Chapter 12

The Regulation and Use of Ocean Incineration by Other Nations

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This chapter provides overviews of the past, present, and future use of ocean incineration by nations other than the United States. The first section provides a brief history of international use and regulation of ocean incineration. The second section discusses the various international and regional conventions and other deliberative bodies that have addressed the use of ocean incineration and describes several important recent actions. The third section presents a summary of data on the past and present use of ocean incineration by other nations. The fourth and final section briefly discusses the policies and practices of 11 individual nations, based on information from several sources, including a survey of foreign embassies conducted by OTA.

HISTORICAL BACKGROUND

Commercial use of ocean incineration by other nations dates back to 1969, when the first incineration vessel, a modified chemical tanker named Mathias I, was launched under the flag of the Federal Republic of Germany. Development of ocean incineration for the purpose of incinerating organochlorine wastes was initially motivated by five factors (12):

1. the many problems encountered on land in operating and maintaining scrubbers in the presence of the corrosive gases produced by incinerating organochlorine wastes;
2. the ability of seawater to neutralize the gases, thereby negating the need for scrubbers;
3. additional problems arising from treating and disposing scrubbing effluents and sludges;
4. the advantage of a centralized, large-scale system for collecting and incinerating organohalogen wastes, which could potentially be better controlled and monitored, as well as more economical, than other alternatives; and
5. unacceptable impacts from ocean *dumping* of certain organochlorine wastes, such as tars arising from the production of ethylene dichloride.

Consideration of these factors led to an increase in the European market for ocean incineration and the launching of two additional ships, the Mathias II and the *Vulcanus I,* in the early 1970s. All three ships operated exclusively in the North Sea.

Also at this time, international concern was increasing over environmental impacts of ocean disposal of wastes in general. These concerns led to the development of the worldwide London Dumping Convention (LDC) and the regional Oslo Convention, both established in 1972. Although these conventions did not initially address ocean incineration, proposals to begin incineration in the Mediterranean Sea prompted two developments. First, the Barcelona Convention, established in 1976, decided to prohibit incineration in the Mediterranean Sea (12). Second, the LDC and the Oslo Commission began developing special provisions and codes of practice to govern the use of incineration at sea. Groups of experts convened by both conventions developed sets of technical guidelines for incorporation into the conventions. The guidelines covered the following topics:

- control and approval of incinerator system design and specifications,
- control over the nature of wastes to be incinerated at sea,
- criteria for the selection of incineration sites,
- control over vessel design and operation,
- requirements for monitoring and the use of recording devices, and
- reporting requirements and procedures for incineration activities.

The next section examines the approaches and recent activities of these and other international bodies with regard to ocean incineration.

INTERNATIONAL BODIES

London Dumping Convention

The LDC considers incineration at sea as legally constituting ocean dumping and has developed extensive procedural and operational requirements, which are contained in Annexes to the Convention (8). Under the LDC, incineration at sea is viewed as an *interim* method of waste management, as reflected in LDC Regulation 2.2:

> Contracting parties shall first consider the practical availability of alternative land-based methods of treatment, disposal or elimination, or of treatment to render the wastes or other matter less harmful, before issuing a permit for incineration at sea in accordance with these Regulations. Incineration at sea shall in no way be interpreted as discouraging progress towards environmentally better solutions including the development of new techniques.

At a meeting of the LDC's Scientific Group on Dumping (SGD) in 1985, a working group on ocean incineration was convened to identify and discuss several unresolved questions regarding the performance of and monitoring capabilities for incineration at sea (7). These issues include the following:

- the relationship between destruction and combustion efficiencies over a broad range of operating conditions;
- the ability to sample incinerator stack gases in a mannner that is representative of the entire emission;
- the ability to accurately sample particulate matter in stack emissions; and
- the nature and significance of newly synthesized compounds (products of incomplete combustion, or PICs) in stack emissions.

A group of experts jointly drawn from the LDC and the Oslo Commission is to undertake further discussion of these issues at an intersessional meeting in 1986 or 1987. This discussion was to be based in part on new information provided by the U.S. PCB research burn (10); given its cancellation, the timing of formal international consideration of these questions is not clear.

The International Maritime Organization (IMO) is designated under the LDC to serve as Secretariat. The IMO, therefore, is responsible for collecting data from Contracting Parties on ocean incineration activities, including the number and status of permits, as well as the quantities and types of wastes authorized for incineration at sea. The most recent of these data (for activities in 1982) are discussed later in this chapter.

0slo Commission

Rule 2.3 of the Oslo Commission Rules, adopted in 1981, stipulates that "the Commission will meet before the 1st of January 1990 to establish a final date for the termination of incineration at sea' in the North Sea, which comprises the Oslo Convention area (15). The 1990 date was formulated at a time when few controls existed over the use of ocean incineration. Since that time, international (LDC and Oslo Commission) and national regulations have been developed to cover most aspects of this technology, leading some Oslo Commission nations to see the need to terminate use of ocean incineration in the near future as less pressing; other members, however, remain committed to its termination by 1990 (see profiles of individual nations later in this chapter).

At the Commission's 11th meeting, held June 11-13, 1985, The Netherlands presented the results of a survey of member nations, which was undertaken to gauge the availability of alternative means of disposing wastes currently incinerated at sea (1 7). The survey provided an initial step toward assessing the practicality of fulfilling the language of Rule 2.3. Responses to The Netherlands survey were received from all but two members (France and Spain). Its conclusions are as follows:

- There is a potential shortfall in the capacity of land-based incinerators and other land-based treatment methods to dispose of the wastes currently being incinerated at sea.
- Spare capacity on land is considered far from sufficient to match the wastes currently being

incinerated at sea, and very little increase in such capacity is expected in the near future.
- It is expected that by 1990 wastes will remain for incineration at sea.

In 1987, at its 13th meeting, the Oslo Commission expects to draft a policy statement on the termination of incineration at sea, contingent on the availability of adequate capacity in acceptable land-based alternatives (16).

The Commission's Standing Advisory Committee for Scientific Advice (SACSA) examined data regarding the location of the current North Sea incineration site, and concluded that ''there is no better compromise between meteorological and logistical requirements (shorter approach to the incineration site resulting in higher cargo safety). This finding was endorsed by the commission at its 11th meeting in 1985 (16).

Commission of the European Communities

This commission exists under the auspices of the European Economic Community (EEC). In July 1985, the commission submitted to its Council of Ministers a proposal for a council directive on the dumping of waste at sea (2). Ocean incineration is explicitly included in the definition of ''dumping at sea. The intent of the directive would be to reduce and terminate all dumping at sea by EEC Member States as soon as possible. Under the directive, ocean incineration 'would be regarded as a ''temporary' disposal option to be used ''only if there are no practical alternative methods of land-based treatment, as determined on a case-by-case basis.

EEC Member States would be required to submit to the commission by January 1, 1990, information required for setting a final date for terminating incineration at sea. The council would be required to act on the information within 6 months of that date.

If adopted, the directive would prohibit the granting of any new special permits for incineration after January 1, 1988. Permits already in effect could be renewed until January 1, 1990, for up to 5 years, but Member States would be required to decrease the quantities of waste incinerated at sea each year by 10 percent.

European Parliament

The European Parliament also exists under the auspices of the EEC. A Parliament report (4) issued by the Committee on the Environment, Public Health, and Consumer Protection in December 1983 identified ocean incineration as a contributor to pollution of the North Sea through the release of ash, hydrogen chloride gas, and small quantities of unburned waste to the atmosphere. The report suggested that ocean incineration be relocated to a less sensitive location in the Atlantic Ocean.

USE OF OCEAN INCINERATION BY OTHER NATIONS

This section presents available data on European incineration vessels, the number of voyages they have made, and the quantities and types of European wastes that have been incinerated at sea.

Incineration Vessels

A total of six vessels have been built and employed to incinerate European wastes at sea. Table 27 provides a summary of the most important features of these six vessels, including dates of operation. All but one vessel (the *Vulcan us I)* have operated exclusively in the North Sea. All but the *Matthias III,* which was only used for a brief time, are much smaller than typical tank ships.

Quantities of Waste Incinerated

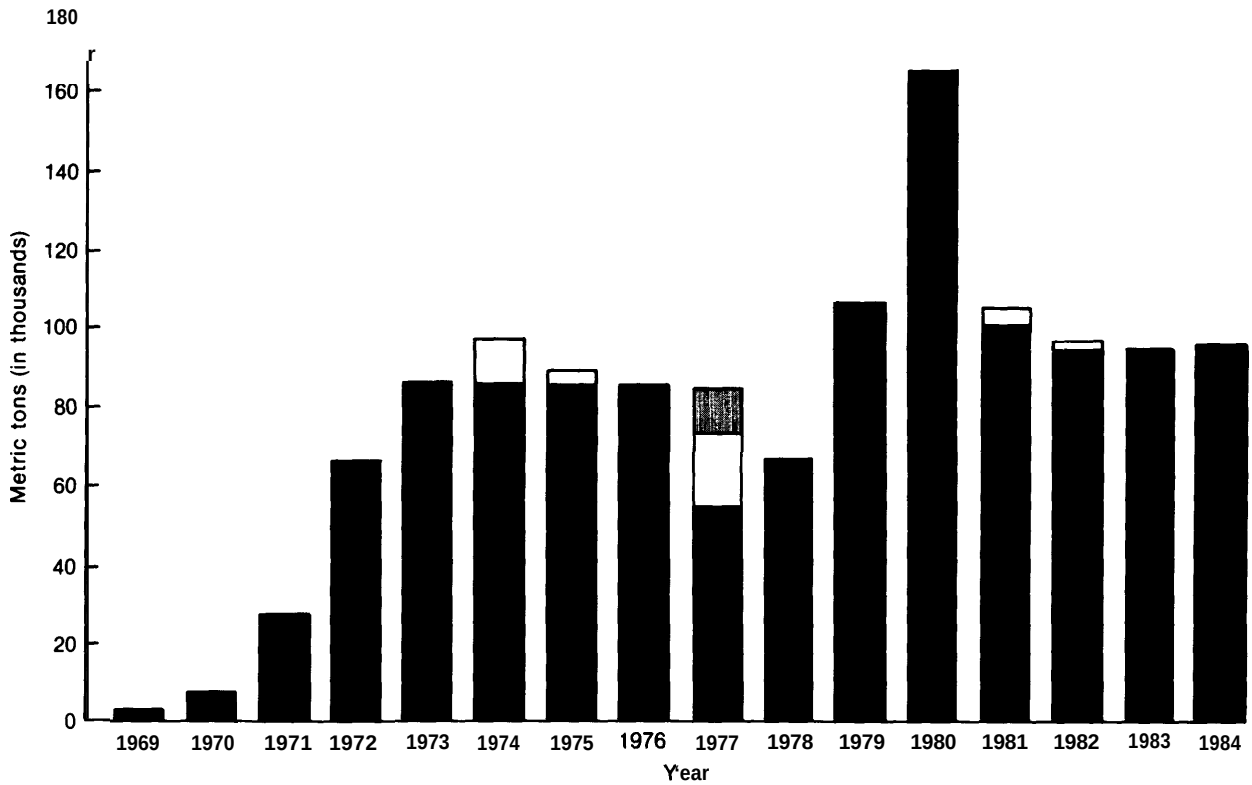
Quantities of wastes managed by ocean incineration steadily increased from 1969, when incineration began in the North Sea, until about 1979, when quantities stabilized at the present level of about 100,000 metric tons annually (fig. 13). The great majority of all waste has been incinerated in

Table 27.-incineration Vessels Employed in Europe, 1969 to Present

	Matthias I	Matthias II	Matthias III	Vulcanus I	Vulcanus II	Vesta
Dates of service	1968-76	1970-83	1975-77	1972-present	1982-present	1979-present
Site of operation	Exclusively in the North Sea			North Sea United States Pacific Australia	North Sea	North Sea
Number of incinerators	1	1	1	2	3	1
Total cargo (ret)	550	1,200	15,000	3,500	3,200	1,400
Total gross tons	438	999	12,636	3,100	3,100	999

SOURCE: Office of Technology Assessment based on M.K. Nauke, "Development of International Controls for Incineration At Sea," Wastes *in the Ocean, vol.* 5, D.R. Kester, et al. (eds.) (New York: John Wiley & Sons, 1985), pp. 33-52; and Ocean Combustion Service, *15 Years of Waste Incineration At Sea: History, State of the Art, Control, Environmental Impact* (Rotterdam, The Netherlands: February 1985).

Figure 13.–Quantities of Waste Annually incinerated At Sea, 1969-84



'This waste was generated In Australia and incinerated while the ship was en route to Singapore.

SOURCE: Ocean Combustion Service, "15 Years of Waste Incineration At Sea: History, State of the Art, Control, Environmental Impact" (Rotterdam, The Netherlands: Ocean Combustion Service, February 1985); M.K. Nauke, "Development of International Controls for Incineration At Sea," in Wastes *in the Ocean,* vol. 5, D.R. Kester, et al. (ads.) (New York: John Wiley& Sons, 1985), pp. 33-52; and International Maritime Organization, "Consideration of Report on Dumping, Draft Report of Permits Issued in 19S2," document LDC/SG.8/INF.3, prepared for 8th Meeting of Scientific Group on Dumping (London: Dec. 20, 19S4).

the North Sea, but smaller amounts were burned by the *Vulcanus I* in the Gulf of Mexico (Shell wastes and PCBs), in the Pacific Ocean (Agent Orange), and in one burn near Australia. Figure 13 presents the estimated quantities burned between 1969 and 1984.

Many different European countries, as well as Australia and Japan, have used ocean incineration. Each member nation must report annually to the LDC, providing data on the quantities of waste sent for incineration at sea. Table 28 presents the most recent available compilation of such data, covering the year 1982.

These data indicate that 14 LDC nations in addition to the United States incinerated wastes at sea in 1982. Actual quantities sent for incineration varied significantly, ranging from 200 metric tons (Spain) to 53,000 metric tons (Germany). Most wastes are sent for loading at Antwerp, Belgium, although other ports have also been used (e. g., Rotterdam in The Netherlands and Le Havre in France); in addition, permits have been **granted** for exporting wastes from nations such as Finland. Four vessels were used to incinerate wastes in the North Sea in 1982. Of the 94,000 mt of waste actually incinerated in the North Sea in 1982, the following proportions were incinerated by each vessel: *Matthias II, 29* percent; *Vulcanus I, 25* percent; *Vesta,* **42** percent, and the newly commissioned *Vulcanus II, 4* percent.

Table 28.—Type of Waste Incinerated and Country of Origin, 1982

Country	Type of waste	Quantity[a]
Australia	Vinyl chloride and PCB wastes	4,820
Austria	Organohalogen wastes	490
Belgium	Organohalogen wastes	10,643
Finland	Organohalogen wastes	2,750
France	Organohalogen wastes	6,582
Germany	Organohalogen wastes	52,751
Italy	Organohalogen wastes	3,431
Japan	Oily sludges	1,488
The Netherlands	Organohalogen wastes	9,396
Norway	Organohalogen wastes	8,000
Spain	Organohalogen wastes	210
Sweden	Organohalogen wastes	6,420
Switzerland	Organohalogen wastes	3,711
United Kingdom	Organohalogen and organophosphorous wastes	6,194
Total		116,886a

[a]These are quantities for which permits were granted; in some cases, the amount of waste actually incinerated in 1982 was smaller,

SOURCE: International Maritime Organization, "Consideration of Report on Dumping, Draft Report of Permits Issued in 1982," Document LDC/SG.8/INF.3, prepared for 8th Meeting of Scientific Group on Dumping (London: Dec. 20, 1984).

Number of Voyages

EPA formulated estimates of the number of voyages, as well as quantities of waste incinerated, by the two *Vulcanus* ships and the *Vesta* from their launch dates through 1983 (app. C in ref. 19). These data indicate that the ships made 322 voyages and incinerated more than 650,000 mt of waste. Comparable data were not available for the three *Matthias* vessels.

The total number of incineration voyages is likely to be substantially higher, because almost twice as much waste was incinerated at sea by all six vessels over the period 1969-84 (see *figure* 13).

Characteristics of Waste Incinerated

The vast majority of waste incinerated in the North Sea is organochlorine waste. Of the 100,000 mt incinerated in the North Sea in 1981, about 80 percent consisted of organochlorines (6). Many of these wastes have appreciable chlorine content, estimated to average between 60 and 70 percent (1 1). The waste burned during testing of the *Vulcanus II* in 1983 (see ch. 11) was derived from vinyl chloride production in Norway and had a chlorine content of 84 percent. Chemical Waste Management, Inc., estimated that 65 percent of the waste incinerated by the *Vulcanus* ships in the North Sea had chlorine contents greater than 35 percent (l).

Few data are available characterizing European wastes with respect to metal content; the available analyses, however, indicate that metals are typically in the parts per million range (12). The Oslo Commission (17) has estimated that approximately 90 percent of the emissions of heavy metals from incineration at sea originate from wastes with chlorine content less than 45 percent. Wastes with high metal content (and low chlorine *content) are in*creasingly being diverted to land-based incineration (3).

With respect to emissions of heavy metals, the Oslo Commission (17) estimates that the total con-

tribution of ocean incineration to the Dutch part of the North Sea (encompassing the incineration site) represents less than 0.3 percent of the total input of metals. The German Hydrographic Institute has compared such emissions to the average input of metals entering the North Sea via the Rhine River (cited in ref. 3). The contribution from the Rhine River is estimated to be 1,000 to 10,000 times higher than that from ocean incineration emissions, for each of six toxic metals.

No PCBs have been incinerated at sea in Europe; LDC regulations list PCBs as a waste about which there is doubt regarding its thermal destructability. However, The Netherlands has announced plans to conduct a research burn using PCBs in late 1986 or 1987. The loss of land-based incineration capacity (located in England and France) previously used for PCBs by The Netherlands necessitated reconsideration of the at-sea incineration option (10,18).

PROFILES OF INDIVIDUAL NATIONS

This section describes the policies and practices of 11 individual nations regarding the use of ocean incineration for managing hazardous wastes. All 11 are signatories to the LDC, and all but two (Canada and Denmark) have used ocean incineration.

Sources for the information presented in this section, unless otherwise noted, include *The First Decade,* a report of the Oslo and Paris Conventions published in 1984 (ref. 14), and letters from foreign embassies received in response to an OTA request for information on practices and policies regarding ocean incineration.

Major Conclusions

The data presented below, as well as that contained in the survey of Oslo Commission members described above, provide the basis for two major conclusions regarding the use of ocean incineration by other nations:

1. The major constraint blocking termination of ocean incineration is the lack of sufficient land-based capacity for treating organochlorine wastes.
2. A broad range of opinion and position regarding future use of ocean incineration exists among European nations. For example, the United Kingdom holds a quite favorable view, whereas Denmark argues for termination as soon as possible. Other nations, such as The Netherlands and the Federal Republic of Germany, are attempting to reduce their reliance on ocean incineration but regard it as a necessary option for the foreseeable future due to lack of land-based capacity.

Belgium

Belgium estimates that it generates about 100,000 mt of hazardous waste each year, an unreported fraction of which is incinerated on land. About 10,000 mt of hazardous waste generated in Belgium was incinerated at sea in 1982.

Belgium regards incineration at sea to be “an acceptable solution whenever difficult technical and/or economic problems arise regarding incineration on land. For Belgium, ocean incineration is ‘‘a fairly attractive method as the burners and furnaces can be relatively simplified and it is not necessary to provide for the neutralization of the combustion gases due to the buffering capacity of seawater. The method’s main drawback is that at sea it is more difficult to efficiently control the effectiveness of the incineration process and the way in which these operations are carried out.

Antwerp, Belgium, has served as the major port for incineration vessels operating in the North Sea. Currently, the loading and transit of incineration vessels occur two or three times each month. Because this activity involves the burning of wastes from numerous European countries, importation and storage of hazardous wastes at Antwerp is routine. For example, in 1982, Antwerp received about 70,000 mt of hazardous waste destined for incineration in the North Sea. This waste originated in seven European nations in addition to Belgium (9).

Belgium's land-based treatment capacity for highly chlorinated wastes is limited to a few private onsite destruction facilities. Thus, chlorinated wastes for which no other alternative exists will continue to be sent for incineration at sea. Belgium has experienced little change in the amount of wastes incinerated at sea over the past decade and anticipates little change for the next 5 years. A new publicly owned incineration plant, scheduled for completion in 1988, should cause some decrease (17).

Canada

Canada views the use of ocean incineration as ''one of many options which, if properly controlled, could help in the management of hazardous wastes. Canada anticipates having only small quantities of waste suitable for ocean incineration, has not incinerated any wastes at sea, and has no immediate plans to do so. However, a general application from Chemical Waste Management, Inc., has prompted a further evaluation of the technology, based in large part on a review of relevant LDC data.

Denmark

Denmark is engaged in a substantial hazardous waste management program administered by public authorities, with land-based incineration representing the primary method of treatment or disposal. Of the 40,000 mt of chemical waste received at the central treatment facility (known as Kommunekemi) in 1980, 80 to 90 percent is treated by incineration. Total incineration capacity of the facility is about 90,000 mt annually.

No permits for ocean incineration have been issued by the Danish Minister for the Environment. Although Denmark regards thermal destruction to be a "useful and acceptable disposal method, " especially for organohalogen wastes, it believes that ''incineration at sea presents great problems in connection with the control of destruction and combustion efficiency. " In addition, Denmark expresses concern about the large areas of the North Sea that are unavailable for other uses because of ocean incineration, and concern about the potential for the technology to aggravate regional problems with acid rain.

The Danish Government, which has been the most vocal and consistent opponent of ocean incineration in the European community, continues to press for an end to the practice, particularly in the North Sea.

Finland

Finland estimates that it produced about 500,000 mt of hazardous waste in 1975. The majority of Finland's oily wastes and about half of its solvent wastes are burned, mostly in land-based incinerators. Finland currently lacks sufficient incineration capacity for PCBS and certain other chlorinated wastes, and hence exports these wastes to the United Kingdom for destruction in a land-based incinerator (1 7).

Finland has recently constructed (at Riihimki) a centralized hazardous waste treatment facility, which has a capacity of 70,000 mt annually. Land-based incineration is the major technology at this facility. It is unclear if and to what extent this will affect the need for Finland to continue to export PCBs and other wastes.

Incineration at sea has twice been used to destroy wastes (a total of 5,250 mt) from one of Finland's petrochemical plants, which is closed at least for the time being. No definitive policy statements by Finland regarding ocean incineration are available.

France

France estimates that it annually generates 18 million mt of hazardous industrial waste, 2 million mt of which are especially toxic or hazardous. In 1982, approximately 200,000 mt of this waste was incinerated at 10 "special collective plants' located throughout France. A comparable quantity was incinerated in onsite facilities operated by various industrial firms. Of the 10 commercial facilities, which have a total annual capacity of 205,000 mt, 4 are equipped to incinerate chlorinated *wastes, and* **3** can burn only liquid wastes. These facilities compete with 5 cement kilns, which have recently increased their share of the market for wastes with high heat content.

France points to insufficient capacity and the high cost of land-based incineration of organochlorine

wastes as factors motivating its use of ocean incineration. Waste to be incinerated in the North Sea is directed to the ports of Le Havre, France, and Antwerp, Belgium, the latter receiving primarily or exclusively wastes with high chlorine content. Waste generators do not have direct access to incineration vessels, which receive waste only from treatment plants. Annual quantities incinerated at sea since 1979 have ranged from 4,600 mt to 11,700 mt, averaging about 10,000 mt.

France anticipates that a gradual increase in land-based incineration capacity and decreases in its cost will reduce the quantities of waste incinerated at sea.

Federal Republic of Germany

The Federal Republic of Germany (FRG) estimates that its annual production of industrial special or toxic waste amounted to about 4.5 million mt in 1980. A total of 17 land-based incineration plants handle an unreported portion of these special wastes.

The FRG has expressed a variety of views on the use of ocean incineration. According to its submission to the Oslo Commission (14), the FRG regards ocean incineration ''to be ecologically the soundest of the available methods for the disposal of halogenated hydrocarbons' but not ''an ideal disposal method, " preferring to develop appropriate reuse and recycling efforts. These methods include land-based thermal destruction technologies that provide for recovery or reuse of chlorine residues released during the process, as well as more conventional heat recovery.

Permits for incineration at sea are evaluated with respect to need on a case-by-case basis, with the unavailability of alternative capacity on land being the major criterion. Wastes to be incinerated at sea are prohibited from containing chlorinated dibenzofurans, PCBs or PCTs, dioxins, or DDT. Quantities of waste incinerated at sea have ranged as high as 100,000 mt annually but have gradually decreased since 1980. For example, a reported 41,000 mt of German waste was incinerated at sea in 1983. Nevertheless, the FRG remains the greatest user by far of ocean incineration.

In its response to the OTA survey, the FRG stated its intent to make "every effort to terminate incineration at sea as soon as possible. The FRG anticipates significant decreases in future quantities of waste incinerated at sea, especially for highly chlorinated wastes (those with chlorine content greater than 45 percent), because of completion of a new land-based incinerator in 1987 and greater application of perchlorination and other reuse technologies (1 7). However, the lack of sufficient land-based capacity precludes the FRG from specifying a date for ending ocean incineration.

The Netherlands

The Netherlands annually generates about 1 million mt of chemical waste, half of which is currently treated or disposed of offsite. Of the waste treated offsite, about 86,000 mt is incinerated on land or at sea. The AKZO treatment facility can incinerate wastes with a high chlorine content (as high as 45 percent; see ref. 17) and regularly receives such wastes from Sweden.

The Netherlands regards "incineration at sea, albeit an environmentally acceptable procedure, as a temporary expedient; land alternatives are to be preferred. Efforts are underway to develop further land-based incineration capacity and make greater use of recycling methods.

A new land-based incinerator is scheduled to begin operation in 1987. If future policy analysis determines that this land-based incinerator constitutes a practical land-based alternative preferable t. ocean incineration, The Netherlands expects a sharp decline in the quantities of waste incinerated at sea (1 7).

The Netherlands has played a central role in much of the testing of the *Vulcanus* ships that has occurred to date; as a result of these studies, it believes that all international requirements are generally being satisfied. As described previously, The Netherlands plans to conduct an ocean incineration research burn of PCB-containing wastes in late 1986 or early 1987, motivated by the loss of land-based incineration capacity in the United Kingdom and France (10, 18).

Norway

Norway estimates that it annually generates about 120,000 mt of hazardous waste, 75 percent of which is used oil or oily wastes. Norway uses a large-capacity cement kiln for destroying significant quantities of incinerable liquids and sludges.

Tar wastes from vinyl chloride production, amounting to some 8,000 mt annually, are currently incinerated at sea. To provide an alternative, Norway is considering the construction of a land-based incinerator equipped to reclaim hydrogen chloride.

Norway's official position is that ocean incineration should be terminated as soon as possible. Although its use of incineration at sea has gradually increased, Norway anticipates gradually reducing its use over the next 5 years, as sufficient land-based incineration capacity and recycling technologies are developed.

Sweden

Sweden estimates that a total of 482,000 mt of hazardous waste was generated in 1978. About half of this quantity was treated or disposed of at the site of generation. Most of Sweden's waste that is sent offsite is treated by the State-owned waste treatment network (SAKAB) or by 1 of about 20 other government-licensed waste treatment companies. SAKAB has recently completed a new hazardous waste treatment facility, which uses a large-capacity rotary kiln incinerator, but which cannot" handle highly chlorinated wastes.

Sweden has taken a generally restrictive position in international discussions on ocean incineration, stating that it ' 'will accept incineration at sea as a last resort during a transition period, if no land-based treatment alternatives exist. A Swedish law dating from 1971 prohibits dumping or ocean incineration from Swedish ports or Swedish vessels. However, Sweden has used incineration at sea on foreign vessels to a limited extent in recent years: 6,420 mt of organohalogen wastes of Swedish origin were incinerated at sea in 1982. No applications have been approved for such activity since 1983.

Sweden regards land-based incineration as the most practical and preferable alternative to ocean incineration. However, the lack of sufficient capacity, especially to process chlorinated wastes, is cited as a major obstacle to ending Sweden's 1imited reliance on ocean incineration.

Switzerland

Because of insufficient land-based incineration capacity within Switzerland, about 10,000 mt of organic wastes are exported for incineration. Those wastes with a high (greater than 15 percent) chlorine content are, without exception, sent for incineration at sea. This quantity averages about 5,000 mt annually and has been increasing over the last several years. Switzerland expects that the quantities of waste it incinerates at sea will continue to increase at least in the short term, because of stricter controls over land disposal and the length of time required to develop land-based capacity. For the long term, Switzerland regards land-based incineration to be environmentally preferable to ocean incineration because of the greater control the authorities are able to exert on land.

United Kingdom

A total of **3.78** million mt of 'hazardous and difficult wastes' are disposed or treated offsite in the United Kingdom each year. An estimated 2 percent (80,000 mt) is incinerated at 11 land-based facilities. The recent closure of one very large land-based incinerator has increased demand for incineration at sea (1 7).

In 1982, the United Kingdom used incineration at sea for only 852 mt of waste, "which would have presented special problems if incinerated in land-based units. Ocean incineration has been increasingly used since 1981: 2,700 mt in 1983 and 3,500 mt in 1984 were incinerated at sea. The United Kingdom regards ocean incineration of certain wastes to be the best practicable environmental option (5).

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