Revised Report

of

The Study on ODS Disposal Options in Article 5 Countries

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1. Background

As a non-Article 5 member of Asia and the Pacific Region, the Ministry of the Environment of Japan has participated in discussion at the SA and SEAP regional networks; there has been several discussions in recent network meetings on a need of Article 5 countries to address the problem of disposal (including long-term storage and destruction) of contaminated CFCs that cannot be re-used, as is pointed out at the International Workshop on the Disposal of Ozone-Depleting Substances which was organized in 2000 by Canada, Switzerland, Australia and UNEP.

For example, in the 2003 Meeting of the South Asia Network of Ozone Officers (8-11 October 2003, Phuket), representatives of Singapore and Iran pointed out the need to take into consideration associated costs of transportation and destruction. Furthermore, in the Small Group Meeting of SA and SEAP Network of Ozone Officers on RMP Review and Update (13-14 June 2003, Dhaka, Bangladesh), need for "more information on reclamation and destruction technologies to address these issues in the future" was pointed out in the recommendations of the meeting.

The Ministry of the Environment of Japan (MOEJ) organized the "ODS Recovery and Disposal Workshop in Asia and the Pacific Region" in Siem Reap, Cambodia on 6 November 2004 with cooperation and participation of ozone officers of SA and SEAP regions, Sweden, Australia, UNEP and UNIDO. In and following the workshop, preliminary information concerning the ODS disposal needs in Article 5 countries in the region are collected for discussion of further actions to be taken.

As a result, a few countries, including Indonesia and the Philippines, were identified which have already recognized the existence of ODS that needs to be disposed of, although detailed situations needed further investigation.

At the 16th MOP held in Prague, 22-26 November 2004, the representative of Colombia expressed his country's desire that destruction activities should be considered for fund allocation under the Montreal Protocol, as an important component of ozone-depleting substance elimination. And it was pointed out that Article 5 countries were starting to face serious problems related to ozone-depleting substance stocks and obsolete ozone-depleting substance-containing equipment, and therefore needed resources in the short and medium term for destruction activities (UNEP/OzL.Pro.16/17).

In February 2005, MOEJ started bilateral dialogue with Indonesia to discuss the need and practicable options of ODS disposal in Indonesia based upon the specific condition of the country on the understanding that such study will be useful for other countries in the region and other regions that find themselves in similar situations sooner or later.

As the latest of the MOEJ's project in this direction, this study compares conceivable options for ODS disposal primarily based upon information of Indonesia and technical information drawn from Japan's experience of ODS disposal.

In the meantime, at the 17th MOP, Dakar, 12-16 December 2005, where the 2006-2008 replenishment of the Multilateral Fund was on the agenda, fund allocation for ODS destruction demonstration projects was discussed based upon the TEAP Task Force's October report which suggested US$ 4,000,000 for destruction activities and the need for further investigation into implications of ODS destruction activities and technologies was pointed out by related proposals by Colombia, Latin America and Caribbean countries, Austria and Japan (UNEP/OzL.Pro.17/11. advance copy).

At the level of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, the recent discussion on the eligibility of funding ODS destruction under the Multilateral Fund was initiated by Japan in the 44th Meeting (Prague, 29 November-3 December 2004). Subsequently, in accordance with requests from the Executive Committee, the Secretariat reviewed and compiled past decisions and policies relating to this issue, *Report on the Review of Guidelines Relating to Collection, Recovery, Recycling and Destruction of Ozone-Depleting Substances* (UNEP/OzL.Pro/ExCom/46/42). Taking into account the proposal of Austria and Japan, at the 47th Meeting (Montreal, 21-25 November 2005), the *Proposed Terms of Reference, Budget and Modalities for a Study Regarding Collection, Recovery, Recycling, Reclamation, Transportation and Destruction of Unwanted Ozone-Depleting Substances* (as a follow-up to Decision 46/36) (UNEP/OzL.Pro/ExCom/47/56) was put on the table for future discussion.

2. Purpose and methodology

2.1 Purpose

The purpose of this study is to provide the basis for considering practicable options for ODS disposal that can be chosen in Article 5 countries. Currently, Article 5 countries are not able to make choices between recycling, reclamation and destruction at all, due to lack of the existence of technical options.

It is not the intention of the study to advocate, indicate or assume destruction as the single best option for ODS disposal; the choice between recycling, reclamation and destruction is up to each country, each sector, or each individual end-user, depending upon the market or the specific decision-making environment.

2.2 Definition

For the purpose of this study, the term, ODS "disposal" is used to mean **options to take care of any ODS that is excluded from the end-users' market** of a certain country for any reason, including contamination, erroneous mixture, lack of quality warrant, no access to refined reclamation technology, etc. In this study, "disposal" does **not** include "**long-term storage**" since it does not guarantee following treatments within a definite timescale such as reuse, reclamation, destruction or export to other countries.

It should be noted that it is not the purpose of this study to define sometimes controversial terms, ODS "disposal" or "unusable ODS", under the Montreal Protocol or the policies of the Multilateral Fund for the Implementation of the Montreal Protocol.

2.3 Methodology

This study first presents information that indicate ODS disposal needs and practices in Article 5 countries, in light of the difficulty in collecting comprehensive data of the amount of "ODS that needs to be destroyed" or "unwanted, excessive ODS" in any nation for various reasons including under-awareness on this specific issue of end-users such as servicing companies.

The information introducing actual cases of ODS destruction as well as existing and expected stock with which the governments or end-users of Article 5 countries at present do not have any options but to keep in storage for an indefinite period will be introduced in Section 3.

Section 4 summarizes the patterns of ODS disposal needs based upon examples and cases in Section 3 and considers options to deal with such needs.

Section 5 provides technical information and cost estimates for the options identified in Section 4.

Section 6 compares the initial costs of these options with qualitative description of advantages and disadvantages.

Finally, Section 7 points out some issues to be taken into consideration for the implementation of ODS disposal options that are discussed in this study.

3. ODS disposal needs

This section introduces examples of actual destruction of ODS and other examples which indicate actual and potential ODS disposal needs in Article 5 countries. These cases have been identified through interviews with the Ozone Officers, servicing workshop owners, halon banks and other stakeholders in some countries.

Table 3.1 List of Identified Cases

Actual cases of ODS destruction

	Country	Substance	Quantity	Type
3.1.1	Indonesia	CFC12	21 MT	Surplus caused by equipment conversion
3.1.2	Thailand	HCFC22	1 MT	Recovered refrigerant (in manufacturing process)
3.1.3	China	HCFC22, etc.	200 MT	Production process residue
3.1.4	China	CTC	Variable	Surplus (by-product)

Actual ODS disposal needs

	Country	Substance	Quantity	Type
3.2.1	Indonesia	CFC11/CFC12	1 MT	Refrigerants mixture
3.2.2	Indonesia	MCF	74 MT	Surplus caused by end use phase-out
3.2.3	Indonesia	CFC11	11 MT	Contamination
3.2.4	Nepal	MBr	2 MT	Obsolete pesticide
3.2.5	Philippines	CFC12, etc.	5 MT	Customs confiscation
3.2.6	Philippines	Halon 1211	2 MT	Recovery without reuse options
3.2.7	Sri Lanka	CFC113	1 MT	Surplus caused by end use phase-out
3.2.8	Cuba	CTC	100 MT	Equipment replacement
3.2.9	Cambodia	CFC12, etc.	23 kg	Refrigerants mixture

Potential ODS disposal needs

	Country	Substance	Quantity	Type
3.3.1	Philippines	CFC11	86 MT +	Surplus expected as a result of equipment replacement
3.3.2	Korea, R.	CFC12	N/A	Recovered MAC refrigerant

3.1 Actual Destruction Cases

3.1.1 Indonesia, 21 MT of CFC12

One servicing company based in Kalimantan Island of Indonesia retrofitted CFC-based equipment installed at one oil company. As a result, 21 MT of CFC was recovered.
This company decided to dispose of the recovered CFC but had to store it for some time. In 2005, the company sent the CFC to Australia and had it destroyed at a cost more than US$ 280,000, including transportation and destruction.
(Refer to Section 5.4 for more detail.)

3.1.2 Thailand, 1 MT of HCFC22 and HFC

A Japanese company in Thailand had been looking over 3 years for disposal options for HCFC22 and R410A (HFC32/125) recovered from air conditioners in the pre-shipment quality check process. When gas leakage is found from end products prior to shipment, the refrigerant is recovered during repair but the product is refilled with new refrigerant instead of the recovered refrigerant for quality assurance.

In accordance with the policy of the headquarters of the company in question, the company's plants in Thailand as well as in other countries are recovering the refrigerant that would otherwise be released into the atmosphere and also seeking for access to appropriate disposal of the refrigerant recovered at its own plants or the market.

The company is aware of the existence of retailers in Thailand who would buy the recovered refrigerant from them. However, the company has decided to destroy the refrigerant, as its social responsibility policy, instead of selling it in a country without a sophisticated reclamation system.

Although the company first contacted local cement companies for refrigerant destruction service, they did not agree to ODS destruction due to the concern that ODS destruction in the cement kiln would damage the kiln[*]. The company considered exporting the refrigerant to Japan for destruction but concluded that it was not practicable due to expected complexity of procedures. Eventually, the company requested the industrial waste management center, which is funded by the Thai government, to investigate necessary conditions for the destruction of the refrigerant. The conditions were verified by technical engineers of the company and the headquarters in Japan before and after the start of the operation.

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[*] This technical concern has been taken care of in the existing cement kiln ODS destruction facilities in Japan and Europe; acidic by-products such as HCl or HF are neutralized in the alkaline environment within the kiln and Cl concentration can be controlled below the cement-quality damaging levels through the controlled injection of ODS into the system. Dioxin is also in control below concern levels in existing facilities.

At present, the destruction is being conducted in the center on an experimental basis at a destruction capacity of 1 kg/hr. Capacity of total waste incineration in the center is 40-50 tons/day. 900 kg of the refrigerant (15 cylinder tanks) that had been stored over the 3-year period was transported to the center and 500 kg has been destroyed already (as of February 2006). The cost of destruction that was conducted on a trial basis was 15,000 Baht/t (planned to be raised when business operation starts), which is being covered by the company.

The company is starting the recovery practice during service operation, which will increase the destruction need of the refrigerant up to 1-1.5 MT.

3.1.3 People's Republic of China, 200 MT of recovered HCFC, etc.

A Japanese company in the People's Republic of China has been destroying HCFC22 and other HCFCs (HCFC124, 124a, etc.), which are recovered in the process of manufacturing fluoropolymers since 2003. Approximately 200 MT of HCFCs has been recovered so far (100 MT in 2005), which is currently decomposed voluntarily together with by-product gases in the devoted destruction facility based on submerged combustion technology that is installed in the plant. The destruction plant is capable of decomposing 360 kg/h; however, there is no excessive capacity to accommodate ODS from external sources at present.

3.1.4 People's Republic of China, CTC (amount depends on the level of CTC being absorbed by non-ODS chemicals)

A sector plan for phase-out of ODS process agent applications (Phase II) and corresponding CTC production in the People's Republic of China was approved in principle at the 47th Meeting of the Executive Committee. The objective of the project is to archive the additional reduction of 10,775 ODP tones of CTC production after the agreed reduction under the Phase I project. Although the demand for CTC for feedstock in China will increase in the coming years, it will not be able to absorb all the CTC co-produced by chloromethane (CM) producers. Hence, disposal of surplus CTC is the only option for complying with the Montreal Protocol; funding was requested to finance on-site incinerators plus the operating cost to destroy the surplus CTC at 4 eligible CM producers.

3.2 Actual ODS disposal needs identified in Article 5 countries

3.2.1 Indonesia, 1 MT of mixed refrigerant (CFC11 and CFC12)

One servicing company based upon Jakarta, Indonesia, is storing 1 MT of mixed refrigerant of CFC11 and CFC12. This mixture happened as a result of accidental confusion during service operation. In the absence of measures to separate this mixed refrigerant, the company stores the cylinder for an indefinite period without access to reclamation or destruction options.

3.2.2 Indonesia, 74 MT of MCF

One private company stores 73,710 kg of MCF for an indefinite period without domestic demand after phase-out of MCF use or access to destruction.

3.2.3 Indonesia, 11 MT of contaminated CFC11

Recently, the Government of Indonesia identified 11 MT of contaminated CFC11 at a private company in East Java Province. The details will be investigated.

3.2.4 Nepal, 2 MT of MBr

Nepal identified the existence of approximately 2 MT (43 cylinders of 50 kg capacity) of obsolete MBr in the country, which has been stored as expired on the understanding that the effective life of MBr or container expires approximately 2 years after production*.

3.2.5 Philippines, 5 MT of confiscated refrigerant (CFC12, etc.)

5.5 MT of refrigerant (in 454 disposable cylinders of 30 lbs. capacity) has been confiscated at the customs of the Philippines as a successful enforcement of the customs inspection upon refrigerant import. The refrigerant in question was labeled as HFC134a, whose import is not prohibited, but turned out to be a mixture of CFC12 and HFC134a.
The government took a decision (DENR-EMB Case No. ODS 004-04, dated 30 June 2004) to direct a trading company to reship the refrigerant immediately back to the country of origin. However, until now, the reshipment has not been effected with the goods lying in the customs' warehouse.

Including the case quoted above, the Government of the Philippines have identified 13 cases of mislabeled refrigerants, i.e. CFC12 labeled as HFC134a, in 2003 and 2004. Most of them resulted in the re-sending of the substance to the country of origin.

However, the re-sending does not necessarily solve the problem but pass the problem on to the country of origin if the refrigerant in question is a mixture, for instance of HFC134a, CFC12, HCFC22 and hydrocarbon, as was the case in some confiscations. Such re-sent substance is useless in the country of origin as well, if it does not have or use sophisticated reclamation facilities.

* It is suggested by chemical company that container was marked with a "Use By" date, not because of expiration of the contents, but because of concern that it might begin to deteriorate and develop leaks.

3.2.6 Philippines, 2 MT of halon 1211

The Philippines have had only the use of halon 1211 with no use of halon 1301 or halon 2402. Its halon bank has been recovering halon 1211 from portable fire extinguishers in the past. The halon bank is capable of recovering halon but is not equipped with a halon reclamation facility.

Under the regulation of the country, it is already prohibited to produce or sell halon-based fire extinguishers. In this situation, the halon bank is storing the recovered halon 1211 (approximately 2 MT) in the plant premises. The quality of the recovered halon is not guaranteed. In the recent years, replacement of halon-based fire extinguishers for alternatives is promoted in the Philippines, assumedly as ISO 14000s are introduced in increasingly more and more companies and organizations.

3.2.7 Sri Lanka, 1 MT of CFC113

A government-owned pharmaceutical company in Sri Lanka has a stock of 13 cylinders (each containing 100 kg) of CFC113 which was supplied by the Government of Japan in the early stage of the factory operation. CFC113 had been used for cleaning purposes but the company stopped using the chemical due to environmental concerns.
The company now seeks assistance from the Sri Lankan NOU to dispose of the stocked ODS in an environmental friendly manner. Sri Lanka does not have any use of CFC113 or an access to ODS destruction.

3.2.8 Cuba, 100 MT of CFC12

The Government of Cuba replaced 3 million CFC12-based domestic refrigerators as part of its initiative to improve energy efficiency in the country. It is estimated that approximately 100 MT of CFC12 is stocked. Cuba is considering the measures to destroy it.

3.2.9 Cambodia, 23 kg of mixed CFC12 and HFC 134a

The Government of Cambodia identified 22.6 kg of mixed CFC12 (89 %) and HFC134a (9.1%) contained in two cylinders at Banteay Menchey Province. They were recovered at a servicing workshop in August 2005 from cars that were brought in for air conditioning repair.

3.3 Potential ODS disposal needs identified in Article 5 countries in the Asia regions

3.3.1 Philippines, 86 MT or more of CFC11

In the Philippines, it is expected that at least 86 MT of CFC11 will be recovered as a result of the approved chiller conversion project. Most of the recovered CFC11 will be out of use, since the project leads to the significant reduction of CFC11-based chillers in the country.

3.3.2 Republic of Korea, CFC12

Without an ODS recovery and destruction regulation in place yet, the Ministry of Environment of the Republic of Korea is currently working to draft a law for motor vehicle recycling, which is expected to be in place in July 2007.
Although at present the refrigerant recovered from end-of-life motor vehicles at motor vehicle disposal facilities are reused or released to the atmosphere, such refrigerant will need to be reused, reclaimed or destroyed.

4. Patterns of ODS Disposal Needs and Considerable Disposal Options

4.1 Patterns of ODS Disposal Needs

The examples of ODS disposal needs and practices that are introduced in Section 3 show that disposal needs exist not only for recovered ODS but also **virgin ODS** such as obsolete pesticide (MBr) in Nepal (3.2.4), MCF and CFC113 **without end uses** after successful conversion of uses that used to be dependent upon them (3.2.2 and 3.2.7).

As for recovered ODS, **mixture of refrigerants** creates ODS disposal needs with such refrigerants stocked at servicing workshops (3.2.6 and 3.2.9) or kept in custody at the customs (3.2.5).

In addition, the collected examples show emerging cases of **recovered ODS without end uses**, such as the extreme case of the comprehensive equipment replacement of domestic refrigerators in Cuba (3.2.8) and the case of halon 1211 recovery in the Philippines, where no new sales of halon 1211-based equipment is permitted (3.2.6). Similarly, not little of CFC11 to be recovered as a result of the chiller conversion incentive project in the Philippines can be surplus without end uses (3.3.1). Similar situations could occur in other countries with the progress of chiller demonstration projects that were approved at the 47th Executive Committee.

Actual cases of ODS destruction shows another important pattern of ODS disposal needs: i.e. the **decision taken by end users in favor of destruction**, shown in 3.1.1 and 3.1.2, as is often the case in developed countries. A similar case is emerging in the Republic of Korea (3.3.2).

4.2 Considerable Disposal Options

As for **virgin ODS without end uses** such as obsolete MBr, the considerable options for disposal are destruction in its own country or exportation to other countries for destruction. Since obsolete MBr does not function as pesticide any longer even in other countries, reclamation or reuse cannot be an option in this case. In the case of MCF and CFC113, exportation to other countries where these substances are still in use can be an option in addition to destruction.

As for **recovered ODS without end uses,** destruction in its own country and exportation to other countries for reuse, recycling, reclamation and destruction are considerable disposal options. In that case, to decide which option should be taken, it is necessary to take into account both economical and technical aspects: in economical terms, the demand for recovered ODS needs to exist in the market. In this regard, cost analysis as compared to virgin ODS in the market should be taken into account. In technical terms, the capability of checking the quality of recovered ODS is essential to ensure that recovered ODS be put into appropriate uses according to the quality. The most feasible option will be derived from well-balanced consideration of these aspects. Figure 4.2-1 shows the theoretical decision tree for the choice between reuse and disposal options (within one country territory).

Mixture of refrigerants needs distillation-based reclamation for reuse or destruction when it is not economically or technically feasible to distill it.

> It should be noted that simplified (non-distillation) reclamation that is supported by recycling facilities that are provided in the conventional R & R projects cannot deal with mixed refrigerants (Table 4.2-1).
> When a certain amount of refrigerant is distilled, the amount of the reclaimed refrigerant will be approximately 70 % of the original amount (Table 4.2-4) and the distillation of lower purity refrigerant below threshold level consumes more energy and time; for that reason, the reclamation facilities in Japan do not accept mixed or contaminated refrigerants that do not satisfy the industry-prepared threshold standards (Table 4.2-3).
> Therefore, the existence of a reclamation facility does not necessarily negate the need for destruction of the residue and low-purity recovered refrigerants.

When distillation or destruction is not available in its own country, as is the case with Article 5 countries at present, exportation to other countries with distillation / destruction facilities is the only remaining option, except for long-term storage for future construction of a distillation or destruction facility. To explore the feasibility and acceptability of exportation, attention needs to be paid to related international agreements and domestic laws and rules of both exporting and importing countries: Import and export of used ODS is not controlled under the Montreal Protocol.
Exportation of used ODS to other countries for reclamation or destruction can be subject to the control and requirements of the Basel Convention when used ODS is legally defined as or considered to be hazardous waste by the State of export, the State of import or State of transit in light of the Basel Convention's process and hazardousness criteria. The application of bilateral agreements and domestic laws and rules relating to transboundary movement of wastes should be ensured.

In summary, the measures to deal with identified ODS disposal needs are considered to be distillation-based reclamation or destruction, which are outside the scope of the conventional R & R projects. To take these measures, Article 5 countries that do not have reclamation or destruction facilities have three approaches to assess: to construct new facilities, to modify the existing facilities such as cement kilns that exist in many Article 5 countries and to export substances to be reclaimed or destroyed in other countries. In consideration of the above, disposal options can be further translated into the following four types:

Option 1a. Construction of a new facility for ODS destruction;
Option 1b. Construction of a new facility for ODS reclamation;
Option 2. Modification of an existing facility for ODS destruction; and
Option 3. Exportation of ODS to other countries for reclamation, destruction, etc.

Table 4.2-1. "Reclamation" Methods and Impurity Removal Capabilities

Reclamation method	Simplified Reclamation (Recycling)		Distillation-based Reclamation		Reclamation equipment
Operation	On-site		Off-site		
Impurities	Single pass filtration	Multi-pass filtration	Simple distillation	Distillation refinery	
Water	△	○	○	◎	Desiccators / distillation
Oil	△	△	◎	◎	Oil separator / distillation
Particle	△	○	○	◎	Strainer / filter
Acid	△	△	△	◎	Silica gel / molecular sieve
Noncondensable gas	—	—	○	◎	Distillation
Evaporation residue	—	—	○	◎	Distillation
Decomposition product	—	—	○	◎	Distillation
Other refrigerant	—	—	—	○	Distillation

Note: Ranking of removal efficiency: ◎: excellent, ○: good, △: some impurity removal, —: no impurity removal.

(Adopted with amendment from *Refrigerant Recovery and Disposal Practice Manual (5th ed.)*. RRC, 2005. Original version written in Japanese.)

Table 4.2-2. Standards for Acceptable Recovered Refrigerants for Reclamation in Japan (Standard Code: RRC1002)

Item	CFC12, R502, HCFC22, FC134a
Purity (% area)	≥99.3
Existence of other refrigerants (low boiling point refrigerant)	≤0.5
Existence of other refrigerants (high boiling point refrigerant)	≤0.1
Water (% weight)	≤0.02
Acid (% weight)	≤0.0004
Noncondensable gas(% volume)	≤3
Evaporation residue (% weight)	≤10

(Source: *Textbook of F-gas Recovery Technical Seminar*. RRC, 2006. Original version written in Japanese)

Table 4.2-3. Standards for Reclaimed Refrigerant in Japan (Standard Code: RRC1001)

Item	CFC12	R502	HCFC22	HFC134a
Color	Colorless and no turbidity			
Odor	Odorless			
Purity (% area)	≥99.98			
Existence of other refrigerants (included in purity)	≤0.2 R22	≤0.2 R12, 115	≤0.2 R12	≤0.2 R12, 115
Existence of other refrigerants (not included in purity)	≤0.02 R11, etc.	≤0.02 R11,114, etc.	≤0.02 R11, etc.	≤0.02 R11, etc.
Water (% weight)	≤0.002			
Acid (% weight)	≤0.0001			
Noncondensable gas (% volume)	≤1.5			
Evaporation residue (% weight)	≤0.01			

(Source: *Textbook of F-gas Recovery Technical Seminar*. RRC, 2006. Original version written in Japanese)

Table 4.2-4 The Amount of Reclaimed Refrigerant as Compared to the Amount of Refrigerants Handed in.

Handed in	Reclaimed
15 kg –21 kg	10 kg
omitted	
65-79	50
omitted	
136-150	100
omitted	
207-222	150
omitted	
279-293	200
omitted	
565-579	400

Note: Less than 15kg of refrigerant is not accepted for reclamation for business reasons.
(Source: *RRC Handbook*. RRC, 2006. Original written in Japanese.)

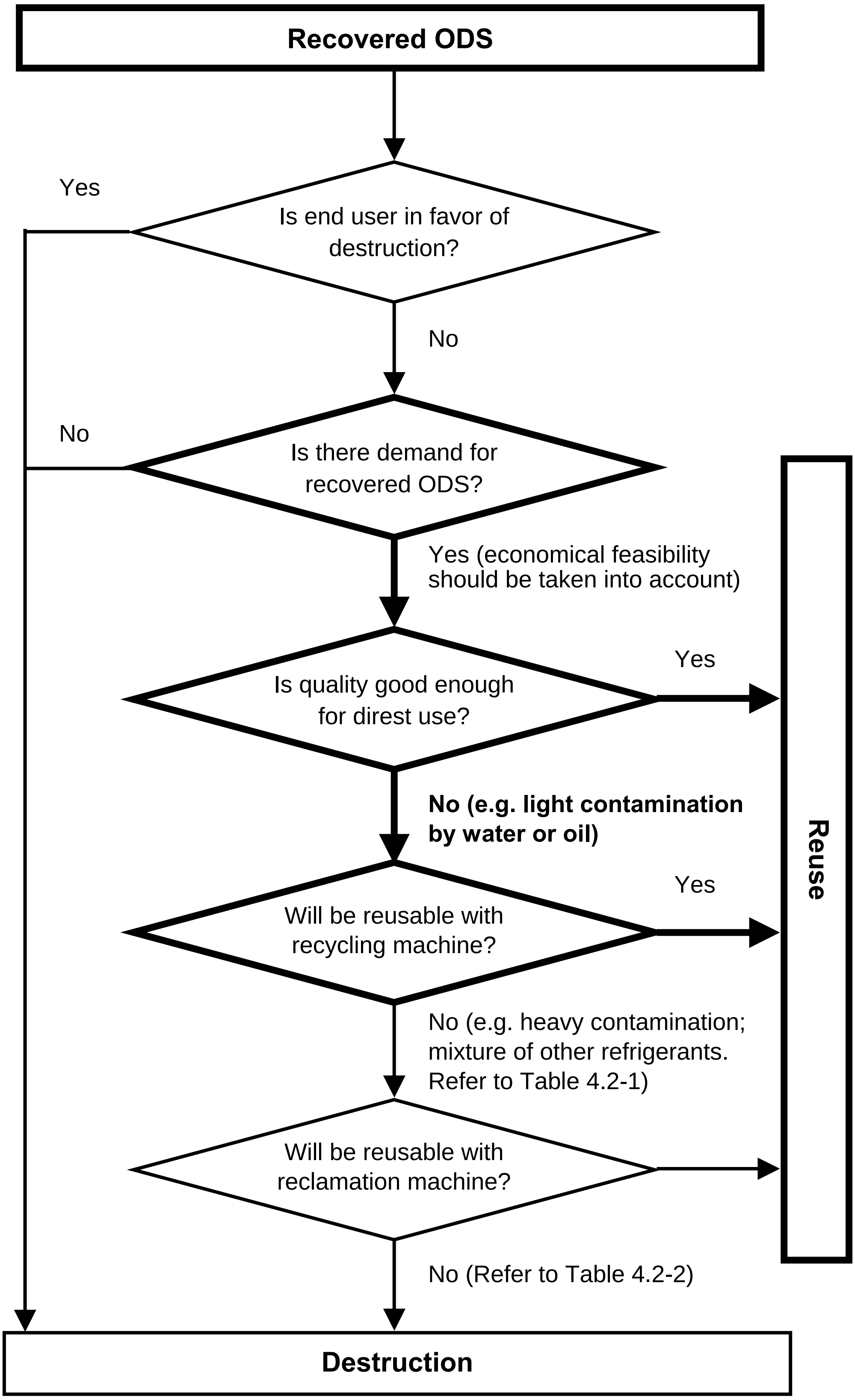


Figure 4.2-1 Theoretical Decision Tree for Choice of Reuse and Disposal Options for Recovered ODS (intra-national context)

5. Technical and Cost Information on Disposal Options

The information on the technologies and estimated initial and operation costs for the disposal options identified in the previous section is given below based upon actual examples from Japan and Indonesia.

Option 1a. Construction of a new facility for ODS destruction **[5.1]**;
Option 1b. Construction of a new facility for ODS reclamation **[5.2]**;
Option 2. Modification of an existing facility for ODS destruction **[5.3]**; and
Option 3. Exportation of ODS to other countries for reclamation, destruction, etc. **[5.4]**

5.1 Construction of a facility for ODS destruction

There are 12 technologies approved to date under the Montreal Protocol for the destruction of CFC or halons. In developed countries, different technologies are in use for CFC destruction on commercial basis; for instance, in Japan more than 10 technologies are used in approximately 82 ODS destruction plants in operation as of 2006 (Annex 1).

Among devoted systems in operation, the thermal oxidation technology based upon submerged combustion and the superheated steam reactor technology cover large portions of F-gas destruction.

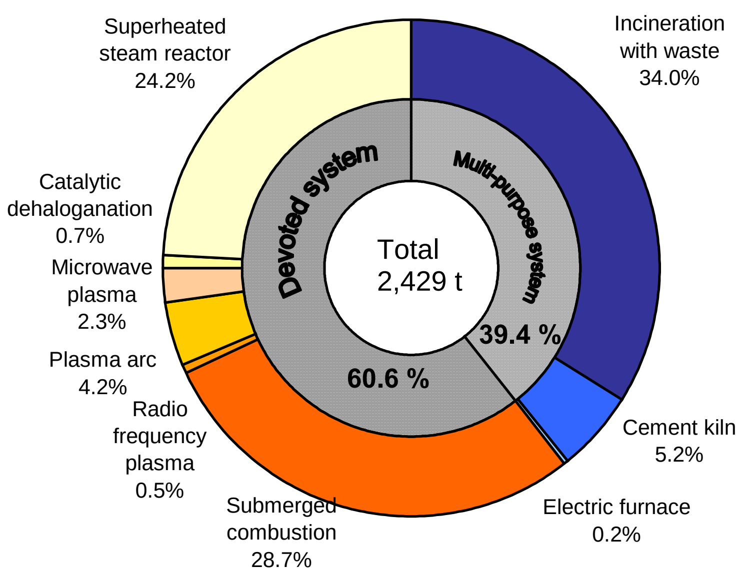


Figure 5.1-1 F-gas Destruction by Technology in Japan (as of FY2003)

For the purpose of this study, the superheated steam reactor system (Daioh Construction Co. Ltd., refer to Figures 4.2-2 to 4.2-4) has been chosen for option 1a, construction of a new facility for ODS destruction, primarily in consideration of the following advantages of the system that are considered to make its introduction in Article 5 countries more feasible:

- The initial cost is low for a devoted ODS destruction facility and has good destruction capacity; and
- The size of the facility is the smallest for a devoted ODS destruction facility. (3m width x 7m depth x 3 m height)

The system manufacture points out other advantages of the system including:

- Simple structure – easy to maintain, fast to construct;
- Operation at the normal pressure environment or reduced pressure environment is possible – safer when an accident happens;
- Can treat solid waste, liquid waste and gaseous waste;
- Over 99.99% destruction ratio of CFC, no dioxin emission; and
- Can decompose not only CFC, but also halon, MBr and PCB.

It costs approximately JPY 50,000,000 (approx. US$ 435, 000)[*] in Japan, as the initial cost, which covers the construction of the system at the plant, transportation of the system to the customer, installation of the system, test operation and training of the operators (approx. 3 days). Even when this system is purchased by a user outside Japan, the system will be constructed within Japan and shipped by sea to the country. The time necessary for the manufacturing of the system is relatively short, i.e. about 3 months, in comparison with other devoted ODS destruction facilities, because of the simple structure. In this case, the transportation cost is additionally incurred and the cost of the training will be slightly higher.

The operation can be taken care of by one person for one system. The cost of maintenance is between JPY 2,000,000 (approx. US$ 17,400) and JPY 3,000,000 (US$ 26,000) per year in the case of Japan.

For the operation of the system, water is necessary (approximately 10 kg water for 10 kg CFC decomposition). The electricity power for one reactor is 30-40 kW; in the case of a two-reactor system with 25kg/h decomposition capacity, 60-80 kW electricity power is necessary. In order to neutralize acidic byproducts that occur as a result of CFC or halon decomposition, approximately 140 kg of $Ca(OH)_2$ is necessary for one batch of operation (one batch = 8 hours operation and 2 hours suspension for replacement of $Ca(OH)_2$).

The system is designed to have the reactor tube, which is corroded by acidic byproducts as is shown in the photo below, replaced periodically. The reactor tube made of

[*] For the initial costs of some of the other types of destruction facilities, refer to Annex 3 in which information given in a TEAP 2002 report is quoted.

stainless steel needs to be replaced with a new one at an interval of one month when the system is operated for 8 hours a day.

The average prices charged upon CFC destruction in Japan are in the range from JPY 500 to JPY 700/kg CFC (4.3 US$ to 6 US$/kg CFC).

The corrosion of the stainless steel tube produces Ni and Cr in the effluent, which would be below environmental standards set out by the country in question under regular operation conditions.

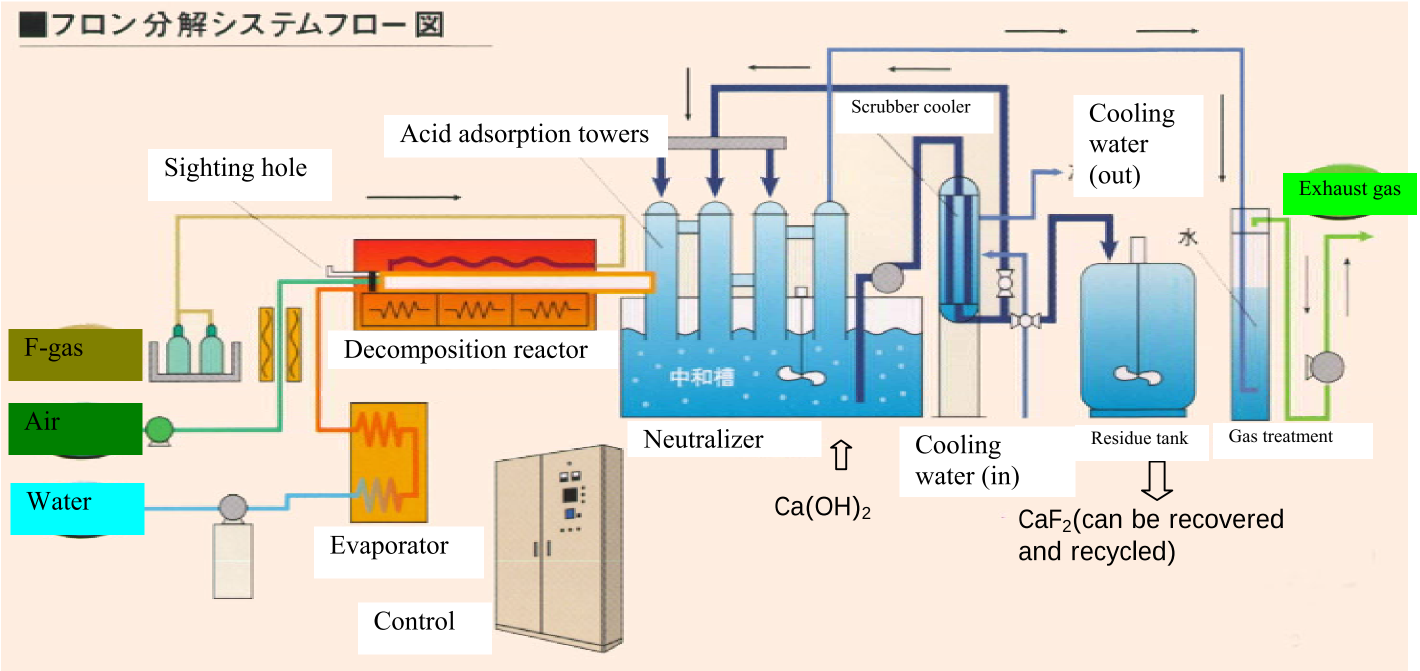


Figure 5.1-2 Schematic Diagram of ODS Destruction in Super Heated Reactor (CFC Decomposition System of Daioh Construction Co. Ltd.)

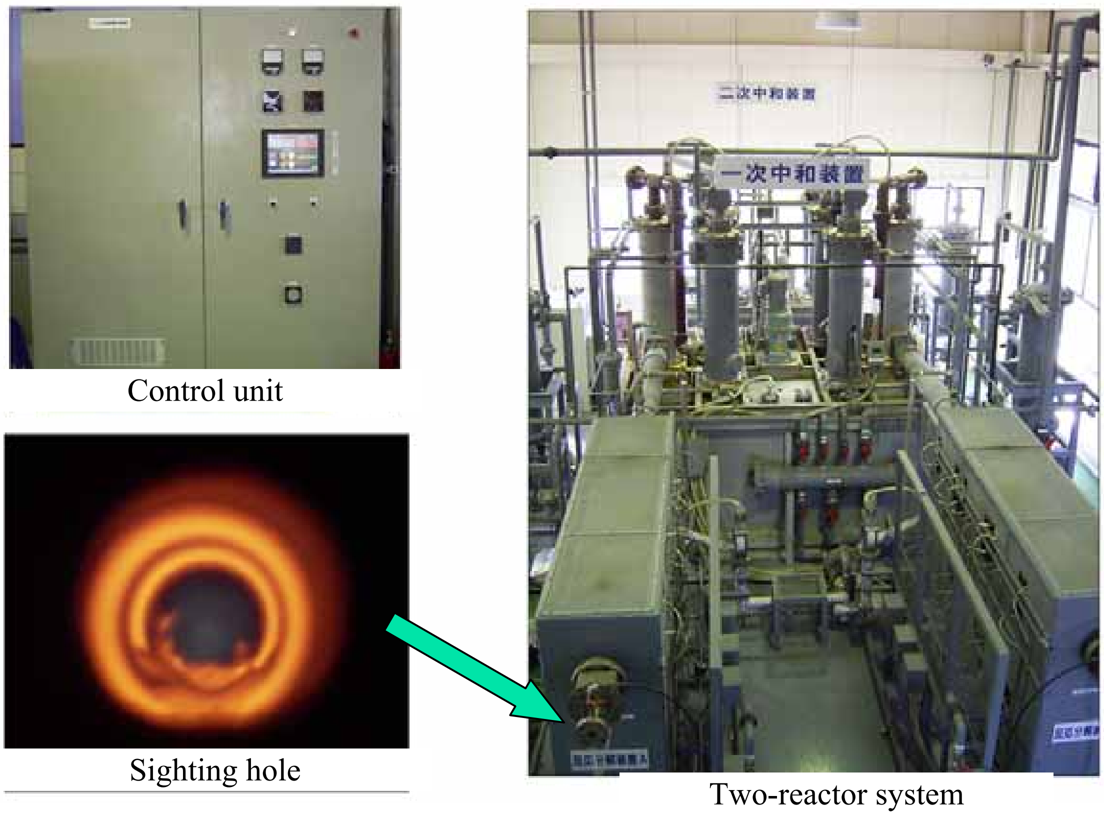


Figure 5.1-3 Photos of the CFC Decomposition System (25 kg/h capacity) of Daioh Construction Co., Ltd.

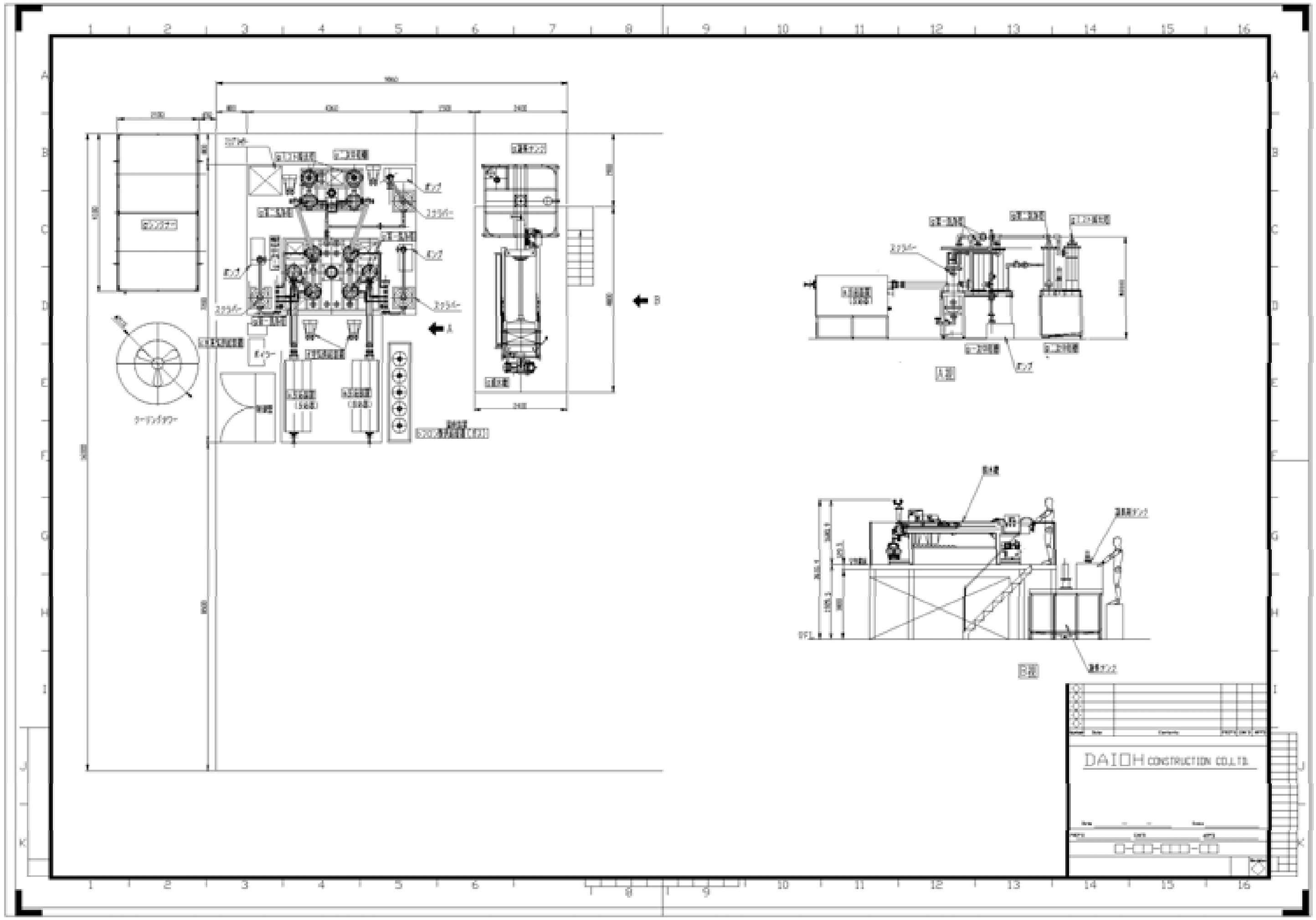


Figure 5.1-4 Basic Drawing of Super Heated Reactor (25kg/h Capacity). Daioh Construction Co., Ltd.

5.2 New construction of an ODS reclamation facility

As of January 2006, there are 5 distillation-based reclamation facilities in operation in Japan that meet the standards of the industry association, the Refrigerants Recycling Promotion and Technology Center (RRC).

An ODS reclamation facility consists of a distillation facility (ies) and a laboratory to check and guarantee the quality of reclaimed refrigerants and other auxiliary facilities such as cylinder cleaning, etc.

- Distillation facility (liquid and gas)

  Different distillation facilities are used for distillation of gas refrigerants (CFC12, HCFC22, etc. Figures 5.2-1 and 5.2-2) and liquid refrigerants (CFC11. Figures 5.2-3 and 5.2-4).

  The initial cost of a distillation facility is JPY 20,000,000 (approx. US$174,000) for a gas refrigerant distillation system to JPY 5,000,000 (approx. US$44,000) for a liquid refrigerant distillation system.

- Laboratory (gas chromatography)

  A reclamation facility needs to be equipped with the capability of checking and guaranteeing the content and quality of the reclaimed refrigerants. For this purpose, gas chromatography is required in Japan, instead of portable, less sophisticated refrigerant identifiers which are technologically based upon infrared absorption. In order to be registered with the RRC, a reclamation operator must not only be equipped with a facility that can meet technical standards for reclaimed refrigerants but also station a qualified chemical analyst (s) to guarantee the quality of reclaimed substances using gas chromatography. Gas chromatography equipment costs JPY approximately 5,000,000 (approx. US$ 44,000).

  The cost of the analysis, which is considered to be part of the operation cost of the reclamation, is included in the price of the reclaimed refrigerant (Table 5.2-1).

- Other auxiliary facilities (cylinder cleaning, etc.)

  Cylinders need to be cleaned if the reclaimed refrigerants are charged into the same cylinders in which the original refrigerants were contained ("portable", one-time use cylinders cannot be used in this manner, necessitating the procurement of other durable cylinders). The cost, though not significant, is *external* to the cost of the reclaimed refrigerant. The prices of cylinder cleaning in Japan are given in Table 5.2-2.

  In Japan, it is mandatory by law in Japan, though not necessarily the case in other non-Article 5 countries, to ensure the safety of cylinders that are used repeatedly over a long period by periodically checking the strength or pressure-resistance and to dispose of cylinders that have lost sufficient strength to prevent accidents by careless use. The installation of the pressure-resistance checking equipment costs approx. JPY 10,000,000 or US$ 87,000 as the initial cost.

Table 5.2-1 Operation Cost (Reclaimed Refrigerant Price)

Refrigerant	Reclamation price (JPY/kg), handed in at the site	US$
CFC12	600	5 US$
R502	1,000	9 US$
HCFC22	600	5 US$

(Source: *RRC Handbook*. RRC, 2006. Original written in Japanese.)

Table 5.2-2 Cylinder Cleaning or Purchasing Prices

Option	Price	US$
Cleaning of a handed in cylinder (10-20 kg)	2,800 JPY/cylinder	24 US$
Cleaning of a handed in cylinder (-100 kg)	3,000 JPY/cylinder	26 US$
New cylinder (- 10 kg)	25,000 JPY/cylinder	220 US$
New cylinder (-20 kg)	28,000 JPY/cylinder	240 US$

(Source: *RRC Handbook*. RRC, 2006. Original written in Japanese.)

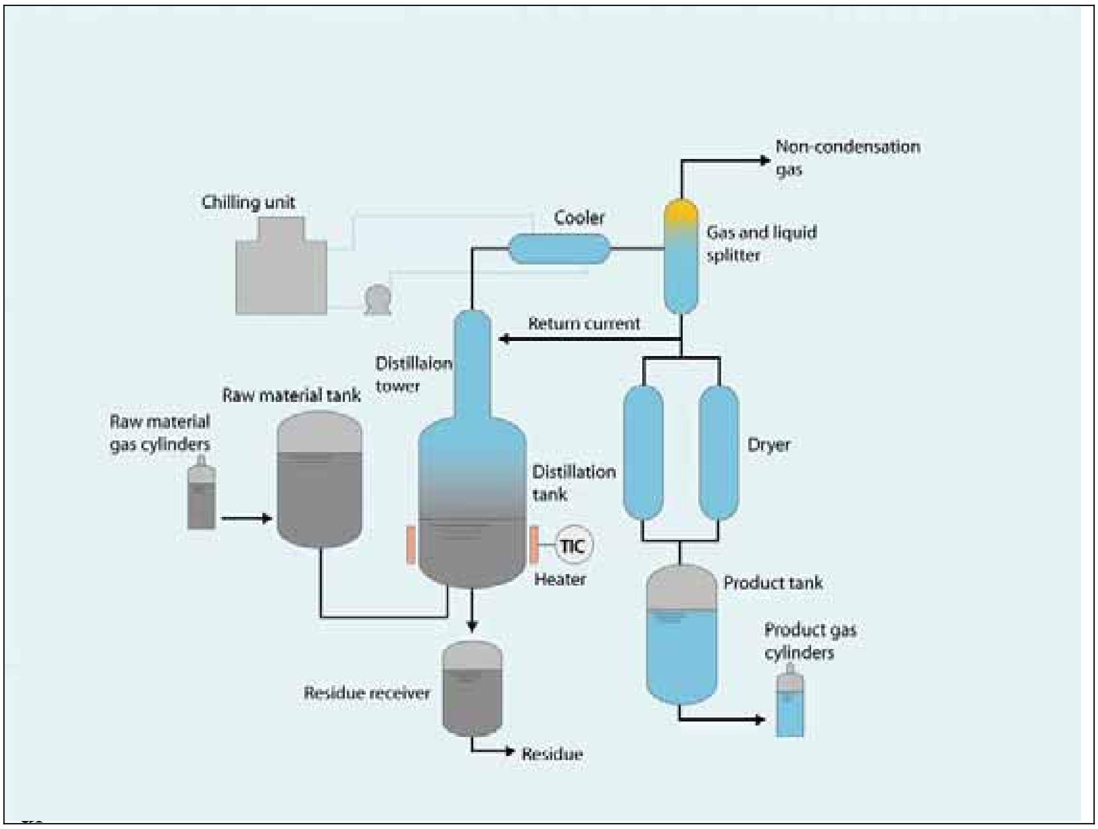


Figure 5.2-1 Distillation Reclamation Facility for Gas Refrigerant (e.g. R12) at Kankyosoken, Japan

Max distillation ability	50 kg/h
Power requirement	15 kW
Distillation tank capacity	100 L
Desiccant	Molecular sieve

Table 5.2-3 Specification of Facility in Figure 4.2-5

	
Reclamation facility (for gas refrigerant)	Distillation part

Figure 5.2-2 Photos of the Distillation Reclamation Facility

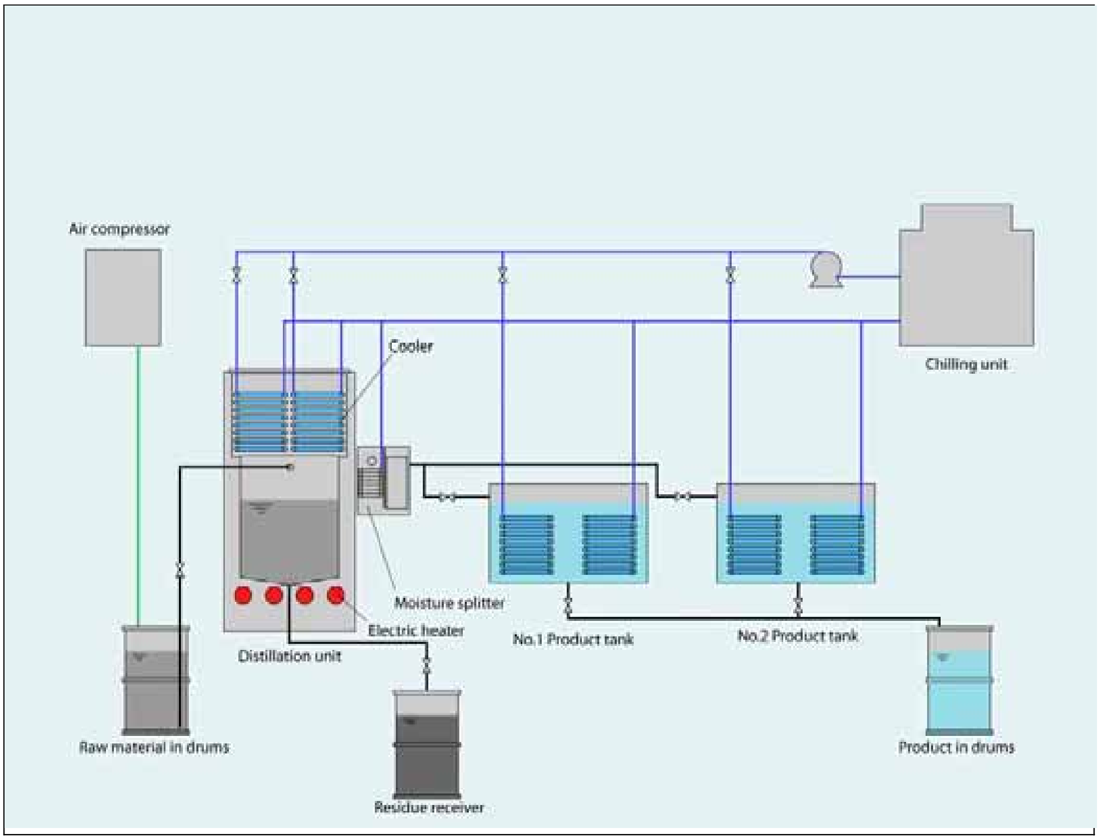


Figure 5.2-3 Distillation Reclamation Facility for Liquid Refrigerant (e.g. R11) at Kankyosoken, Japan

Max distillation ability	200 kg/h
Power requirement	20 kW
Desiccant	Molecular sieve

Table 5.2-4 Specification of Facility in Figure 4.2-7

Figure 5.2-4 Photos of the Distillation Reclamation Facility for Liquid Refrigerant

Gas chromatography

Cylinder strength measurement equipment

Cylinder strength measurement equipment

Figure 5.2-5 Auxiliary Facilities for Reclamation

5.3 Modification of an existing facility for ODS destruction

The existing facilities that were constructed for other purposes than ODS destruction such as waste incineration or cement production are also used for CFC destruction with modification.

For the purpose of this study, the cement-kiln ODS destruction facility is considered for Option 2, modification of an existing facility for ODS destruction, primarily because:

- The initial cost for modification is low;
- The modification is relatively easy;
- Large destruction capacity; and
- The acidic by-products produced in the process of ODS destruction are neutralized in the alkaline environment of the cement kiln without neutralization equipment.

F-gas decomposes completely in a few seconds at high temperatures in the kiln, thus generating hydrochloric and hydrofluoric acids which are then reacted with alkaline calcium and fixed to form non-toxic and harmless clinker mineral.

Modification of a cement-kiln facility for ODS destruction purposes needs the addition of gas-injection system. The schematic diagrams of this technology are shown below (Fig. 5.3-1 – Fig. 5.3-3).

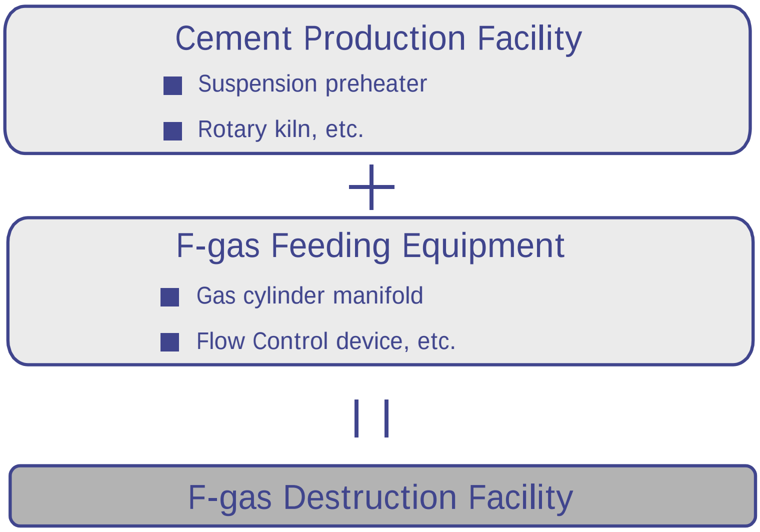


Figure 5.3-1 Modification of Cement Kiln for ODS Destruction

(1) Initial cost

Table 5.3-1 shows the overview of necessary parts to attach ODS feeding equipment to an existing cement kiln with cost estimates based upon the actual experience of a cement kiln modification in Japan.

Table 5.3-1 Initial Cost (Necessary Parts) of Modification of Cement Kiln for ODS Destruction

Item	Specification	Quantity	Unit	Cost (JPY)	(US$)
Emergency shut valve	Magnetic solenoid valve	1	Unit	60,000	520
Pressure control valve	15A	1	Unit	80,000	700
Flow meter	Range between 0 and 50 – 100 kg/h, as appropriate	1	Unit	400,000	3,500
Piping /valve	SGP, STPG, 15A ball valve	1	Unit	900,000	7,800
Electric parts	Current-pneumatic converter	1	Unit	700,000	6,100
Miscellaneous	Thermometer, barometer, etc.	1	Unit	500,000	4,300
Total				2,640,000	23,000

Note: US dollars are converted from Japanese Yen estimates and rounded; therefore, the total does not agree with the sum of the individual items.

The costs quoted above are those in Japan and only includes the costs for the CFC injection equipment to which 20 cylinders can be attached at one time and does not include the labor cost for assemblage and installation of these parts, which vary from country to country.

It should also be noted that the cost is based upon CFC-injection equipment, not halon. When halon is injected into the system, the whole set of equipment needs to be designed to tolerate the high pressure of halon, which is usually more than 2 times that of CFC. This means that the pipes and valves that can stand higher pressure (40 kg/cm^2) should be selected when the destruction of halon is envisaged*, while the CFC injection system shown above is designed to resist 15 kg/cm^2 (the pressure of the gas in the CFC/HCFC/HFC cylinders does not normally exceed 1 MPa at the normal temperature, while the pressure of the gas in halon cylinders for fire extinguishing facilities reaches 4.2 MPa).

* Cement kiln technology is not "approved" for halon destruction under the Montreal Protocol. This does not mean the Montreal Protocol prohibits the destruction of halon with cement kiln technology. Technically speaking, cement kiln technology is capable of destroying halon. Hypothetically speaking, there can be a case in which destruction of halon in a specific country is permitted even when it is not "approved" for halon destruction under the Montreal Protocol, without putting the country in non-compliance with the Montreal Protocol. However, the amount of destroyed halon cannot be deducted from the halon consumption according to Article 1 (5) of the Montreal Protocol.

(2) Operation cost

It is not practicable to differentiate the operation cost of the cement kiln for ODS destruction from that of the cement kiln for its primary purpose of cement production, since, once the ODS injection equipment is in place, the ODS destruction is carried out in tandem with the cement production operation.

Instead, for the purpose of this study, the destruction fees charged for CFC destruction are used here as the operation cost that is considered to cover the incremental cost related to CFC destruction operation at the cement kiln.

500 JPY –700 JPY/kg CFC (4.3 US$ - 6 US$/kg CFC)

It should be noticed here that the price quoted here does not include the transportation cost of the substance to be destroyed. In addition, the price charged for destruction does not necessarily represent the incremental cost per se; even when the actual incremental cost is lower, the price can be set at higher levels and vice versa.

On the other hand, the operation of a cement kiln ODS destruction facility depends upon the production of cement, which is quoted as a disadvantage of the system; however, this can be an advantage in terms of sustainability of operation because the cement kiln can operate as long as cement production continues even when there is no constant supply of ODS to be destroyed. As such, the cement kiln ODS destruction facility is to serve ODS destruction purposes when needed.

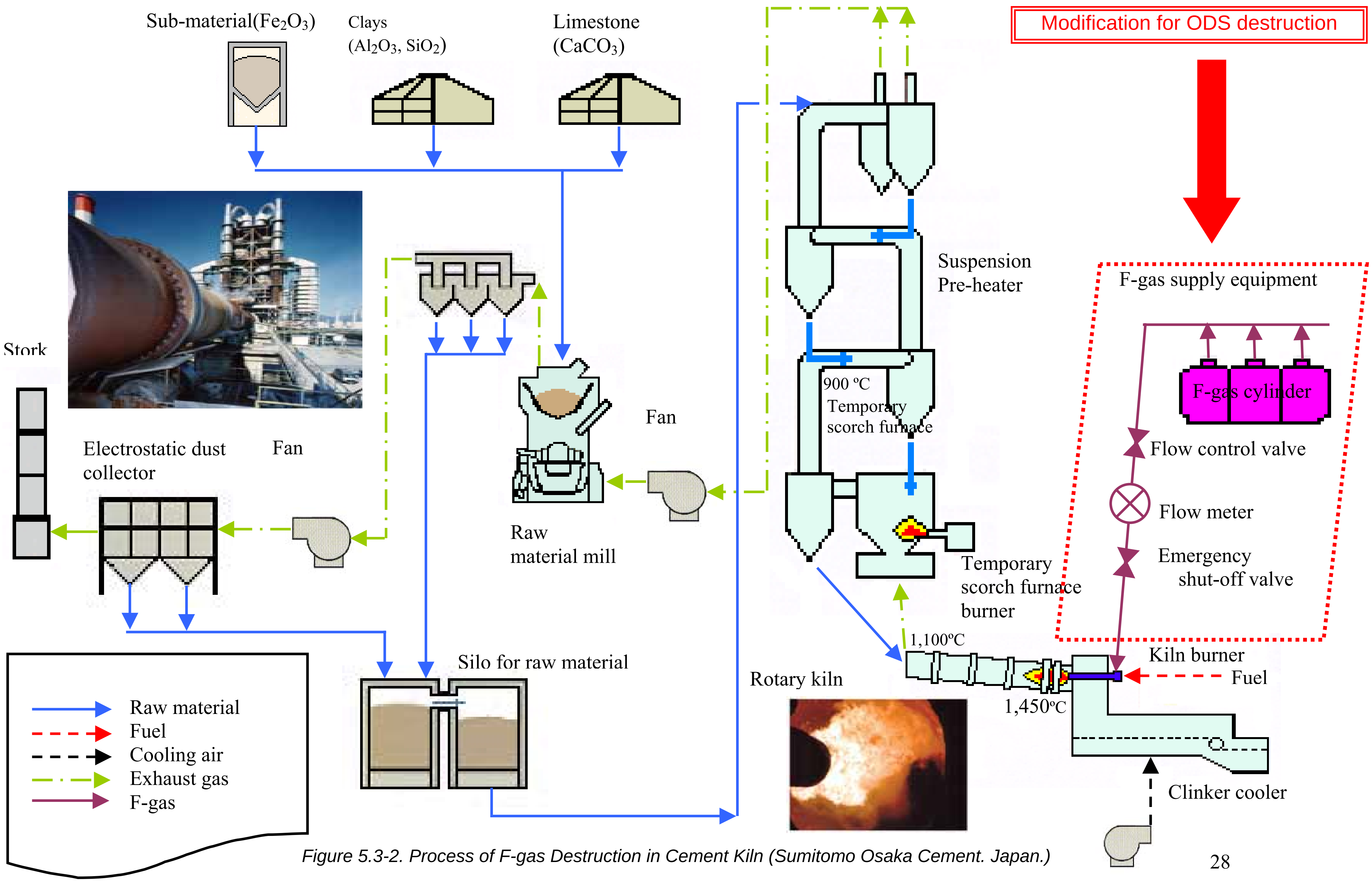


Figure 5.3-2. Process of F-gas Destruction in Cement Kiln (Sumitomo Osaka Cement. Japan.)

Size of rotary kiln	4.1mφ ～ 5.8mφ， 58m length ～ 100m length
Production capacity of clinker	200 t/h ～ 300t/h
Amount of fuel use of kiln	5t/h ～ 15t/h
Amount of F-gas decomposition	30 Kg/h ～ 50 Kg/h
Stay time of F-gas in kiln	8 seconds ～ 12 seconds
Rate of F-gas decomposition	over 99.9 %

(Sumitomo Osaka Cement. Japan)

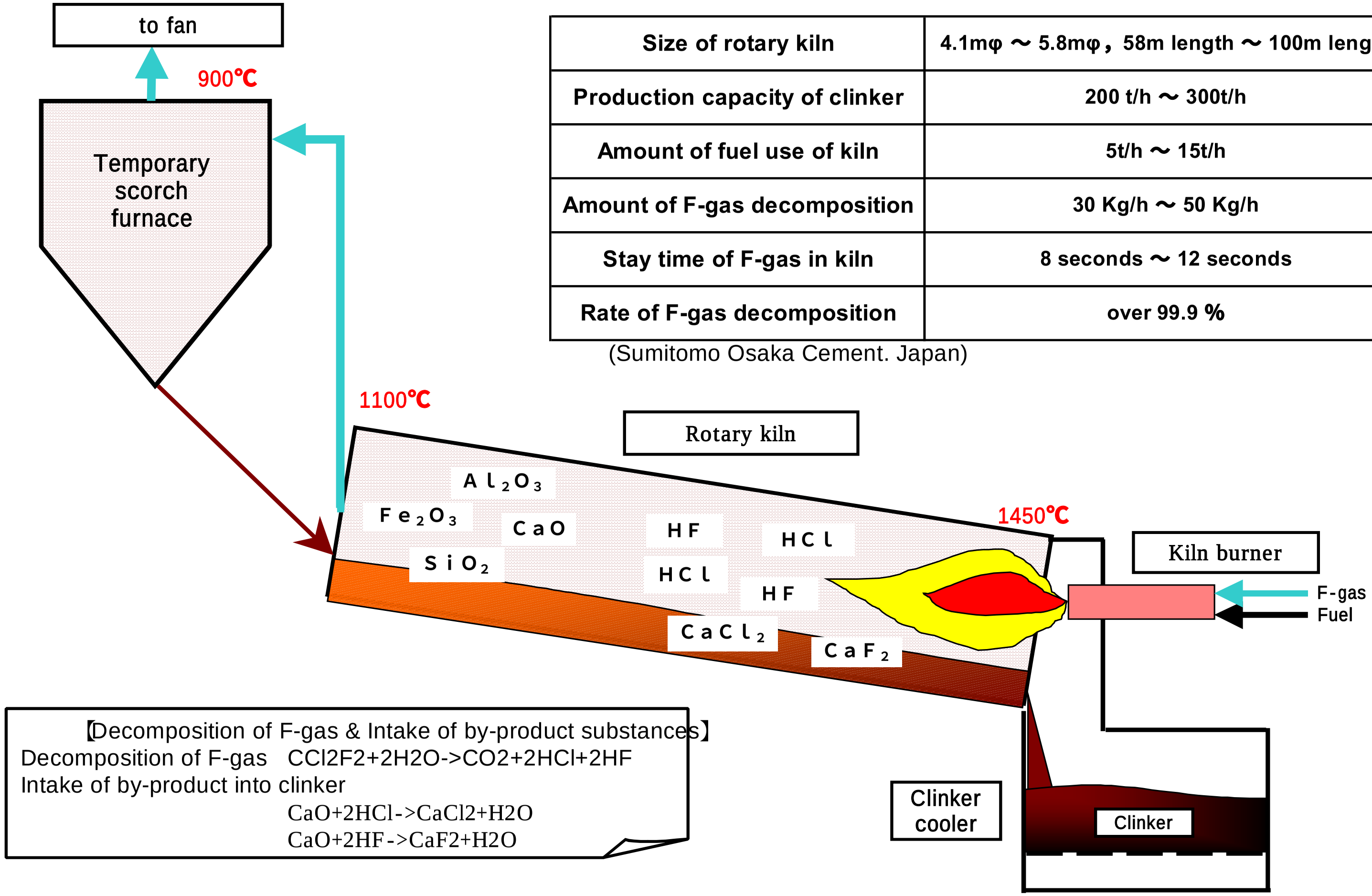
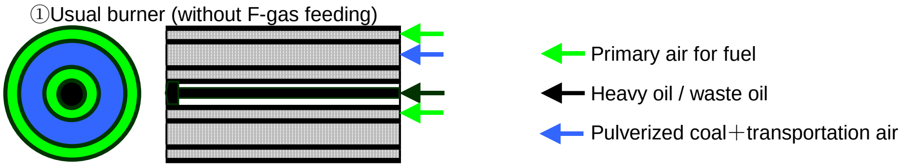


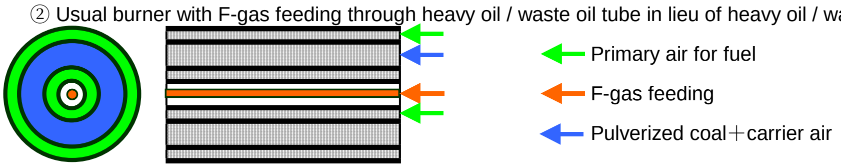
Figure 5.3-3 Specification and Process of F-gas Decomposition in the Cement Kiln

【Multi-tube burner】 (The type of kiln burner that is generally in use in Japan.)

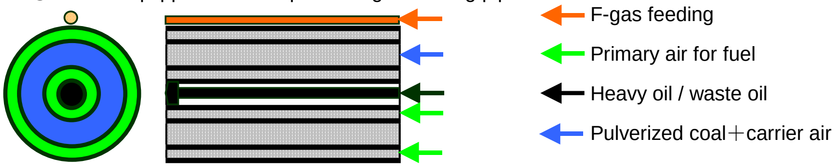
①Usual burner (without F-gas feeding)



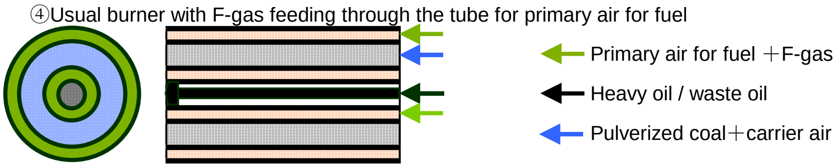
② Usual burner with F-gas feeding through heavy oil / waste oil tube in lieu of heavy oil / waste oil



③ Burner equipped with a separate F-gas feeding pipe



④Usual burner with F-gas feeding through the tube for primary air for fuel



【Feature of each method of F-gas feeding】

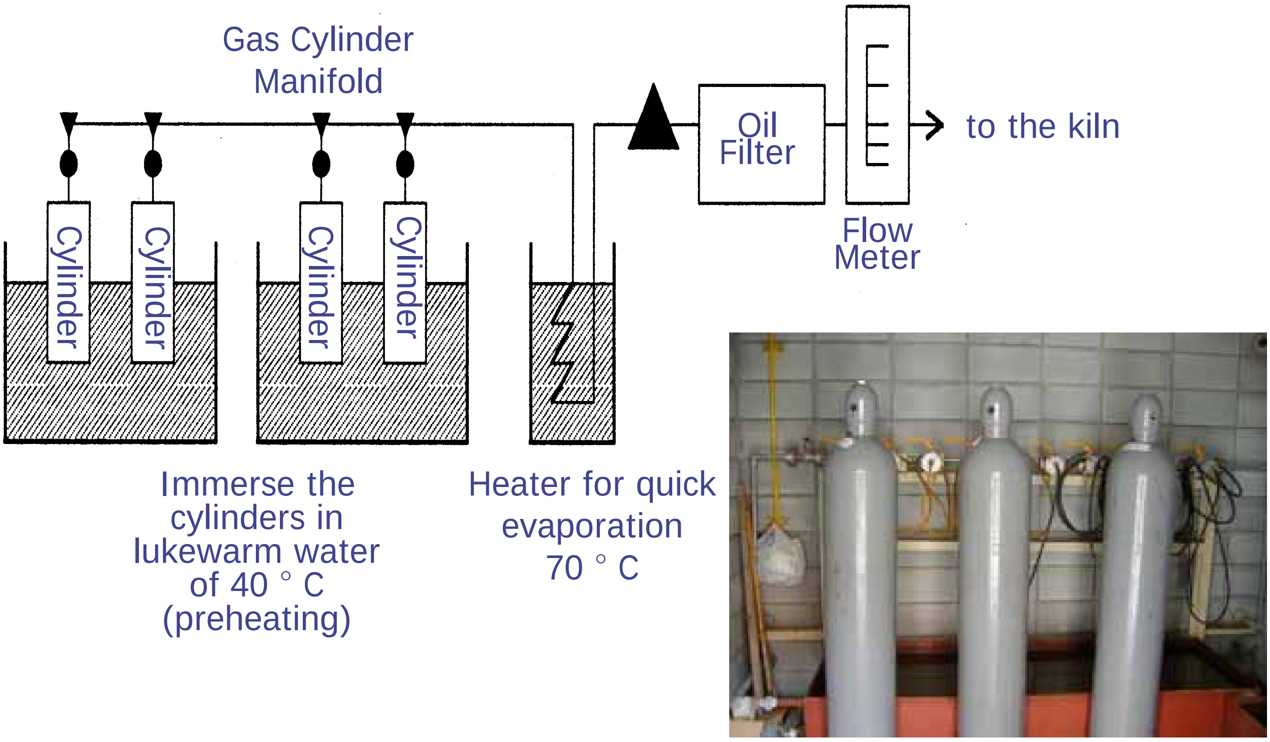
② Feed F-gas after stopping the use of crude petroleum and wasted oil （Effective use of feed pump of crude petroleum and wasted oil）
F-gas feeding can be made by installation of feed pump, although the use of crude petroleum and wasted oil will be limited during F-gas
There is a case of a damage of the F-gas feed pump depending on the burner frame heat. (Patented)

③ Install F-gas feed pump separately
There is no limitation of the use of crude petroleum and wasted oil by installation of F-gas feed pump to the upper part of kiln burner.
There is a case of damage of the F-gas feed pump depending on the burner frame heat as well as ②.(Patented)

④Feed F-gas mixed with primary air for fuel
There is no limitation of the use of crude petroleum and wasted oil by installation of F-gas feed pump to the upper part of kiln burner.
Also damage of the F-gas feed pump can be avoided .
The use of primary air for fuel becomes a condition. (Patented by Sumitomo Osaka Cement.)

Figure 5.3-4 Modification Methods of Kiln Burner for ODS Injection

Figure 5.3-5 Cement Plant (Upper: Cement Kiln; Lower: Suspension Heater)
(Chichibu Taiheiyo Cement. Japan)



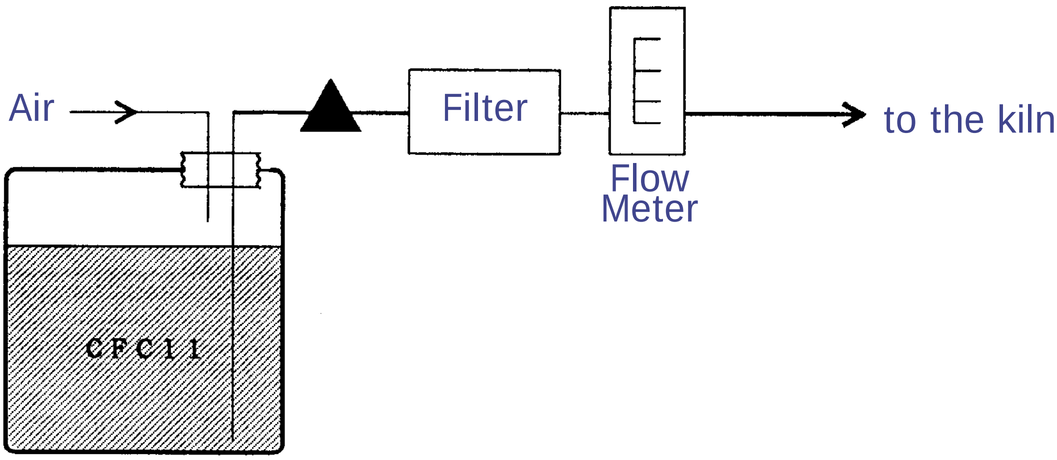


Figure 5.3-6 ODS Injection Equipment for Gaseous ODS (Upper) and Liquid ODS (Lower)

5.4 Exportation of ODS to other countries

This is the option of exporting ODS that are use-less in a certain country to other countries that have facilities for reclamation or destruction.

For the purpose of this study, an actual case based upon the actual stocked CFC from Indonesia are used.

One servicing company based upon Kalimantan Island of Indonesia retrofitted CFC-based equipment installed at one oil company. As a result, 21 metric tons of CFC was recovered in 2002.

The company stored the recovered CFC for the time being. After consultation with the Government of Indonesia about how to deal with it, the company decided to export the 21 MT of CFC to Australia for destruction on an experimental basis in cooperation with the government. The expense was covered by the company.
1.5 years passed since the recovery of CFC without preceding experience of a similar case in Indonesia.

The preparatory work involved the purchase of a certified cylinder from Germany to contain CFC during transportation (the transportation of the cylinder took about one month by ship), notifying the port of call (Singapore) of the intention of CFC transportation and obtaining the permit under the Basel Convention, and getting the permit from the Indonesian government for exportation.

In October 2005, the exported CFC was received by the Refrigerant Reclaim Australia. As a result of gas chromatography analysis that was carried out in Australia, the content was confirmed to contain 80 % CFC12 and 18% HCFC22. The CFC was destroyed with the argon plasma arc plant at the Australian National Halon Bank.

It took about 6 months from the preparatory work to the destruction of CFC.

The total cost involved for the exportation of 21 MT of CFC-12 for destruction in Australia in this case is approximately US$ 280,000, as is shown below.

Table 5.4-1. Actual Cost of CFC Export from Indonesia to Australia for Destruction (including Destruction)

Item	Unit	@	Cost (US$)
Cylinder (rental for 5 months + insurance)	1	7,500	17,500
Transportation from			
1. Land	1	5,000	5,000
2. Sea (Balikpapan, Kalimantan to Sydney)	1	15,000	15,000
Destruction (including laboratory analysis)	21,000 kg	10.5 USD/kg	220,500
Insurance (2.25 % of the value, i.e. destruction cost)	1		4,961
Paper work			
1. Customs	1	15,000	15,000
2. Permit from Singapore to Australia	-	-	-
3. Monitoring	-	-	-
TOTAL			277,961

6. Comparison of Disposal Options

The comparison of initial costs between the four options are given in Table 6-1 and qualitative comparison of advantages and disadvantages in Table 6-2.

It is difficult to compare cost effectiveness between these options due to the difference in nature of resulting ODP phase-out: in case of destruction (Options 1a and 2), the amount of ODP destroyed with approved technologies is construed as reduction in the calculated consumption level; in case of reclamation, it does not directly phase out ODP consumption but has been expected to replace virgin ODS consumption in the MLF-funded R & R projects.

The initial costs for new construction facilities for reclamation or destruction were estimated at approximately US$ 300,000 and 500,000, respectively. It is to be as cost effective (10 US$/kg) as the threshold values for investment projects in the commercial refrigeration sector (15.21 US$/kg ODP) and domestic refrigeration sector (13.76 US$/kg ODP) (Annex 2) by 50 MT of CFC destruction or replacement of 30 MT virgin CFC supply with reclaimed CFC.
The modification of a cement kiln, if available, can be 1 US$/kg if 50 MT is destroyed, or 10 times as cost-effective as the other options.
The cost effectiveness of exportation of 21 MT for destruction was 13 US$/kg.

Table 6-1. Cost Comparisons

Option	Initial Cost	Reclamation / Destruction Capacity
1a. Construction of new facility for ODS destruction (superheated steam reactor)	Approx. US$ 500,000 (US$ 435,000 + equipment transportation and installation) * destruction cost can be variable	25 kg/h
1b. Construction of new facility for reclamation	Approx. US$ 300,000 (US$ 44,000 (for liquid distillation facility) and/or US$ 174,000 (for gas distillation facility) and US$ 44,000 (gas chromatography) + equipment transportation and installation) *reclamation cost can be variable	15 kg/h (CFC12, etc.) 200 kg/h (CFC11, etc.)
2. Modification of cement kiln	Approx. US$ 50,000 (US$ 23,000 (parts locally procured) + labor) * destruction cost can be variable	30 kg/h – 50 kg/h
3. Exportation to other countries (Indonesia's case)	Approx. US$ 280,000 Based upon an experience of Indonesia, the cost can be lower than construction of new ODS destruction facility but as high as construction of new facility for reclamation	Not applicable

Table 6-2. Qualitative Comparison of Major ODS Disposal Options

Option	Advantages	Disadvantages	Note
1a. New construction of ODS destruction facility	➢ Operation is self-dependent (not like cement kiln which depends upon cement production).	➢ Sustainability of facility operation is dependent upon constant supply of ODS to be destroyed.	➢ POPs and other hazardous wastes can be destroyed in the same facility. ➢ Stable electricity supply needed.
1b. New construction of reclamation facility	➢ Operation is self-dependent (not like cement kiln which depends upon cement production).	➢ Sustainability of facility operation is dependent upon constant supply of ODS to be reclaimed.	➢ Stable electricity supply needed. ➢ When a certain amount of refrigerant is distilled, the amount of the reclaimed refrigerant will be approximately 70 % of the original amount; the distillation of low-purity refrigerant below threshold level consumes more energy and time; therefore, the existence of a reclamation facility does not necessarily negate the need for destruction of the residue and low-purity recovered refrigerants.
2. Modification of cement kiln for ODS destruction	➢ Relatively small additional cost ➢ Large destruction capacity ➢ Sustainability of facility operation does not depend upon constant supply of ODS for disposal.	➢ Dependent upon cement production (operation may stop when cement demands are low). ➢ The input of ODS into the facility needs to be controlled to avoid Cl deteriorating the quality of cement.	➢ Disposal of POPs and other wastes (solid) involves a technology different from ODS destruction (gas); hence, no significant financial saving through synergies with disposal of other solid wastes.
3. Exportation to other countries	➢ No need for new construction or modification of facilities.	➢ It may take much time, workload, and financial burden to take procedures required by the Basel Convention* and other international and domestic regulations.	

* Attention needs to be paid to related international agreements and domestic laws and rules of both exporting and importing countries. Generally, import and export of used ODS is not controlled under the Montreal Protocol. Exportation of used ODS to other countries for reclamation or destruction can be subject to the control and requirements of the Basel Convention when used ODS is legally defined as or considered to be hazardous waste by the State of export, the State of import or State of transit in light of the Basel Convention's process and hazardousness criteria. In addition, some countries which categorize ODS as hazardous substances under the domestic law take safe decisions to follow prior consent procedures for ODS transportation under the Basel Convention.

7. Issues to be taken into consideration for project implementation

Measures to deal with ODS disposal needs in a specific country or region should be tailored, choosing from or combining the above-mentioned options or other effective options, if any. In preparing and implementing such projects, the following issues should be taken into consideration.

- Need for legislation to ban the atmospheric release of ODS as a measure to promote reclamation and destruction.

- Need to consider the systematic coordination with ongoing R&R or banking activities in the case of refrigerants and halons.

- Need to consider the way in which the financial burden is allocated among stakeholders.

- Need to consider subsidy, other financial incentives or the market-driven approaches to make the system functional in the stages from recovery to reclamation or destruction.

- Need to include operator training as a project component.

- Possibility of co-financing with other funding resources and coordination with other multilateral activities of chemical waste management such as POPs-related movements and CDM-approved HFC destruction facilities.

  However, POPs treatment in a cement kiln is expected to be solid-state co-processing. Therefore, destructions of POPs (solid, as mixed with fuel) and ODS (gas) need different types of modification even though they are destroyed in the same facility. On the other hand, CDM-approved HFC23 destruction facilities in China (superheated steam reactor) and the Republic of Korea (submerged injection) are fully occupied with HFC23 destruction without room for ODS destruction even though they are technically capable of destroying ODS.

- Need in case of destruction to ensure that the ODP phase-out by destruction should not lead to net increase of production or consumption through, for instance, an agreement in the project document.

Annex 1

Table 1. Approved Destruction Technologies as of 15th MOP

Destruction technologies	Applicability		
	Concentrated sources		Dilute sources
	CFCs	Halon	Foam CFCs
Destruction and removal efficiency (DRE)	99.99%	99.99%	95%
Cement kilns (**IV**/11)	Approved	*Not Approved*	
Liquid injection incineration (**IV**/11)	Approved	Approved	
Gaseous/fume oxidation (**IV**/11)	Approved	Approved	
Municipal solid waste incineration			Approved (V/26)
Reactor cracking (**IV**/11)	Approved	*Not Approved*	
Rotary kiln incineration	Approved	Approved	Approved
Argon plasma arc (X**IV**/6)	Approved	Approved	
Inductively coupled radio frequency plasma (**VII**/35)	Approved	Approved	
Microwave plasma (X**IV**/6)	Approved	Approved	
Nitrogen plasma arc (X**IV**/6)	Approved	Approved	
Gas phase catalytic dehalogenation (X**IV**/6)	Approved	Approved	
Superheated steam reactor (X**IV**/6)	Approved	Approved	

Table 2. Number of F-gas Destruction Facilities in Japan by Destruction Technologies (as of 2004)

Category	Destruction Technologies		No.
Multipurpose system (32)	Incineration with waste	Municipal solid waste incineration	24
		Rotary kiln incineration	
		Two-staged burning system	
	Cement kiln	Cement kiln	7
	Others	Electric furnace	1
Devoted system (50)	Submerged combustion	Gaseous / fume oxidation	7
		Liquid injection incineration	
	Plasma	Radio frequency plasma	1
		Plasma arc	8
		Microwave plasma	8
	Gas phase catalytic dehalogenation	Gas phase catalytic dehalogenation (catalyst: TiO_2)	1
	Superheated steam reactor	Superheated steam reactor	25
Total			82

Note: Colored cells represent “approved processes for CFC, CTC and HCFC”.

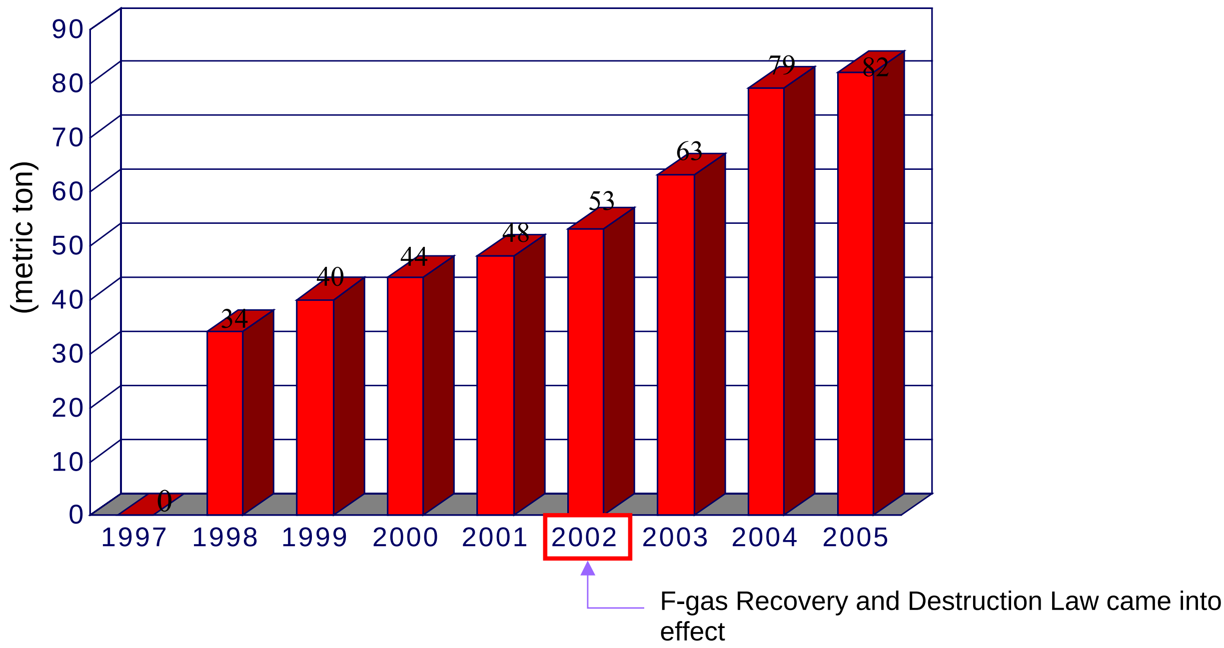


Figure 1. Number of F-gas Destruction Facilities in Japan

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CFC	46	101	267	760	508	506	639	354	627	954
HCFC					480	596	1,116	1,173	1,467	1,604
HFC			0	34	16	28	81	126	335	418

* Up to 2001, the amount of destruction of substances recovered during servicing had been included in the statistics

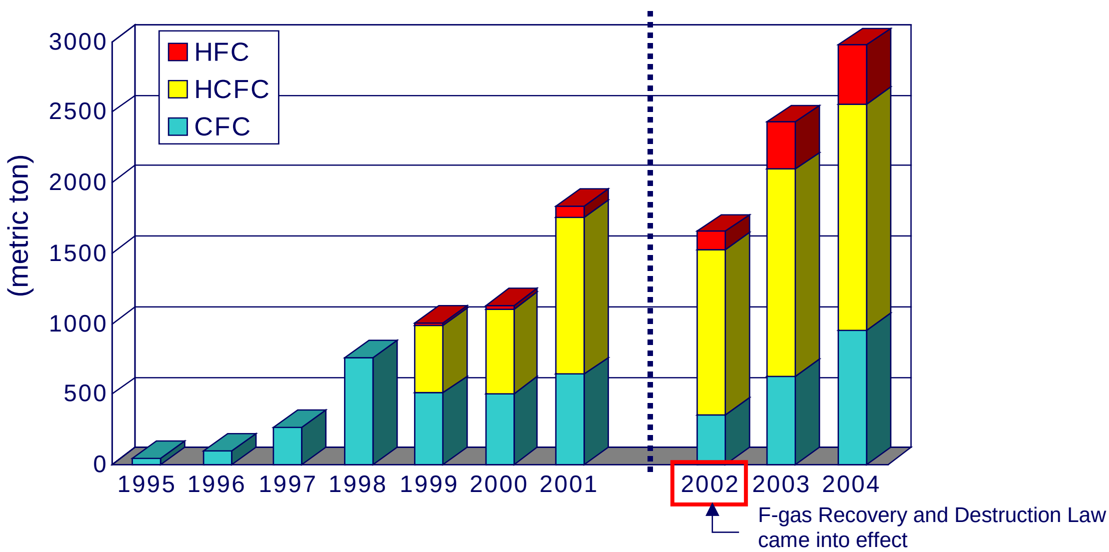


Figure 2. Amount of F-gas Destruction in Japan

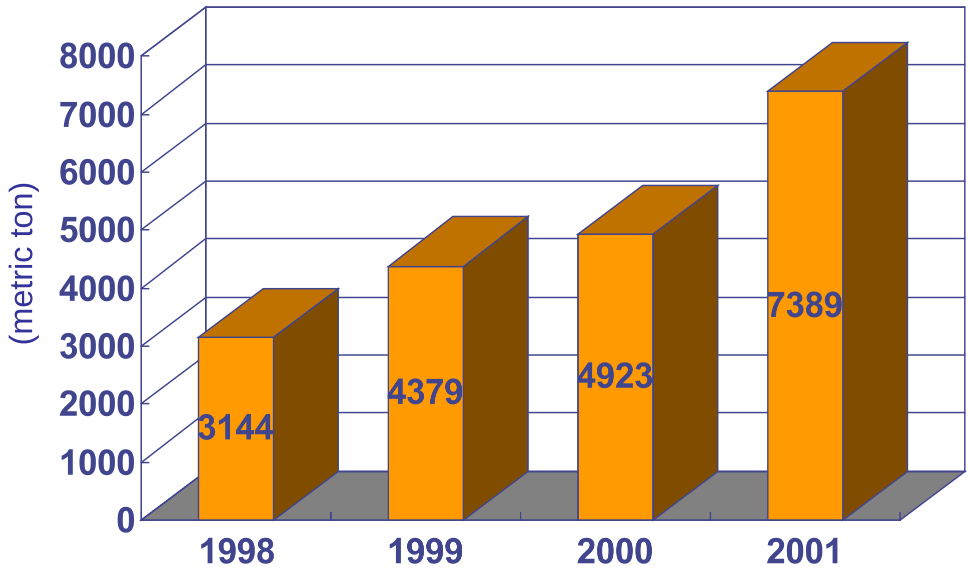


Figure 3. Estimated F-gas Destruction Capacity in Japan.
Source: 2002 survey done by the Ministry of the Environment of Japan

Annex 2. Threshold values currently used to examine cost-effectiveness

1. Threshold values by project type and by sector

1.1 Investment projects

Sector		US$/kg ODP
Aerosol	Hydrocarbon	4.40
Foam	General	9.53
	Flexible polyurethane	6.23
	Integral skin	16.86
	Polystyrene/polyethylene	8.22
	Rigid polyurethane	7.83
Halon	General	1.48
Refrigeration	Commercial	15.21
	Domestic	13.76
Solvent	CFC-113	19.73
	TCA	38.50

(UNEP/OzL.Pro/ExCom/16/20 (paras. 32c, 32d).

N.B. Applied to both LVC and non-LVC (UNEP/OzL.Pro/ExCom/17/60, Decision 17/11 para.19b)

1.2 Non-investment projects
12.1 US$/kg ODP

N.B. Not applicable to LVC

Annex 3. Costs of destruction operation and facilities from TEAP 2002 Report

Technology	Cost for Destruction	Initial Cost
Reactor Cracking	US$ 4-6/kg	US$ 4 million (capacity 2,500 t CFC/y)
Gaseous/Fume Oxidation	US$ 3-5/kg CFC (slightly higher for halon)	
Rotary Kiln	US$ 3-5/kg CFC US$ 7/kg Halon	
Liquid Injection Incineration	"No cost data was reported"	
Municipal Solid Waste Incineration		
Cement Kiln	"No costs were reported"	
Argon Plasma Arc	US$ 3-4/kg	
Inductively Coupled Radio Frequency Plasma	"No operating costs for a commercial-scale unit are reported"	
AC Plasma	US$ 3-5/kg	
CO_2 Plasma Arc		
Microwave Plasma		US$ 60,000 (capacity 2 kg/h)
Nitrogen Plasma Arc	US$ 5-6/kg CFC, HCFC, HFC	
Solvated Electron Decomposition	US$ 7/kgCFC or higher （vary depending upon prices of sodium）	
Gas Phase Chemical Reduction	US$ 3-5/kg	
Gas Phase Catalytic Dehalogenation	US$ 2-3/kg CFC-12 (US$ 5-7/kg)	US$ 250,000 (capacity 1kg/h) US$ 1 million (capacity 10 kg/h)
Superheated Steam Reactor	US$ 2-3/kg CFC	US$ 300,000 (capacity10kg/h)

Source: TEAP, 2002. *Report of the Task Force on Destruction Technologies.*

Annex 4. ODS destruction operating companies listed by the UNEP DTIE on its web page with information on status of ODS acceptance from other countries for destruction purposes

Name of Company	Country	Status of ODS Acceptance
DASCEM Holdings Pty Ltd	Australia	○
INDAVER N.V.	Belgium	○
TdB Incineracão Ltda	Brazil	○
City Swan Hills	Canada	○
Ekokem Oy Ab	Finland	○
Solvay Fluor GmbH	Germany	○
Onyx Magyarország Ltd.	Hungary	×
INEOS Fluor Japan Limited	Japan	×
Valorec Services AG	Switzerland	○

Source: UNEP DTIE OzonAction Programme. ODS Destruction Page.
< http://www.uneptie.org/ozonaction/sector/destruction/facilities.htm >

Annex 5. Past MOP decisions and comments on ODS recovery and disposal

1. The Montreal Protocol

- The 6th paragraph of the preamble

Determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge, taking into account technical and economic considerations and bearing in mind the developmental needs of developing countries,

- The 9th paragraph of the preamble

Considering the importance of promoting international co-operation in the research, development and transfer of alternative technologies relating to the control and reduction of emissions of substances that deplete the ozone layer, bearing in mind in particular the needs of developing countries,

2. Decisions adopted by the Meeting of the Parties to the Montreal Protocol

- Decision I/12F: Clarification of terms and definitions: Destruction

The First Meeting of the Parties decided in Dec. I/12F with regard to destruction:

(a) to agree to the following clarification of the definition of Article 1, paragraph 5 of the Protocol: 1a destruction process is one which, when applied to controlled substances, results in the permanent transformation, or decomposition of all or a significant portion of such substances";

(b) to request the Panel for Technical Assessment to address this subject for the Parties to return to it at its second and subsequent meetings with a view to determining whether it would be necessary to have a Standing Technical Committee to review and recommend for approval by the Parties methods for transformation or decomposition and to determine the amount of controlled substances that are transformed or decomposed by each method.

- Decision II/11: Destruction technologies

The Second Meeting of the Parties decided in Dec. II/11 with regard to destruction technologies to establish an Ad Hoc Technical Advisory Committee on Destruction Technologies and to appoint its Chairman, who shall appoint in consultation with the Secretariat up to nine other members on the basis of nomination by Parties. The members shall be experts on destruction technologies and selected with due reference to equitable geographical distribution. The Committee shall analyze destruction technologies and assess their efficiency and environmental acceptability and develop approval criteria and measurements. The Committee shall report regularly to meetings of the Parties.

- Decision III/10: Destruction technologies

The Third Meeting of the Parties decided in Dec. III/10 to note the constitution of the Ad Hoc Technical Advisory Committee on Destruction Technologies, established by the Second Meeting of the Parties, and to request the Committee to submit a report to the Secretariat for presentation to the Fourth Meeting of the Parties, in 1992 at least four months before the date set for that meeting;

- Decision IV/11: Destruction technologies

The Fourth Meeting of the Parties decided in Dec. IV/11:

1. to note the report of the Ad Hoc Technical Advisory Committee on Destruction Technologies and, in particular, the recommendations contained therein;

2. to approve, for the purposes of paragraph 5 of Article 1 of the Protocol, those destruction technologies that are listed in Annex VI to the report on the work of the Fourth Meeting of the Parties which are operated in accordance with the suggested minimum standards identified in Annex VII to the report of the Fourth Meeting of the Parties unless similar standards currently exist domestically;

3. to call on each Party that operates, or plans to operate, facilities for the destruction of ozone-depleting substances:
   (a) to ensure that its destruction facilities are operated in accordance with the Code of Good Housekeeping Procedures set out in section 5.5 of the report of the Ad Hoc Technical Advisory Committee on Destruction Technologies, unless similar procedures currently exist domestically; and

   (b) for the purposes of paragraph 5 of Article 1 of the Protocol, to provide each year, in its report under Article 7 of the Protocol, statistical data on the actual quantities of ozone-depleting substances it has destroyed, calculated on the basis of the destruction efficiency of the facility employed;

4. to clarify that the definition of destruction efficiency relates to the input and output of the destruction process itself, not to the destruction facility as a whole;

5. to request the Technology and Economic Assessment Panel, drawing on expertise as necessary:
   (a) to reassess ozone-depleting substances destruction capacities;

   (b) to evaluate emerging technology submissions;

   (c) to prepare recommendations for consideration by the Parties to the Montreal Protocol at their annual Meeting;

   (d) to examine means to increase the number of such destruction facilities and making available the utilization to developing countries which do not own or are unable to operate such facilities;

6. to list in Annex VI to the report on the work of the Fourth Meeting of the Parties approved destruction technologies;

7. to facilitate access and transfer of approved destruction technologies in accordance with Article 10 of the Protocol, together with provision for financial support under Article 10 of the Protocol for Parties operating under paragraph 1 of Article 5.

➢ Decision IV/12: Clarification of the definition of controlled substances

The Fourth Meeting of the Parties decided in Dec. IV/12:

1. that insignificant quantities of controlled substances originating from inadvertent or coincidental production during a manufacturing process, from unreacted feedstock, or from their use as process agents which are present in chemical substances as trace impurities, or that are emitted during product manufacture or handling, shall be considered not to be covered by the definition of a controlled substance contained in paragraph 4 of Article 1 of the Montreal Protocol;

2. to urge Parties to take steps to minimize emissions of such substances, including such steps as avoidance of the creation of such emissions, reduction of emissions using practicable control technologies or process changes, containment or destruction;

3. to request the Technology and Economic Assessment Panel:
   (a) to give an estimate of the total emissions resulting from trace impurities, emission during product manufacture and handling losses;

   (b) to submit its findings to the Open-ended Working Group of the Parties to the Montreal Protocol not later than 31 March 1994.

➢ Decision IV/24: Recovery, reclamation and recycling of controlled substances

The Fourth Meeting of the Parties decided in Dec. IV/24:

1. to annul decision I/12 H of the First Meeting of the Parties, which reads "Imports and exports of bulk used controlled substances should be treated and recorded in the same manner as virgin controlled substances and included in the calculation of the Party's consumption limits";

2 not to take into account, for calculating consumption, the import and export of recycled and usedcontrolled substances (except when calculating the base year consumption under paragraph 1 of Article 5 of the Protocol), provided that data on such imports and exports are subject to reporting under Article 7;

3. to agree to the following clarifications of the terms "recovery", "recycling" and "reclamation":
   (a) Recovery: The collection and storage of controlled substances from machinery, equipment, containment vessels, etc., during servicing or prior to disposal;

   (b) Recycling: The re-use of a recovered controlled substance following a basic cleaning process such as filtering and drying. For refrigerants, recycling normally involves recharge back into equipment it often occurs "on-site";

   (c) Reclamation: The re-processing and upgrading of a recovered controlled substance through such mechanisms as filtering, drying, distillation and chemical treatment in order to restore the substance to a specified standard of performance. It often involves processing "off-site" at a central facility;

4. to urge all the Parties to take all practicable measures to prevent releases of controlled substances into the atmosphere, including, inter alia:
   (a) to recover controlled substances in Annex A, Annex B and Annex C of the Protocol, for purposes of recycling, reclamation or destruction, that are contained in the following equipment during servicing and maintenance as well as prior to equipment dismantling or disposal:
      (i) stationary commercial and industrial refrigeration and air conditioning equipment;
      (ii) mobile refrigeration and mobile air-conditioning equipment;
      (iii) fire protection systems;
      (iv) cleaning machinery containing solvents;

   (b) to minimize refrigerant leakage from commercial and industrial air-conditioning and refrigeration systems during manufacture, installation, operation and servicing;

   (c) to destroy unneeded ozone-depleting substances where economically feasible and environmentally appropriate to do so;

5. to urge the Parties to adopt appropriate policies for export of the recycled and used substances to Parties operating under paragraph 1 of Article 5 of the Protocol, so as to avoid any adverse impact on the industries of the importing Parties, either through an excessive supply at low prices which might introduce unnecessary new uses or harm the local industries, or through an inadequate supply which might harm the user industries;

6. to request the Scientific Assessment Panel to study and report, by 31 March 1994 at the latest, through the Secretariat, on the impact on the ozone layer of continued use of recycled controlled substances and of the utilization or non-utilization of available environmentally sound alternatives/substitutes and to request the Open-ended Working Group of the Parties to consider the report and to submit their recommendations to the Sixth Meeting of the Parties;

7. to request the Technology and Economic Assessment Panel to review and report, by 31 March 1994 at the latest, through the Secretariat, on:
   (a) the technologies for recovery, reclamation, recycling and leakage control;

   (b) the quantities available for economically feasible recycling and the demand for recycled substances by all Parties;

   (c) the scope for meeting the basic domestic needs of the Parties operating under paragraph 1 of Article 5 of the Protocol through recycled substances;

   (d) the modalities to promote the widest possible use of alternatives/substitutes with a view to increasing their usage and release their reclaimed substances to Parties operating under paragraph 1 of Article 5 of the Protocol; and

   (e) other relevant issues and to recommend policies with respect to recovery, reclamation and recycling, keeping in mind the effective implementation of the Montreal Protocol;

8. to request the Open-ended Working Group of the Parties to the Protocol to consider the reports of the Scientific Assessment Panel and the Technology and Economic Assessment Panel and any recommendations in this regard made by the Executive Committee and submit their recommendations to the Sixth Meeting of the Parties, in 1994.

➢ Decision V/26: Destruction Technologies

The Fifth Meeting of the Parties decided in Dec. V/26, further to decision IV/11 on destruction technologies:

(a) That there shall be added to the list of approved destruction technologies, which was set out in Annex VI to the report of the work of the Fourth Meeting of the Parties, the following technology: Municipal solid waste incinerators (for foams containing ozone-depleting substances);

(b) To specify that pilot-scale as well as demonstration-scale destruction technologies should be operated in accordance with the suggested minimum standards identified in Annex VII to the report of the Fourth Meeting of the Parties unless similar standards currently exist domestically.

➢ Decision VII/12: Control measures for Parties not operating under Article 5 concerning halons and other agents used for fire-suppression and explosion-inertion purposes

The Seventh Meeting of the Parties decided in Dec. VII/12:

1. To recommend that all Parties not operating under Article 5 should endeavour, on a voluntary basis, to limit the emissions of halon to a minimum by:
   (a) Accepting as critical those applications meeting the essential-use criteria as defined in decision IV/25, paragraph 1 (a);

   (b) Limiting the use of halons in new installations to critical applications;

   (c) Accepting that existing installations for critical applications may continue to use halon in the future;

(d) Considering the decommissioning of halon systems in existing installations, which are not critical applications, as quickly as technically and economically feasible;

(e) Ensuring that halons are effectively recovered;

(f) Preventing, whenever feasible, the use of halon in equipment testing and for training of personnel;

(g) Evaluating and taking into account only those substitutes and replacements of halon, for which no other more environmentally suitable ones are available;

(h) Promoting the environmentally safe destruction of halons, when they are not needed in halon banks (existing or to be created);

2. To request the Technology and Economic Assessment Panel and its Halons Technical Options Committee to prepare a report to the Eighth Meeting of the Parties to provide guidance on the above.

- Decision VII/31: Status of recycled CFCs and halons under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

The Seventh Meeting of the Parties decided in Dec. VII/31 that the international transfers of controlled substances of the Montreal Protocol which are recovered but not purified to usable purity specifications prescribed by appropriate international and/or national organizations, including International Standards Organization (ISO), should only occur if the recipient country has recycling facilities that can process the received controlled substances to these specifications or has destruction facilities incorporating technologies approved for that purpose.

- Decision VII/35: Destruction technology

The Seventh Meeting of the Parties decided in Dec. VII/35:

1. To note that the Technology and Economic Assessment Panel examined the results of testing and verified that the "radio frequency plasma destruction" technology of Japan meets the suggested minimum emission standards that were approved by the Parties at their Fourth Meeting for destruction technologies;

2. To approve, for the purposes of paragraph 5 of Article 1 of the Protocol, the radio frequency plasma destruction technology and to add it to the list of destruction technologies already approved by the Parties.

- Decision IX/21: Decommissioning of non-essential halon systems in non-Article 5 Parties

The Ninth Meeting of the Parties decided in Dec. IX/21:
Noting that in its 1994 report, the Scientific Assessment Panel identified decommissioning and destruction of halon as the second most environmentally beneficial potential approach to further lowering stratospheric chlorine and bromine abundances but that the Technology and Economic Assessment Panel concluded that such an approach, while technically feasible, was not appropriate at that time,
Noting that the Seventh Meeting of the Parties took action in relation to methyl bromide controls, which was the approach identified by the Scientific Assessment Panel as the most environmentally beneficial approach at that time,
Noting also that Parties are considering further controls on methyl bromide, Recognizing that, since 1994, some Parties have taken action to decommission and commence destruction of non-essential halon,

Recognizing that depletion of the ozone layer continues to be a significant environmental concern and that atmospheric concentrations of halons continue to increase,
Recognizing that the Technology and Economic Assessment Panel is currently conducting an assessment of the availability of halons for critical uses under the terms of decision VIII/17,

1. To request the Technology and Economic Assessment Panel to examine the feasibility of early decommissioning in non-Article 5 Parties of all non-essential halon systems, and the subsequent destruction or redeployment of halon stocks not required for those critical uses that have no identified substitutes or alternatives, bearing in mind the need of Article 5 Parties for halon. In undertaking such an examination, TEAP should also examine the efficacy of halon alternatives, experience with potential measures to ensure safety and to minimize any emissions of halons during decommissioning, and experience with the cost and efficiency of storage prior to destruction and with halon destruction activities undertaken to date;

2. To request TEAP to report on this matter to the Tenth Meeting of the Parties.

- Decision X/7: Halon-management strategies

The Tenth Meeting of the Parties decided in Dec. X/7:
Noting that in the executive summary of its 1998 report, the Scientific Assessment Panel identifies complete elimination and destruction of halon-1211 and 1301 as the most environmentally beneficial option to enhance the recovery of the ozone layer,
Noting that the Technology and Economic Assessment Panel, in its 1998 report pursuant to decision IX/21, concludes that by definition all non-critical uses of halon-1211 and 1301 can be decommissioned, taking into account the costs and benefits of such operations,

1. To request all Parties to develop and submit to the Ozone Secretariat a national or regional strategy for the management of halons, including emissions reduction and ultimate elimination of their use;

2. To request Parties not operating under Article 5 to submit their strategies to the Ozone Secretariat by the end of July 2000;

3. In preparing such a strategy, Parties should consider issues such as:
   (a) Discouraging the use of halons in new installations and equipment;

   (b) Encouraging the use of halon substitutes and replacements acceptable from the standpoint of environment and health, taking into account their impact on the ozone layer, on climate change and any other global environmental issues;

   (c) Considering a target date for the complete decommissioning of non-critical halon installations and equipment, taking into account an assessment of the availability of halons for critical uses;

   (d) Promoting appropriate measures to ensure the environmentally safe and effective recovery, storage, management and destruction of halons;

4. To request the Technology and Economic Assessment Panel to update its assessment of the future need for halon for critical uses, in light of these strategies;

5. To request the Technology and Economic Assessment Panel to report on these matters to the Twelfth Meeting of the Parties.

- Decision XII/8: Disposal of controlled substances

The Twelfth Meeting of the Parties decided in Dec. XII/8:

Noting decisions II/11, III/10, IV/11, V/26 and VII/35 on destruction technologies and the previous work of the Ad Hoc Technical Advisory Committee on Destruction Technologies;

Also noting the innovations that have taken place in the field of destruction technologies since the last report of Advisory Committee;

Recognizing that the management of contaminated and surplus ozone-depleting substances would benefit from further information on destruction technologies and an evaluation of disposal options;

1. To request the Technology and Economic Assessment Panel to establish a task force on destruction technologies;

2. That the task force on destruction technologies shall:
   (a) Report to the Parties at their Fourteenth Meeting in 2002 on the status of destruction technologies of ozone-depleting substances, including an assessment of their environmental and economic performance, as well as their commercial viability;

   (b) When presenting its first report, include a recommendation on when additional reports would be appropriate;

   (c) Review existing criteria for the approval of destruction facilities, as provided for in section 2.4 of the Handbook for the International Treaties for the Protection of the Ozone Layer;

3. To request the Technology and Economic Assessment Panel:
   (a) To evaluate the technical and economic feasibility for the long-term management of contaminated and surplus ozone-depleting substances in Article 5 and non-Article 5 countries, including options such as long-term storage, transport, collection, reclamation and disposal of such ozone-depleting substances;

   (b) To consider possible linkages to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal and other international treaties as appropriate regarding the issue of disposal;

   (c) To report to the Parties on these issues at their Fourteenth Meeting in 2002.

- Decision XIV/6: Status of destruction technologies of ozone-depleting substances, including an assessment of their environmental and economic performance, as well as their commercial viability

The Fourteenth Meeting of the Parties decided in Dec. XIV/6:

1. To note with appreciation the Report of the Task Force on Destruction Technologies presented to the twenty-second meeting of the Open-ended Working Group;

2. To note that the Task Force has determined that the destruction technologies listed in paragraph 3 of this decision meet the suggested minimum emission standards that were approved by the Parties at their Fourth Meeting;

3. To approve the following destruction technologies for the purposes of paragraph 5 of Article 1 of the Protocol, in addition to the technologies listed in annex VI to the report of the Fourth Meeting and modified by decisions V/26 and VII/35:
   (a) For CFC, HCFC and halons: argon plasma arc;

   (b) For CFC and HCFC: nitrogen plasma arc, microwave plasma, gas phase catalytic dehalogenation and super-heated steam reactor;

(c) For foam containing ODS: rotary kiln incinerator;

4. To request the Technology and Economic Assessment Panel to update, in time for consideration by the twenty-third Open-ended Working Group, the Code of Good Housekeeping to provide guidance on practices and measures that could be used to ensure that during the operation of the approved destruction technologies, environmental release of ODS through all media and environmental impact of those technologies is minimized;

5. To consider, at the twenty-fourth meeting of the Open-ended Working Group, the need to review the status of destruction technologies in 2005, including an assessment of their environmental and economic performance, as well as their commercial viability.

- Decision XV/9. Status of destruction technologies for ozone -depleting substances and code of good housekeeping

1. To recall that the Montreal Protocol on Substances that Deplete the Ozone Layer does not require the Parties to destroy ozone-depleting substances;

2. To note that the report of the Technology and Economic Assessment Panel of April 2002 (volume 3, report on the Task Force on Destruction Technologies) provides information on the technical and economic performance and commercial viability of destruction technologies for ozone-depleting substances;

3. To take note of the previous decisions of the Meeting of the Parties on the approval of destruction technologies (decisions IV/11, VII/35 and XIV/6) and, in particular, to note that those decisions did not distinguish between the capabilities of destruction technologies for specific types of ozone-depleting substances;

4. To approve, for the purposes of paragraph 5 of Article 1 of the Montreal Protocol, the destruction technologies listed as "approved" in annex II to the present report, which were found by the Task Force on Destruction Technologies to meet the destruction and removal efficiencies set out therein;

5. To recognize that, in approving the technologies listed in annex I, the Parties acknowledge that two technologies previously approved for all ozone-depleting substances have been limited in their scope to omit halons;

6. To call on each Party that operates, or plans to operate, approved technologies in accordance with paragraph 2 above to ensure that its destruction facilities are operated in accordance with the Code of Good Housekeeping Procedures, contained in annex III to the present report, as updated in the progress report of the Technology and Economic Assessment Panel in May 2003 and subsequently amended by the Parties, unless similar or stricter procedures currently exist domestically;

7. To highlight the need for Parties to pay particular attention to the adherence of facilities for the destruction of ozone-depleting substances to relevant international or national standards addressing hazardous substances and taking into account cross-media emissions and discharges, including those identified in annex IV to the present report;

- Decision XV/10. Handling and destruction of foams containing ozone –depleting substances at the end of their life

To request the Technology and Economic Assessment Panel, in its April 2005 report:

(a) To provide updated useful information on the handling and destruction of ozone-depleting substance-containing thermal insulation foams including thermal foams situated in buildings, with particular attention to the economic and technological implications;

(b) To clarify the distinction between the destruction efficiency achievable for ozone-depleting substances recovered from foams prior to destruction (reconcentrated) and the destruction efficiency achievable for the foams themselves containing ozone-depleting substances (dilute source);

- Decision XVI/14. Sources of carbon tetrachloride emissions and opportunities for reductions

Noting with appreciation the 2002 report of the Scientific Assessment Panel and the April 2002 report of the Technology and Economic Assessment Panel on destruction technologies,

Recognizing the need to understand the latest technology and best practices for mitigating emissions and destruction of carbon tetrachloride,

Expressing concern that measured atmospheric concentrations of carbon tetrachloride are significant,

Recognizing the need to access further the sources of carbon tetrachloride being measured in the atmosphere,

1. To request the Technology and Economic Assessment Panel to assess global emissions of carbon tetrachloride being emitted:

(a) From feedstock and process agent sources situated in Parties not operating under paragraph 1 of Article 5;

(b) From sources situated in Parties operating under paragraph 1 of Article 5 already addressed by existing agreements with the Executive Committee of the Multilateral Fund;

(c) From feedstock and process agent uses of carbon tetrachloride applied in Parties operating under paragraph 1 of Article 5 not yet addressed by agreements with the Executive Committee of the Multilateral Fund;

(d) From sources situated both in Parties operating under paragraph 1 of Article 5 and in those not so operating that co-produce carbon tetrachloride;

(e) From waste and incidental quantities of carbon tetrachloride that are not destroyed in a timely and appropriate manner;

2. To request the Technology and Economic Assessment Panel to assess potential solutions for the reduction of emissions for the categories above;

3. To request the Technology and Economic Assessment Panel to prepare a report for the consideration of the Parties at the Eighteenth Meeting of the Parties in 2006;

- Decision XVI/15. Review of approved destruction technologies pursuant to decision XIV/6 of the Parties

Recalling the report of the task force on destruction technologies presented to the Parties at the twenty-second meeting of the Open-ended Working Group,

Noting the need to keep the list of approved destruction technologies up-to-date,

Mindful of the need to minimize any additional workload for the Technology and Economic Assessment Panel,

1. To request the initial co-chairs of the task force on destruction technologies to reconvene in order to solicit information from the technology proponents exclusively on destruction technologies identified as "emerging" in the 2002 report of the task force on destruction technologies;

2. Further to request the co-chairs, if new information is available, to evaluate and report, based on the development status of these emerging technologies, whether they warrant consideration for addition to the list of approved destruction technologies;

3. To request that that report be presented through the Technology and Economic Assessment Panel to the Open-ended Working Group at its twenty-fifth meeting;

- Decision XVII/11: Recapturing/recycling and destruction of methyl bromide from space fumigation

Welcoming the 2005 progress report of the Technology and Economic Assessment Panel,

Noting in particular that the report was inconclusive on recommendations on recapturing, recycling and destruction (Section 7.6, p. 147 of the 2005 progress report) but highlighted local environmental and occupational health and safety concerns,

Recalling decision XI/13, paragraph 7, "To encourage the use of methyl bromide recovery and recycling technology (where technically and economically feasible) to reduce emissions of methylbromide, until alternatives to methyl bromide for quarantine and pre-shipment uses are available",

Noting that recapture of methyl bromide from small-scale fumigations in containers is already carried out in several countries,

Recognizing the need to further reduce methyl bromide emissions in an effort to protect the ozone layer,

1. To encourage Parties who have deployed in the past, currently deploy or plan to deploy technologies to recapture/recycle/destroy or reduce methyl bromide emissions from fixed facilities or sea container fumigation applications to submit to the Technology and Economic Assessment Panel details of efficacy, including Destruction and Removal Efficiency (DRE), logistical issues, and the economic feasibility of such fumigations by 1 April 2006;

2. To encourage Parties to report on any harmful by-products created using this technology;

3. To adopt the form annexed to this decision for the purpose of submitting data;

4. To include the findings of data submitted in the 2006 progress report of the Technology and Economic Assessment Panel and summarize Parties' positive and negative past experiences of recovery and destruction technologies.

- Decision XVII/17: Technical and financial implications of the environmentally sound destruction of concentrated and diluted sources of ozone-depleting substances

Recognizing that, in the preamble to the Montreal Protocol, the Parties affirmed that, for the protection of the ozone layer, precautionary measures should be taken to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge,

Bearing in mind that, for most Parties operating under paragraph 1 of Article 5, chlorofluorocarbons which remain to be phased out are concentrated in the refrigeration servicing sector and that, as a result, their final elimination will only be achieved when all the existing installed equipment has been replaced,

Considering that the replacement of the said equipment necessitates a range of complex activities, including, among other things, economic incentives for the end-users, the development of recovery, transport and environmentally sound destruction processes for the obsolete equipment, with particular attention to training for this purpose and to the destruction of the chlorofluorocarbons released in that process, Noting the outcomes of the expert meeting on destruction of ozone depleting substances that will be held in Montreal from 22 to 24 February 2006,

1. To request the Technology and Economic Assessment Panel to prepare terms of reference for the conduct of case-studies in Parties operating under paragraph 1 of Article 5 of the Protocol, with regional representation, on the technology and costs associated with a process for the replacement of chlorofluorocarbon-containing refrigeration and air-conditioning equipment, including the environmentally sound recovery, transport and final disposal of the said equipment and of the associated chlorofluorocarbons;

2. That these studies should explore economic and other incentives which will encourage users to phase out equipment and ozone-depleting substances and to reduce emissions, as well as the viability and costs of setting up destruction facilities in countries operating under paragraph 1 of Article 5, and that the said studies should include a regional analysis relating to the management, transport and destruction of chlorofluorocarbons;

3. Also to request the Technology and Economic Assessment Panel to review possible synergies with other conventions, such as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade and the Stockholm Convention on Persistent Organic Pollutants;

4. To request the Technology and Economic Assessment Panel to adopt the recovery and destruction efficiency parameter proposed in the Panel's report to the Open-ended Working Group at its twenty-fifth meeting, as the parameter to be applied in developing the proposed study referred to above;

5. That said terms of reference shall be submitted to the Parties at the twenty-sixth meeting of the Open-ended Working Group, and that provision will be made for resources for this purpose in the 2006–2008 replenishment of the Multilateral Fund.

- Decision XVII/18: Request for assistance of the Technology and Economic Assessment Panel for the meeting of experts on destruction

Noting decision 47/52 of the Executive Committee, adopted at its forty-seventh meeting, requesting the secretariat of the Multilateral Fund to convene a meeting of experts in Montreal, from 22 to 24 February 2006,

Recalling that the Multilateral Fund secretariat was requested to recruit consultants to collect and prepare data on this subject for dissemination to participants in the meeting of experts and to develop a standard format for reporting data on unwanted, recoverable, reclaimable, non-reusable and virgin stockpiled ozone-depleting substances,

1. To request the Technology and Economic Assessment Panel and its technical options committees to submit to the Multilateral Fund secretariat available data to enable the Multilateral Fund secretariat to assess the extent of current and future requirements for the collection and disposition (emissions, export, reclamation and destruction) of non-reusable and unwanted ozone-depleting substances in Article 5 Parties in pursuance of decision 47/52 of the Executive Committee, adopted at its forty-seventh meeting.

3. Comments made by Parties to the Montreal Protocol on recovery and destruction

- 12th Meeting of the Parties

After reporting on the number of new Parties to the Vienna Convention and the Montreal Protocol, he mentioned that a draft decision was before the Parties concerning the long-term strategy for ODS disposal and destruction technologies, as well as another on prevention of illegal trade in ODS and products containing ODS. (9th paragraph of the report)

- 14th Meeting of the Parties

In his opening address, Mr. Clini welcomed participants to the combined sixth meeting of the conference of the Parties to the Vienna Convention and the Fourteenth Meeting of the Parties to the Montreal Protocol. He described the process under the Montreal Protocol as a major example of global initiatives aimed at achieving sustainable development, noting that efforts to ensure the protection of the ozone layer had been marked by a strong driving force for global technological innovation in several industrial sectors in both developed and developing countries. He welcomed the remarkable results that had been achieved in restructuring industrial practices and altering consumer behaviour and trade patterns, and which had involved millions of enterprises and consumers, as well as considerable financial resources.
Given the fact that the phasing-out of ozone-depleting substances (ODS) had almost been completed in industrialized countries, the focus was now on the phasing-out of critical and essential uses, the recovery of the ozone layer, the destruction of ODS and the fight against illegal trade. (4th paragraph of the report)

A number of representatives sought to know what action should be taken regarding illegally imported quantities of substances seized by customs agencies. One representative observed that Article 5 Parties could come under pressure from multinational companies in this regard; he quoted an example where his Government had recently destroyed banned products and had been asked to reimburse the operator. The representative of Poland clarified that the disposal of seized products was a matter for the Government concerned; Article 5 Parties, where consumption was still allowed, could sell them at auction, export them or stockpile them, though of course the quantities thus disposed of would then count against their own consumption limits. Destruction was also a possibility, but may pose problems of cost and practicality. (93rd paragraph of the report)

- 15th meeting of the parties

The Panel had determined that over 1,000,000 tonnes of ozone-depleting substances were available for recovery and destruction. Parties might therefore wish to consider exempting production for approved essential and critical applications in non-Article 5 countries only if equal or greater ozone-depleting-potential quantities were recovered and destroyed. (212 paragraph of the advance report)

Annex 6. Model project proposal document (draft)

This project proposal is provisional pending final agreement from all the involved project participants and subject to change.

PROJECT COVER SHEET

Geographical Scope:	South Asia and Asia and the Pacific Regions
Title of Project:	Demonstration Project on ODS Disposal
Project in Current Business Plan:	Yes
Sectors Covered:	All
Duration of the Project:	1.5 years
Local Ownership:	77.33 % (Holderfin BV.) 22.67 % local / public
Project Cost:	US$ 257,100
Requested Grant:	US$ 192,100
Coordinating Agency (ies):	National Ozone Units of participating countries (Indonesia, etc.)
Implementing Agency:	Japan in cooperation with [Implementing Agencies]

Introduction

This project will seek to address emerging needs of ODS disposal in Article 5 countries by transferring ODS destruction technology in accordance with Decision IV/11 of the Meeting of the Parties to the Montreal Protocol.

This is a demonstration project on ODS destruction in which Indonesia will host the demonstration implementation of a cement kiln modification for ODS disposal and the experience will be shared with other Article 5 countries in the region as well as interested IAs in an overall and wider effort to explore and choose practicable options in consideration of economical, technical and legislative factors.

The project components include as the core component the modification of an existing cement kiln in Jakarta, Indonesia for ODS destruction, which option has been judged to be cost effective as compared to other options of ODS disposal, i.e. construction of new reclamation / destruction facilities, exportation to other countries. Besides, technical assistance components include personnel training and enhancement of logistics to transport and track recovered ODS based upon the ongoing R&R programme.
The modification process itself will serve as a demonstration project and an on-site training project for other countries to learn from. The recipient country is expected to be a center for ODS disposal on a regional basis and to disseminate the gained expertise to address specific situations in other countries in following years.

This project will contribute to compliance by making the existing R&R system functional and enabling countries to reduce the calculated production / consumption by destruction with approved technologies when other measures are not available.

As conditions for the project approval, the following agreements are to be included in the Memorandum of Understanding between the funding organization (e.g. Multilateral Fund Secretariat) and the recipient country:

- The Government's commitment to introducing a ban on the deliberate or avoidable releases of ODS into the atmosphere;
- The agreement that the destroyed ODP by the approved destruction facility relevant to this project cannot be used to increase the net production or consumption of ODS in the recipient country; and
- The agreement of the recipient company to serve as a demonstration case study open to NOUs and technical counterparts from other countries and cooperate with technology transfer activities such as on-site study visits, workshops and deployment of its technical staff as a resource person in the future (without obligatory financial commitment).

ODS Disposal Needs and Choice of Disposal Option

At present, 1 MT of mixed refrigerant (CFC11 and CFC12), 74 MT of unwanted MCF, and 11 MT of contaminated CFC11 (19.4 ODPt in total) have been identified as ODS disposal needs in Indonesia.
In addition, 21 MT of CFC12 recovered in an oil company was already exported to Australia and destroyed in 2005.
These existing and past cases indicated that similar cases are likely to follow in the future, necessitating ODS disposal beyond these overt cases.

Table 1. Identified ODS Disposal Needs in Indonesia

1 MT of mixed refrigerant (CFC11 and CFC12)	One servicing company based upon Jakarta, Indonesia, is storing 1 MT of mixed refrigerant of CFC11 and CFC12. This mixture happened as a result of accidental confusion during service operation. In the absence of measures to separate this mixed refrigerant, the company stores the cylinder for an indefinite period without access to reclamation or destruction options.
74 MT of MCF	An industry association in Jakarta, Indonesia stores 73,710 kg of MCF for an indefinite period without domestic demand after phase-out of MCF use or access to destruction.
11 MT of contaminated CFC11	A private company based in East Java Province stores 11 MT of contaminated CFC11.

Indonesia has recovery and recycling machines procured in the ongoing R&R project; however, there is no sophisticated reclamation facility that can separate mixed refrigerants or no destruction facility.

As a measure to deal with the identified and potential ODS disposal needs in Indonesia, three options have been considered:

(1) Installation of new facilities for reclamation and/or destruction;
(2) Modification of an existing cement kiln for ODS destruction; and
(3) Exportation of ODS to Australia for destruction.

(1) The cost of the installation of new facilities for reclamation and/or destruction will range from US$ 300,000 (gas and liquid refrigerant reclamation facilities) to US$ 500,000 (a stand-alone super heated steam destruction facility) or US$ 800,000 (a combination of both).

(2) Modification of an existing cement kiln for ODS destruction is an option available in Indonesia, which has several cement factories. Among them, PT Holcim Indonesia Tbk (former PT Semen Cibinong), which has already been operating waste destruction, including waste tires and PCB (as mixed with the fuel) based upon its cement-kiln plants is interested in the modification for ODS destruction on the condition that necessary assistance be provided.
The cost of modification is estimated at approximately US$23,000 [local prices to be confirmed], excluding labor, when necessary parts are procured and assembled locally.

(3) Exportation of ODS to Australia for destruction which was actually done by one servicing company based in Kalimantan Island of Indonesia, which retrofitted CFC-based equipment installed at one oil company. In that case, in which 21 MT of CFC was destroyed in Australia in 2005, it cost US$ 280,000, including transportation and destruction (Table 2).
By extrapolation based upon this experience, the cost of exportation of 84 MT of identified unwanted ODS to Australia for destruction is estimated to be about US$ 1,100,000 (Table 3).

Table 2. Actual Cost of CFC Export from Kalimantan, Indonesia to Australia for Destruction (including Destruction)

Item	Unit	@	Cost (US$)
Cylinder (rental for 5 months + insurance)	1	7,500	17,500
Transportation from			
1. Land	1	5,000	5,000
2. Sea (Balikpapan, Kalimantan to Sydney)	1	15,000	15,000
Destruction (including laboratory analysis)	21,000 kg	10.5 USD/kg	220,500
Insurance	1	2.25 % of the value, i.e. destruction cost	4,961
Paper work			
1. Customs	1	15,000	15,000
2. Permit from Singapore to Australia	-	-	-
3. Monitoring	-	-	-
TOTAL			277,961

Table 3. Estimated Cost of Export of Already Identified Unwanted ODS (1MT of mixed CFC11 and 12, from Indonesia to Australia for Destruction (including Destruction)

Item	Unit		Cost (US$)
Cylinder (rental for 5 months + insurance)	1	17,500/21*86	71,666
Transportation from			
1. Land	1	5,000/21*86	20,476
2. Sea (to Sydney)	1	15,000/21*86	61,428
Destruction (including laboratory analysis)	1,000 kg of CFC11/12 74,000 kg of MCF 11,000 kg of CFC11	10.5 USD/kg	903,000
Insurance	1	2.25 % of the value, i.e. destruction cost	20,318
Paper work			
1. Customs	1	15,000	15,000
2. Permit from Singapore to Australia	-	-	-
3. Monitoring	-	-	-
TOTAL			1,091,880

In addition to the cost comparison, the following advantages and disadvantages of the three options were taken into consideration.

Table 2. Qualitative Comparison of ODS Disposal Options

Option	Advantages	Disadvantages	Note
1a. Construction of new ODS destruction facility	➢ Operation is self-dependent (not like cement kiln which depends upon cement production).	➢ Sustainability of facility operation is dependent upon constant supply of ODS to be destroyed.	➢ POPs and other hazardous wastes can be destroyed in the same facility. ➢ Stable electricity supply needed.
1b. Construction of new reclamation facility	➢ Operation is self-dependent (not like cement kiln which depends upon cement production).	➢ Sustainability of facility operation is dependent upon constant supply of ODS to be reclaimed.	➢ Stable electricity supply needed. ➢ When a certain amount of refrigerant is distilled, the amount of the reclaimed refrigerant will be approximately 70 % of the original amount; the distillation of low-purity refrigerant below threshold level consumes more energy and time; therefore, the existence of a reclamation facility does not necessarily negate the need for destruction of the residue and low-purity recovered refrigerants.
2. Modification of cement kiln for ODS destruction	➢ Relatively small additional cost ➢ Large destruction capacity ➢ Sustainability of facility operation does not depend upon constant supply of ODS for disposal.	➢ Dependent upon cement production (operation may stop when cement demands are low). ➢ The input of ODS into the facility needs to be controlled to avoid Cl deteriorating the quality of cement.	➢ Disposal of POPs and other wastes (solid) involves a technology different from ODS destruction (gas); hence, no significant financial saving through synergies with disposal of other solid wastes.
3. Exportation to other countries	➢ No need for new construction or modification of facilities.	➢ It may take much time, workload, and financial burden to take procedures required by the Basel Convention and other international and domestic regulations.	

In consideration of the above, the modification of a cement kiln for ODS destruction has been chosen.

ODS Destruction Facility

Figure 1 shows the existing cement kiln, one of the two kilns in operation at the company, which is the candidate for ODS destruction with attachment of gas injection equipment.

It should be noted that, although PT Holcim Indonesia Tbk is already destroying industrial wastes and hazardous wastes in this kiln, these wastes are injected into the kiln as liquids, solids and sledges. Therefore, if ODS (gas) is to be injected, the installation of gas injection equipment is still necessary.

The parts that are expected to be procured for the modification are listed below with reference costs in Japan. These parts will be procured locally and assembled by technical engineers of the recipient company to minimize the cost and as part of technology transfer.

Table 3 Initial Cost (Necessary Parts) of Modification of Cement Kiln for ODS Destruction

Item	Specification	Quantity	Unit	Cost (JPY)	(US$)
Emergency shut valve	Magnetic solenoid valve	1	Unit	60,000	520
Pressure control valve	15A	1	Unit	80,000	700
Flow meter	Range between 0 and 50 – 100 kg/h, as appropriate	1	Unit	400,000	3,500
Piping /valve	SGP, STPG, 15A ball valve	1	Unit	900,000	7,800
Electric parts	Current-pneumatic converter	1	Unit	700,000	6,100
Miscellaneous	Thermometer, barometer, etc.	1	Unit	500,000	4,300
Total				2,640,000	23,000

Note: US dollars are converted from Japanese Yen estimates and rounded; therefore, the total does not agree with the sum of the individual items.

The modification, or the attachment of an ODS feeding equipment, will be done on the existing kiln shown in Figure 1. The technical specification of the facility (Table 4) has indicated that the facility will have sufficient capacity to be capable of destroying 30 to 50 kg/h CFC or more.

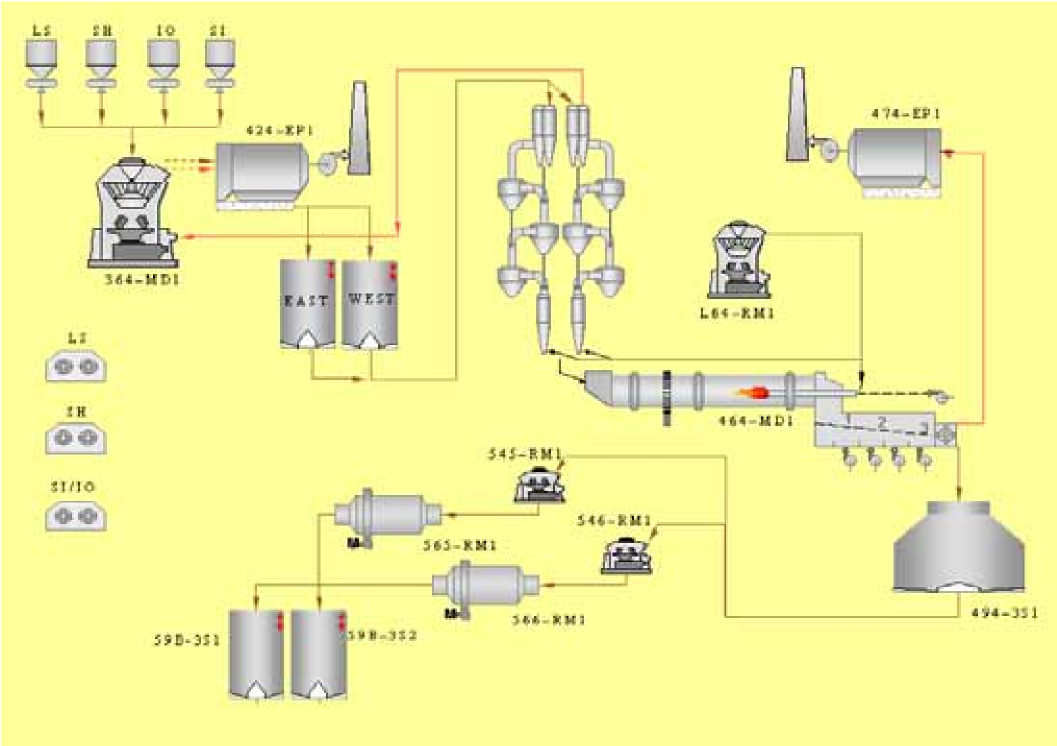


Figure 1. Diagram of Existing Cement Kiln
PT Holcim Indonesia Tbk, Narogong Plant Kiln NR 4

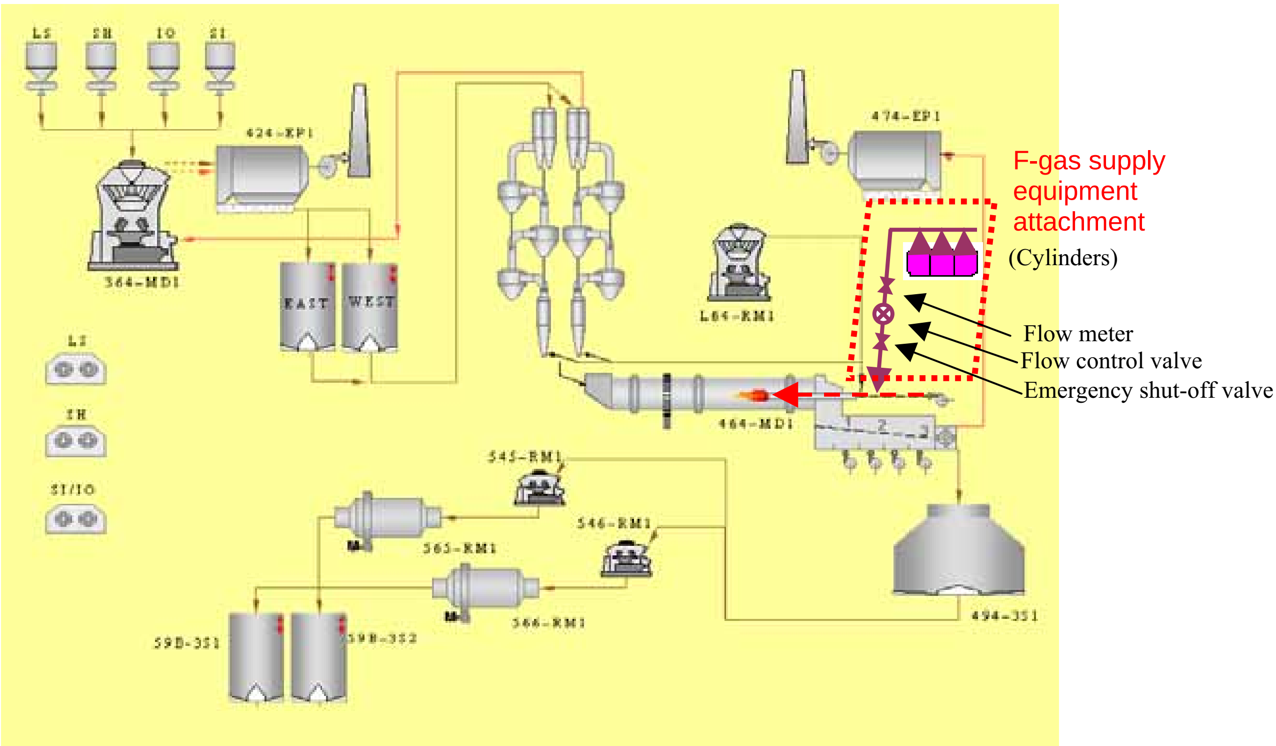


Figure 2. Schematic Explanation of Modification

Table 4. Information Collected from PT Holcim Indonesia Tbk for Evaluation of Technical Feasibility for Use as ODS Destruction Facility

<table>
<tr><th>No.</th><th>Item</th><th colspan="4">Data (for Kiln No.4)</th></tr>
<tr><td>1</td><td>Diameter of the kiln (m)</td><td colspan="4">5.7 m</td></tr>
<tr><td>2</td><td>Effective diameter of the kiln (m)
* The real diameter inside of the fire-resistant coating inside the kiln</td><td colspan="4">5.6 m</td></tr>
<tr><td>3</td><td>Length of the kiln (m)</td><td colspan="4">80 m</td></tr>
<tr><td>4</td><td>Clinker production (t/d) (of the kiln that is expected to be used for ODS destruction)</td><td colspan="4">8000</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Type and consumption of fuel</td><td>Fuel type</td><td colspan="3">Daily consumption
(specify the unit: t/d, kl/d, or m^3/d)</td></tr>
<tr><td>Coal</td><td colspan="3">53 ton / hour</td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td>6</td><td>Temperature of the burning point in the kiln（℃）</td><td colspan="4">1,500℃ (Material temperature)</td></tr>
<tr><td>7</td><td>Pressure of the burning point in the kiln（mmaq）</td><td colspan="4">- 6 mm H_2O (Kiln hood pressure)</td></tr>
<tr><td>8</td><td>Temperature of exhaust gas from the kiln（℃）</td><td colspan="4">1100℃</td></tr>
<tr><td>9</td><td>Pressure of exhaust gas from the kiln（mmaq）</td><td colspan="4">- 40 mm H_2O (back end)</td></tr>
<tr><td>10</td><td>Oxygen concentration in exhaust gas from the kiln (%)</td><td colspan="4">3 %</td></tr>
<tr><td>11</td><td>Type of the kiln burner</td><td colspan="4">Multi-tube</td></tr>
<tr><td>12</td><td>Existence of a primary air fan</td><td colspan="4">Yes</td></tr>
<tr><td rowspan="4">13</td><td rowspan="4">If yes to 12, its performance（mmaq, m^3/min）</td><td></td><td>Flow rate air (m^3/min)</td><td>Stat. pressure (mmaq)</td><td>Temperature (℃)</td></tr>
<tr><td>Axial air</td><td>93.45</td><td>1040.11</td><td>42</td></tr>
<tr><td>Swirl air</td><td>168.88</td><td>887.16</td><td>42</td></tr>
<tr><td>Transport air</td><td>58.67</td><td>1407.21</td><td>70</td></tr>
<tr><td>14</td><td>Quantity of vapor produced in the cement plant (m^3/d)</td><td colspan="4">Moisture content at main stack : 14 % v/v</td></tr>
<tr><td>15</td><td>Average Cl concentration in the cement</td><td colspan="4">0.009 %</td></tr>
<tr><td>16</td><td>Maximum Cl concentration in the cement by law</td><td colspan="4">-</td></tr>
<tr><td rowspan="3">17</td><td rowspan="3">Climate information (rough figures) at the cement plant location</td><td colspan="3">Annual average temperature</td><td>30 ℃</td></tr>
<tr><td colspan="3">Max temperature in the year</td><td>38 ℃</td></tr>
<tr><td colspan="3">Min temperature in the year</td><td>25 ℃</td></tr>
<tr><td>18</td><td>Horizontal distance from the ODS feeding facility (planned) to the kiln burner (m)</td><td colspan="4">50 m</td></tr>
<tr><td>19</td><td>Vertical distance from the ODS feeding facility (planned) to the kiln burner (m)</td><td colspan="4">30 m</td></tr>
</table>

Table 5. Project Components and Indicative Budget Lines

Project component	Items	Total
Study tour to Japan and draw-up of technical and financial plan	Logistics (DSA and travel) of 5 persons (Ozone Officer and hazardous waste destruction officer from the Ministry of Envrionment of Indonesia, two technical persons and one project manager from Pt Holcim Indonesia) from Jakarta to Japan to visit existing cement kiln ODS destruction facilities to work out detailed modification plan and get technical consultation on site. Honorarium for 2 resource persons for 5 days excluding travel to resource persons in the receiving company in Japan. The outcome is the detailed modification plan to be drafted during the visit (exluding quotation of local prices of necessary parts, which will be done in Indonesia after the study tour)	US$ 10,000 (To be funded by Japan's ODA budget)
Facility modification	Procurement of necessary parts (US$ 23,000) Engineering work	US$ 50,000 (To be funded by Pt Holcim Indonesia) [Cost will increase because the central control system is preferred]
	Technical consultation during the on-site designing stage Logistics (DSA and travel) of 2 resource persons from Japan to the site in Indonesia Consultation fee. Report writing.	US$ 5,000 (To be funded by Japan's ODA budget)
Initial test operation and Technical verification (on-site)	Environmental sampling and laboratory analysis (HF, HCl, CO, dioxin, etc. in the emitted gas and destruction efficiency, etc.) 3 runs x 6 hours for initial test operation During these hours, 540 kg – 900 kg (30 kg/h - 50kg/h) of ODS is calculated to be destoryed without destruction charges, which amount to in-kind cooperation of US$ 2,322 – US$ 5,400 (540 kg * US$ 4.3/kg - 900 kg * US$ 6/kg)*	US$ 30,000

* The range of destruction costs is based upon prices charged by destruction operators in Japan.

Continuous test operation	Continuous test operation Some of the already identified unwanted ODS will be destroyed without destruction charges [Transporation cost -- ???]	Refer to Table 6
Operation training ➢ Operation manual ➢ Operation standards	Preparation of the operation manual (English, local language) Preparation of operation standards Training workshop Issuance of certificate	US$ 10,000
Reaching out to servicing workshops and identification of additional unwanted ODS		US$ 15,000
Setting up logistics for collection, transportation and tracking recovered ODS (integration with R & R logistics mechanism)	Consultation and necessary equipment, if any.	US$ 15,000
Legislation	Legislation to ban atmospheric release of ODS Consultation, as necessary	In-kind consultation from Japan in cooperation with the Policies Enforcement Officer of UNEP CAP
Demonstration workshop for other countries in the region	Logistics (DSA and travel) of 1 person per country (Ozone Officer) to disseminate the gained expertise to addres specific situations in other countreis. Holding a workshop back-to-back with a regional network meeting, as appropriate. IA representatives will be invited (with no funding for participation.)	US$ 30,000
On-site study visit for technical trainees from other countries	Logistics (DSA and travel) of 2 persons per country (Ozone Officer and technical person) to visit the site in Indonesia. Logistics of one technical adviser from Japan to Indonesia. IA representatives will be invited (with no funding for participation.) The countries eligible for participation are those with cement kiln plants. The participating countries will be requested to work out and submit the action plan for cement kiln modification.	US$ 60,000
Consultation to other contries	One resource person from the recipient company. Visits (DSA and travel) to	US$ 10,000

	selected countries in the region (e.g. China, India, Thailand). The selection criteria are to be decided upon.	
Project Monitoring		In-kind (as part of IS)
Sub-total	MLF-funded components	170,000
	Japan ODA	15,000
	Pt Holcim Indonesia	50,000
	Indoenesian Government	In-kind
Support cost	13 % of the MLF-funded components	22,100
Total		257,100

Table 6. Hypothetical Destruction Prices of Already Identified ODS

	US$ 4.3/kg (Japan – low price)	US$ 6/kg (Japan – high price)	10.5 US$/kg (Australia – high price)	Domestic transportation
1 MT of mixed refrigerant (CFC11 and CFC12) 33 hours @ destruction capacity of 30 kg/h = 5 days @ 8 hours operation/day	US$ 4,300	US$ 6,000	US$ 10,500	[Quotation to be obtained via the NOU from the location of the cylinder in Jakarta to PT Holcim Indonesia]
74 MT of virgin MCF 2,466 hours @ destruction capacity of 30 kg/h = 309 days @ 8 hours operation/day	US$ 318,200	US$ 444,000	US$ 777,000	[Quotation to be obtained via the NOU from the location of the cylinders in Jakarta to PT Holcim Indonesia]
11 MT of contaminated CFC11 366 hours @ destruction capacity of 30 kg/h = 46 days @ 8 hours operation/day	US$ 47,300	US$ 66,000	US$ 115,500	[Quotation to be obtained via the NOU from Surabaya to PT Holcim Indonesia]
Total	369,800	516,000	1,942,500	

Table 7. Indicative Project Timetable

		Year 1				Year 2			
	Place	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Study tour to Japan and draw-up of technical and financial plan	Japan	X							
Facility modification engineering work	Indonesia		X						
Initial test operation and technical verification	Indonesia		X						
Constinuous test operation Operation training	Indonesia			X					
Reaching out to servicing workshops and identification of additional unwanted ODS	Indonesia	X	X	X	X	X	X		
Setting up logistics for collection, transportation and tracking recovered ODS (integration with R & R logistics mechanism)	Indonesia	X	X	X	X	X	X		
Legislation	Indonesia	X	X	X	X	X	X		
Demonstration workshop for other countries in the region	[To be decided]						X		
On-site study visit for technical trainees from other countries	Indonesia						X		
Consultation to other contries	[To be decided]							X--------	----▶
Project monitoring	Indonesia	X	X	X	X	X	X	X	X