids contained in the waste. (2) In the contact digestion tank, suspended matter is removed, and the wastewater is transported gradually by gravity to the soil treatment tank. (3) The soil treatment tank is enclosed on all four sides by waterproof sheets to prevent the infiltration of processed water into the groundwater. The processed water in the contact digestion tank seep into the soil layer by permeation via the porous spray pipe (trench) buried underground, and are decomposed and purified in the process. (4) The water purified by this soil treatment method is then stored in an underground water storage tank located beneath the soil treatment tank, and is reused as wash water. * Note that the water is transported from one tank to another by gravity, except when processed water is transported from the underground water storage tank to the lower water tank or when the water in the lower water tank is pumped up by a foot-pedal to wash the toilet bowl.

(2) Summary of Verification Test

a) Description of Test Site

Name of municipality	Toyama prefecture
Name of mountain	▪ Name of mountain: Ichinokoshi, Tateyama ▪ Name of mountain range: Kita Alps ▪ Altitude: 2,700 m
Start of toilet service	July 2002 (start of toilet utilization after installation)
Period of toilet service	(Year-round • only during the climbing season) *Season: July 1 – Oct. 14

a. Full view b. Soil-treatment section [located at the rear of building in photo a] c, d. Cubicles

b) Specifications of the Verification Apparatus and Treatment Capacity

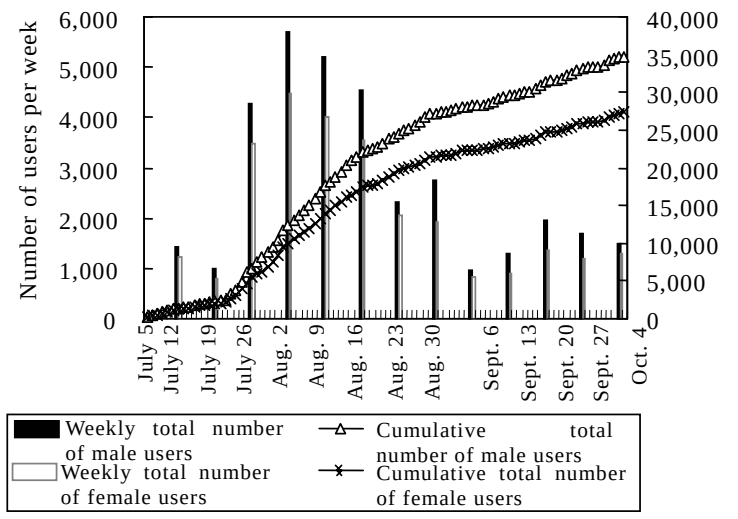
Items	Specifications and treatment capacity	
Name of apparatus	Name: Sunlet; Model: FT-II	
Dimensions	Building: 71.0 m^2 (5,920 mm (W) × 12,000 mm (D)) Soil-treatment section: 81.3 m^2; Contact digestion tank: 2.6 m^2 (1,550 mm (W) × 550 mm (D) × 3 units) Others: 0.8 m^2 (7,600 mm (L) × Φ100 mm) Total area: 155.7 m^2	
Number of toilets	For men (Toilets: 1 Japanese style, 1 western style; Urinals: 3) For women (1 western style, 5 Japanese style) Common (–)	
Treatment capacity (design and spec.)	Number of users	Normal usage: 1,000 users/day Heavy usage: 1,500 users/day
	Water consumption	Initial volume: 10 m^3 Replenishment: 0 m^3
	Electric-power consumption	Required power: 0.15 kW Power consumption: – kWh/month
	Fuel consumption	Unnecessary
	Utilization of natural energy sources	Purpose: To transport treated water to the lower water tank (wash-water tank) by pump Type: Solar panels Specifications: Maximum design output above 979 W (61.2 W/panel × 16 panels)
	Operational temperature range	Above 0ºC
	Specialized maintenance	Approximately once per year
	Waste to be removed from site	Generated waste: Sludge
		Volume of generation and frequency of transport: Dependent on the state of usage
		Final disposal method: Treated and disposed of as domestic wastewater sludge

(3) Verification-Test Results

a) Operational Conditions and Status

Items	Results of validation test
Test period	Test period: Oct. 15, 2003 – Oct. 5, 2004 (357 days) Wintering period: Oct. 15, 2003 – July 4, 2004 (264 days)
Utilization conditions	Total number of users: 62,182 (92 days) Heavy usage: July 17 – Aug. 15 (30 days); maximum: 2,303 users/day; average: 1,194 users/day Normal service: maximum, 1,168 users/day; average: 425 users/day
Toilet paper	Disposal of used paper: (Dispose of in toilet • dispose of separately)
Charge and/or tip	Boxes for tips are placed at the entrance to the men's and ladies' rooms.
Temperature	Maximum: 22.6ºC; minimum: 2.2ºC; average: 10ºC
Water consumption	Initial volume: 10 m^3; replenished volume: 0 m^3 (In the future, water may have to be replenished when sludge is collected.) Method of securing the required water: Waterworks • rainwater • streams • springs • others
Electric-power consumption	Required power: 0.15 kW Method of securing the required power: Commercial power • private generation • others (solar power)
Method of transporting required materials in and out of the Test Site	Method of transporting fuel • maintenance supplies • sludge, etc. [Automobile • helicopter • bulldozer • manpower • others (none required during the test period)]

Graph showing number of users



- Throughout the Test Period, the number of male users tended to be higher than the number of female users.
- A large peak was observed during the summer vacation period, and a small peak in the fall. The maximum number of users was 2,303 in a single day (total of male and female users).

b) O&M Performance

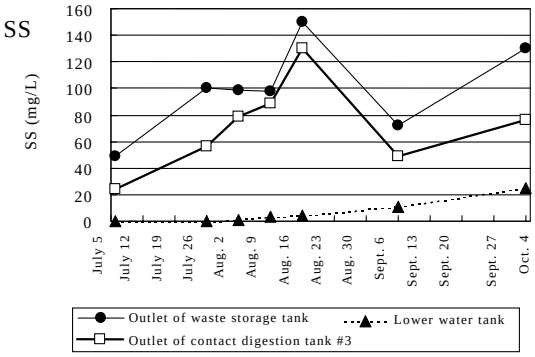
Items	Verification-Test Results	
Routine maintenance	Workload per process: Approx. 30 min. with 1 operator; frequency of maintenance: once per day	
Specialized maintenance	Workload per process: Approx. 2 hrs and 10 min. with 2 operators	
Preparations for closing and opening of climbing season	Workload per process: Approx. 2 hrs with 3 operators for both the closing and opening	
Removal, treatment, and disposal of generated waste	None (Although this was not required during the Test Period, it will be necessary to collect the sludge over the long term.)	
Problems encountered	a. Freezing of the lower water tank (during winter), b. The lid of the inspection box was blown off (typhoon).	
Running cost (not including air shipment)	Cost of electricity or fuel for electricity	--- yen/month
	Cost of water	--- yen/month
	Cost of consumables	Average of 7,500 yen/month for enzymes
	Cost of transportation for generated waste, etc	--- yen/month
	Miscellaneous costs	--- yen/month

b) O&M Performance	
Ease of O&M procedure	There are no serious problems in the operation of the apparatus. However, improvements need to be made in order to facilitate the inspection procedure.
Removal of sludge, etc.	Although there was no need for this step during the Test Period, there will come a time when the sludge and waste must be recovered from the apparatus and transported out of the Test Site. Thus, arrangements must be made to transport them and secure a disposal site.
O&M manual	No complex procedures are involved in the daily maintenance. However, it was found that an on-site tutorial session would be more effective in ensuring understanding of the procedures than use of the manual alone. There is also a need to present clear figures and drawings showing the specialized maintenance procedures in detail.

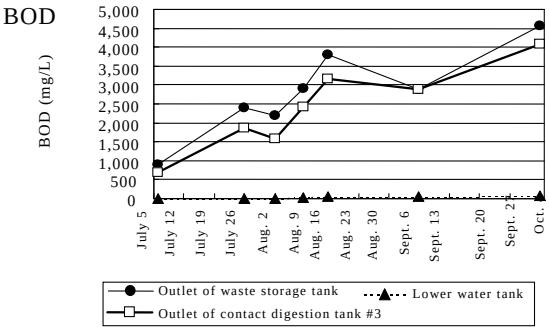
c) Indoor Conditions	
Below are replies to the main questions in our survey of users regarding the conditions inside the cubicles.	
a. Odor	69% found it acceptable
b. Brightness	75% found it acceptable
c. Color and turbidity of wash water	75% found them acceptable
d. User-friendliness of foot pedal	48% found it acceptable, 29% indicated that improvements were needed

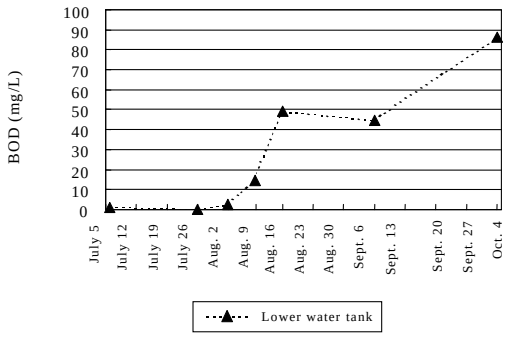
d) Treatment Capacity

SS



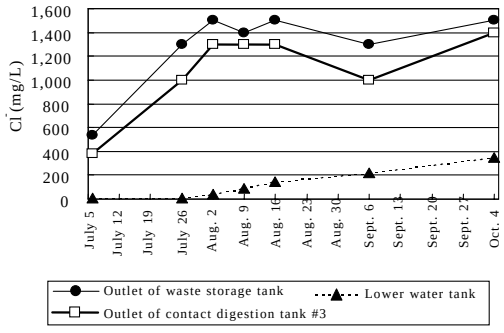
BOD





- During the Test Period, there were 6 days on which the number of users exceeded 1,500. However, there were no major problems associated with this.
- The data collected on Sept. 6 showed a deterioration in water quality for all indexes due to the dilution of water inside the tank by large amounts of rainwater.
- It was found that a majority of the suspended solids (SS) were successfully removed by precipitation in the dual-purpose tank for waste storage and digestion, and by the filter placed at the outlet.
- The BOD of the treated water (inside the lower water tank) was below 10 mg/L for 1 month after the opening of the climbing season, but began to increase after the period of heavy usage.
- While the chloride ion concentration in the soil treatment tank was 1/4 to 1/5 of that in the dual-purpose tank for waste storage and digestion, the BOD value was 1/30 to 1/40, indicating the successful decomposition of organic materials.

Cl^-



(4) Points to Consider in Adoption of the Present Target Apparatus

a) Points Regarding Installation Conditions

- This requires a sufficiently large area for the installation of a soil treatment tank. It also requires the introduction of special additional soil, and thus measures must be taken to prevent it from affecting the surrounding vegetation and the like.
- This apparatus requires drilling of the ground and construction of a concrete foundation. Therefore, its installation will require careful planning concerning the contents of the construction work, carrying in of materials and equipment, and the period and cost of the construction work.
- A relatively large volume of water is initially required in the soil treatment tank and waste storage tank before the facility is ready for service. Thus, measures must be taken in advance to collect the required volume through the use of a rainwater collection tank or the like.

b) Points Regarding Planning, Operation, and Maintenance

- Make sure the trench is level, and secure an inspection hole and method that will make it possible to check the volume of influx to the trench and rainwater permeation box, test the water quality, and make necessary adjustments.
- Although the treatment section of the apparatus will be installed underground, appropriate countermeasures must be taken to prevent freezing and wind damage to the above-ground part, as well as to prevent the soil-treatment section from being covered with snow.
- The compact toilet bowl has a greater tendency to become dirty than normal flush-type bowls. Thus, measures must be taken to clean and deodorize the toilet bowls and cubicles.
- In addition to the routine O&M procedures, regular O&M by specialized management operators significantly affects the performance of this apparatus. However, a certain level of expertise and knowledge is required for specialized O&M management of the apparatus.
- When rainfall causes large amounts of rainwater to flow into the soil treatment tank, there is a danger of soil-treated water being released from the system via the rainwater permeation box. Measures must be taken to prevent such an occurrence.

(6) Future Themes and Expectations

[Installation Conditions]

- It is possible to install this apparatus at sites without electricity or roads, provided that the initial volume of water can be obtained. Thus, this apparatus will enable a reasonably comfortable toilet to be installed in areas such as mountainous districts where the social infrastructure is insufficient.

[Technical Improvements]

- To achieve stable operation of this apparatus over an extended period, it will be necessary to collect data on the frequency of accumulated-sludge removal, the rate of clogging of the pores in the soil treatment layer, and the extent of salt accumulation in the soil treatment layer. Furthermore, it is expected that significant improvements will be made to the wash-water circulation system by storing the rainwater flowing into the rainwater permeation box, and using it as the wash water required during sludge removal and for replenishment thereafter.

[O&M]

- In order to operate the system through the collaborative efforts of the specialized and non-specialized operators, it is recommended that a check sheet providing details of the actual O&M procedures be prepared, in addition to advanced manuals for specialized operators containing directions on the specialized O&M procedures, inspection points for assessing the status of the apparatus, and troubleshooting measures for the apparatus. This should minimize the number of required outside specialists and allow effective management.

(Reference Information)

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○ Product Data

Items		Entry by the environmental-technology developer			
Name/model		Sunlet/FT-II MK			
Human-waste treatment method		Soil treatment			
Name of manufacturer (dealer)		Reinforce Co., Ltd.			
Contact information	TEL & FAX	TEL: int-81-467-33-0500 FAX: int-467-33-0501			
	Website	http://reinforce.co.jp			
	e-mail	hukuda@reinforce.co.jp			
Dimensions/weight		Building: 1,200 mm (W) × 2,400 mm (L) × 3,100 mm (H)/0.7 tons Foundation: 200 mm (W) × 2,300 mm (L) × 600 mm (H)/0.4 tons			
		If components of the apparatus may be taken apart to facilitate transport and then reassembled at the site, indicate the dimensions and weight of each part. Improved soil 0.8 tons × 12 bags = 9.6 tons Soil materials 2 tons Total area: 35 m^2			
Time required for installation		20 days			
Design life of target apparatus		30 years			
Cost estimation (yen)*		Item	Unit price	Number of Units	Total
Initial cost		Building		1 set	Specified separately
		Insulated waste storage tank and sanitation equipment		1 set	¥650,000
		Soil treatment materials		1 set	¥3,560,000
				Total	¥4,210,000
Operating cost		Digestive enzyme		1 box per year	¥10,000
		Deodorizing enzyme		1 box per year	¥10,000
				Total	¥20,000
*The following conditions (treatment capacity, number of holes, etc.) were assumed for cost estimation. The estimation does not include shipping. Treatment capacity Normal usage: 160 users/day Heavy usage: 320 user/day Number of toilets 1 unit Circulation system uses foot-pedal pump					

○ Other information provided by manufacturer

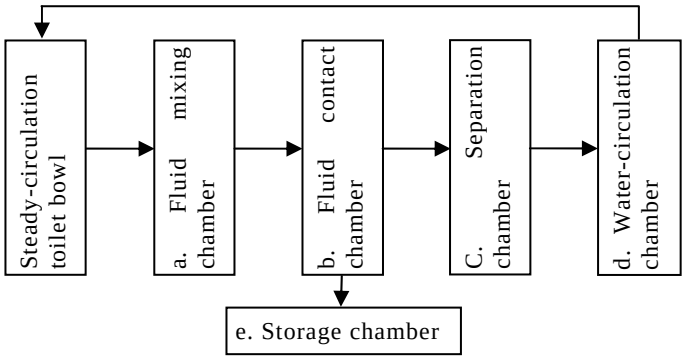
"A system for replacing the foot-pedal pump"

We are pleased to introduce our new "Solar-Powered Sunlet," an improved system having an elevated water tank that has been developed to facilitate the flushing process. This new system uses solar power as its energy source, and has a small pump to charge water into the elevated tank. This combination of a toilet and elevated water tank will allow users to flush toilets more easily.

2. Non-Profit Organization Yamano ECHO

Human-waste treatment (See Note)	Physicochemical treatment method (Steady-circulation-type human-waste treatment system)
Verification Organization	NPO “Yamano ECHO” TEL: int-81-3-3580-7179 FAX: int-81-3-3580-7176
Verification applicant /Environmental technology developer	Orient Ecology Co., Ltd. TEL: int-81-3-3237-0558 FAX: int-81-3-3237-0575

Note) Enter the category name of the human-waste treatment method defined in the Protocol that corresponds to the present technology.

(1) Summary of the Verification Apparatus	
Features of the apparatus	The present apparatus only requires water at the beginning of the operation. Once in operation, it requires neither the feeding nor release of water, and the water in the system is circulated continuously. The wastewater is purified by precipitation, separation and/or oxidation, and is reused over and over as wash water for flushing. Prior to the start of service, an odor-suppressant is added to the water, and the pH is also suppressed to limit the generation of odor and the proliferation of *E. Coli* bacteria. However, after a certain period, the circulating water must be removed from the system together with the accumulated sludge
Flow and description of human-waste treatment	 a) The waste entering the circulating water is aerated, mixed, fragmented, and sent to the fluid contact chamber. b) Supernatant fluid that has passed through the immersed aeration screen is then sent to the separation chamber. The solid particles that were not able to pass through the screen are separated by precipitation and sent to the storage chamber. c) Solids with large specific gravities precipitate, and the supernatant is sent to the water-circulation chamber. d) The water inside the circulation chamber is reused as wash water for flushing the toilets e) Sludge sent from the fluid contact room is stored here. When the storage chamber becomes full, the sludge is removed together with the circulating water.

(2) Summary of Verification Test

a) Description of Test Site

Name of municipality	Tochigi prefecture
Name of mountain	▪ Name of mountain: West shore of Lake Chuzenji, Nikko ▪ Altitude: 1,270 m
Start of toilet service (pre-installed)	Aug. 7, 2003 (start of toilet utilization after installation)
Period of toilet service	(Year-round • only during the climbing season) *Season: Apr. – Nov.


Outer view of restroom


Japanese-style toilets


Multi-purpose western-style toilet


Water-circulation chamber


Fluid mixing chamber

b) Specifications and Treatment Capacity of the Verification Apparatus

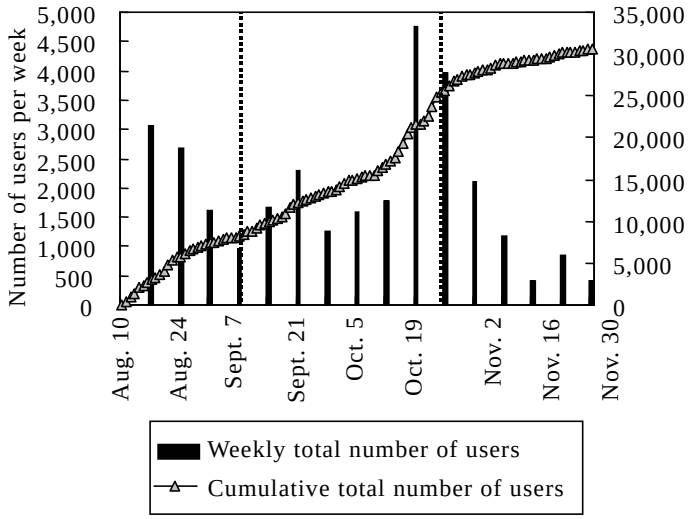
Items	Specifications and treatment capacity	
Name of apparatus	Name: Steady-circulation-type human-waste treatment system; Model: SY-1 • SY-2 • SY-3	
Dimensions	Floor area of building (8,645 mm (W) × 4,850 mm (D) = 41.93 m^2) (that shared with treatment equipment: 0 m^2) Human-waste-treatment instrument dimensions (2,715 mm (W) × 920 mm (D) × 2,760 mm (H)) (3 units: Male, Female, Multi-purpose)	
Number of toilets	For men (1 toilet, 2 urinals) For women (2) Multi-purpose (1)	
Treatment capacity (design and spec.)	Number of users	Normal usage: Maximum continuous usage 4,000 users/unit Heavy usage: As above
	Water consumption	Initial volume: 5.37 m^3 Replenishment: 0 m^3
	Electric-power consumption	Power consumption: 9.90 kWh/day, not including power consumed by ventilation fan and lighting
	Fuel consumption	Unnecessary
	Utilization of natural energy sources	None
	Operational temperature range	Above -5ºC
	Specialized maintenance	Sludge removal
	Waste to be removed from site	Generated waste: Sludge and circulation water
		Volume of generated waste: 9 m^3; frequency: for every 12,000 users (assuming a unit human-waste volume of 0.3 L/person)
		Disposal method: After being removed from the system, the sludge and circulation water are treated at human-waste treatment facilities.

(3) Verification-Test Results

a) Operational Conditions and Status

Items	Results of validation test
Test period	Test period [Aug. 11, 2004 – Dec. 3, 2004 (115 days)]
Utilization conditions	Total number of users: 30,629 (115 days) Heavy usage: Sept. 15 – Oct. 13 (29 days) (maximum: 830 users/day; average: 254 users/day) Normal service: Maximum, 1,219 users/day; average, 280 users/day
Toilet paper	Disposal of used paper: [Dispose of in toilet] • dispose of separately)
Temperature	Maximum: 28.5ºC; minimum: -3.6ºC; average: 12.3ºC
Water consumption	Initial volume: 5.4 m^3; replenished volume: 0 m^3 Method of securing required water: Waterworks • rainwater • [streams] • springs • others
Electric-power consumption	Required power: 412.3 kW/month Method of securing required power: [Commercial power] • private generation • others (natural energy, etc.)
Method of transporting required materials in and out of Test Site	Method of transporting human-waste treatment instrument and fuel • maintenance supplies • sludge, etc. [Automobile] • helicopter • bulldozer • manpower • others

Graph showing number of users and O&M status



- All of the Sludge was removed on Sept. 7 and Oct. 25 (as indicated by the dotted vertical line) during the Verification Test. Along with the sludge, all of the circulation water was removed and replaced with new, clean water.
- Two peaks were observed: one in the middle of August during the height of the summer vacation season, and the other in the middle of October during the autumn foliage season.
- Although the limit set for the present instrument is 4,000 users per unit, there were no problems evident with uses exceeding this limit.

b) O&M Performance

Items	Verification-Test Results	
Routine maintenance	Workload per process (Approx. 60 min. with 2 operators) Frequency of maintenance (once per day)	
Specialized maintenance	Workload per process (Approx. 60 min., average of 2.4 operators) Frequency of maintenance (7 times during the Test Period)	
Preparations for closing and opening of climbing season	Workload per process [Opening (120 min., 5 operators) Closing (120 minutes, 4 operators)]	
Removal, treatment, and disposal of generated waste	Workload per process (Approx. 120 min., 3 operators) Frequency of maintenance (3 times during the Test Period) Types of generated waste (sludge • circulation water)	
Problems encountered	Clogging of immersed aeration screen (Once during the Test Period)	
Operating Cost (not including air shipment)	Cost of electricity or of fuel for electricity	– yen/month, consumed electricity: 412.3 kWh/month
	Cost of water	0 yen/month
	Cost of consumables	60,000 yen/cycle Name of consumable: Odor suppressant
	Cost of transportation for generated waste, etc.	175,000 yen/month

O&M Performance	
Ease of O&M procedure	Instructions for the O&M procedures were included in the manual, and the flow of the work was clearly labeled in the machine room, and was therefore easy to follow. The workload and the time required were adequate, and no serious problems were encountered during the Test Period.
Removal of sludge, etc.	The removal of generated waste from the system was made difficult by the fact the space for this work was cramped by the pipes and pieces of machinery.
O&M manual	The O&M manual was particularly reliable in providing instructions for routine O&M maintenance. A sufficient amount of information on specialized O&M was also provided in the manual, although understanding of the specialized O&M procedures may have been greatly assisted by the design plan of the instruments, and the flow of water inside a single instrument unit.

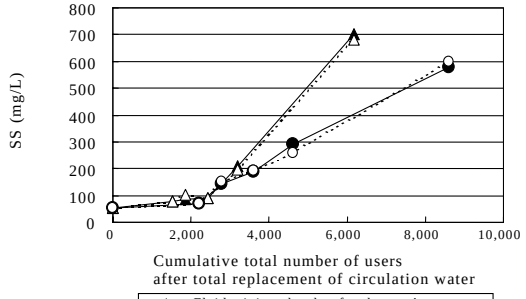
c) Indoor Conditions

Below are replies to the main questions in our survey of users regarding the conditions inside the cubicles.

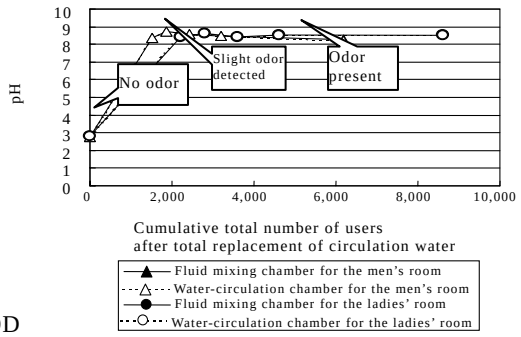
a. Odor	93% found it acceptable
b. Brightness	89% found it acceptable
c. Color and turbidity of wash water	85% found them acceptable

d) Treatment Capacity

SS



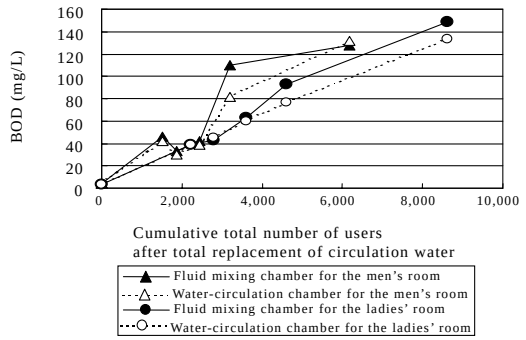
pH



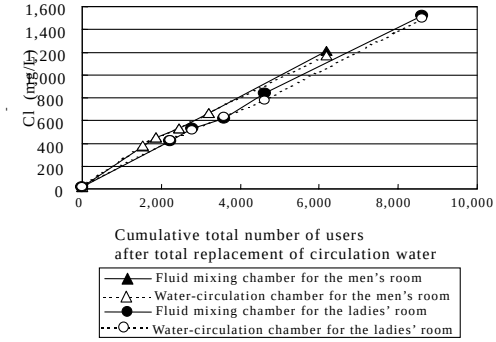
The plots show the relationship between the number of users and the quality of the circulation water during the period from Sept. 7 to Oct. 25, during which time usage peaked.

- An increase in the number of users caused the coloration, decreased transparency, and decreased DO of the circulation water. However, the temporal variations in usage (peak) did not seem to affect them.
- The addition of an odor suppressant (which suppresses the pH and thus prevents the evaporation of ammonia) when circulation water is replaced suppresses the ammonia odor while maintaining the acidity of the circulation water. However, once the circulation water becomes alkaline, odor is generated.
- A difference was observed in the rate of sludge accumulation and the storage limit between the units; the former was naturally affected by the number of users.

BOD



Cl^-



(4) Points to Consider in Adoption of the Present Target Apparatus

a) Points Regarding Installation Conditions

- Power sources for pumps and blowers, and the water necessary for initial feeding and replenishment must be secured.
- When year-round operation is intended, special caution must be taken to prevent freezing, condensation, and wind damage.
- The circulation water must be removed from the system during cleaning and shutdown for the winter season. Thus, plans must be made in advance for disposal of the removed sludge and water.

b) Points Regarding Planning, Operation, and Maintenance

- In the present verification test, it was found that when the unit of maximum usage became full, the other units also required cleaning. Thus, an instrument that can be additionally installed to allow effective utilization of the lesser-used units (such as a sludge transfer instrument) or the transfer of sludge during specialized O&M procedures should be effective when multiple units are installed.
- Each unit has a compact design, and while this may be favorable in terms of reducing the amount of required space, it seems to prevent the easy insertion or removal of some component parts, such as pumps, blowers, diffusion units, valves, electromagnetic valves, and circuitry. In addition, the complex piping makes it difficult to perform O&M procedures. We recommend that the design be reexamined with consideration given to the space required for O&M, footings, and inspection aisles.
- Special care must be taken during cleaning to prevent damage to internal fixtures caused by-vacuum cleaner hoses.
- In the event of a problem, a pilot lamp will light up to notify the daily operator of the problem. However, we believe it is necessary to provide on-site training for the operators in order to enable them to respond adequately to the problem.
- Countermeasures must be taken to prevent contamination from wastewater droplets, and to prevent the release of hydrogen sulfide generated by the decomposition of sludge inside the storage chamber.

(6) Future Themes and Expectations

- Because the toilet section and the treatment instrument of the present technology may be joined to create a single unit, this technology can be installed in an extremely short time. It may even allow this technology to be used as a mobile toilet facility that may be suitable for riverside parks. The application of this technology need not be restricted to mountainous districts; it can also be used in regions with natural surroundings that require a non-discharge-type human-waste treatment system that is environmentally friendly, as this technology is.
- In the present Verification Test, an odor suppressant was added to the circulation water. However, when the cumulative total number of users exceeded 1,000, it was found that the suppressant lost its effectiveness. Further research and development are required to find more effective ways of adding suppressants so as to sustain their effectiveness, or to produce a new additive. Another strategy may be to improve the solid-liquid separation performance and to enhance the storage function.
- Based on the treatment capacity, it was found that BOD removal and nitration reaction have partially proceeded. As the lowering of the pH resulting from the promotion of nitration should suppress odor generation, an additional nitrogen removal function should also contribute to creating a better environment.

(Reference Information)

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○ Product Data

Items		Entry by the environmental-technology developer			
Name/model		"Seseragi" treatment unit/SY-1•SY-2•SY-3			
Human-waste treatment method		Steady-circulation-type human-waste treatment system			
Name of manufacturer (dealer)		Orient Ecology Co., Ltd.			
Contact information	TEL & FAX	TEL: int-81-3-3237-0558 FAX: int-81-3-3237-0575			
	Website	http://www.toyo-const.co.jp/orieco/index.html			
	e-mail	Kobayashi-toshiyuki@toyo-const.co.jp			
Dimensions/weight		If components of the apparatus may be taken apart to facilitate transport and then reassembled at the site, indicate the dimensions and weight of each part.			
		Upper treatment tank: (2,700 mm (W) × 800 mm (D) × 1,500 mm (H); 250 kg/set) × 3 sets Lower treatment tank: (2,700 mm (W) × 900 mm (D) × 1,250 mm (H); 100 kg/set) × 3 sets			
Time required for installation		3 days (1 day for installation, 1 day for piping installation, 1 day for a test run and adjustments)			
Design life of the target apparatus		30 years			
Cost estimation (yens)*		Item	Unit price	Number of Units	Total
Initial Costs		Treatment unit	¥3,130,000	3 units	¥9,390,000

				Total	¥9,390,000
Operating Cost		Sludge removal	¥7,600/m^3	9 m^3	¥68,400
		Water replenishment	¥5,500/m^3	5.5 m^3	¥30,250
		Toyo-shume	¥5,000/L	12L	¥60,000
				Total	¥158,650

*The following conditions (treatment capacity, number of holes, etc.) were assumed for cost estimation. The estimation does not include shipping.

Initial cost: 6 toilet units with 3 treatment units (limit of continuous usage: approx. 12,000 uses)

Operating cost: Cost for removal of sludge and circulation water (for every 12,000 cumulative total uses)

(As the present Test Site lacked a municipal water supply, the water for replenishment was brought in by a water tank truck. In locations where a water supply is available, the cost for water replenishment would only consist of the water bill.)

○ Other information provided by the manufacturer

Mobile toilet units integrating a cubicle and a treatment instrument are also available from our company.

(Reference)Single-seat type "Seseragi" SS-1 Price ¥5,000,000 (tax not included)

Double-seat type "Seseragi" SS-2 Price ¥7,500,000 (tax not included)

We also have a wide range of products, including triple-seat types and multiple-purpose types.

Rainwater permeation box

I. Concluding Remarks

The present pilot project will be continued into FY 2005 and beyond. Changes and additions may be made to the verification-test items and contents when necessary. Please visit our website for the latest information and details on the Verification Tests (http://etv-j.eic.or.jp).