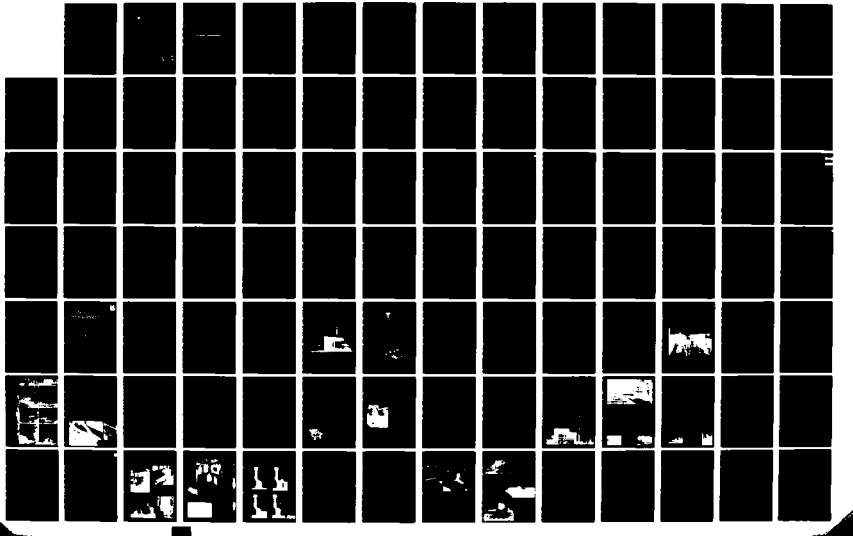
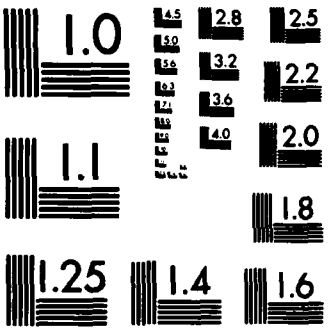
AD-A127 461 SURVEY OF FOREIGN SYSTEMS FOR INCINERATION AND ENERGY RECOVERY(U) SYSTECH CORP XENIA OH R FROUNFELKER ET AL. APR 83 NCEL-CR-83.025 N62583-82-MT-150 1/2

UNCLASSIFIED F/G 13/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CR 83.025

NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

Sponsored by
CHIEF OF NAVAL MATERIAL
NAVAL FACILITIES ENGINEERING COMMAND

SURVEY OF FOREIGN SYSTEMS FOR INCINERATION AND ENERGY RECOVERY

April 1983

An Investigation Conducted by
SYSTECH CORPORATION
245 North Valley Road
Xenia, Ohio

N62583-82-MT-150

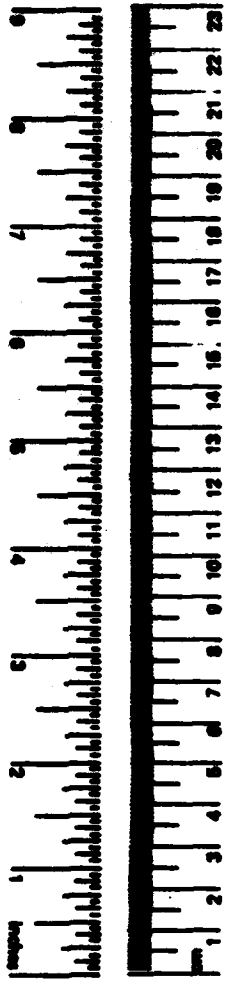
Approved for public release; distribution unlimited

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

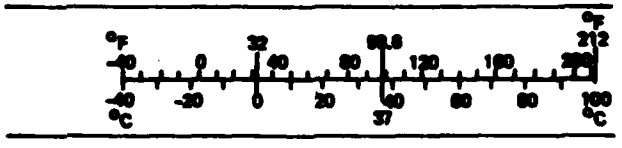
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1 REPORT NUMBER: CR 83.025	2 GOVT ACCESSION NO: AD-A129 464
	3 RECIPIENT'S CATALOG NUMBER
4 TITLE (and Subtitle): SURVEY OF FOREIGN SYSTEMS FOR INCINERATION AND ENERGY RECOVERY	5 TYPE OF REPORT & PERIOD COVERED: Not final; June 1982 - Nov 1982
	6 PERFORMING ORG. REPORT NUMBER
7 AUTHOR(s): Richard Frounfelker, Brian A. Hausfeld	8 CONTRACT OR GRANT NUMBER(s): N62583-82-MT-150
9 PERFORMING ORGANIZATION NAME AND ADDRESS: SYSTECH CORPORATION, 245 North Valley Road, Xenia, OH 45385	10 PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Y0817-006-01-002, S0371-01-421A/B
11 CONTROLLING OFFICE NAME AND ADDRESS: Naval Civil Engineering Laboratory, Port Hueneme, CA 93043	12 REPORT DATE: April 1983
	13 NUMBER OF PAGES: 143
14 MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office): Chief of Naval Material, Washington, DC; Naval Facilities Engineering Command, Alexandria, VA	15 SECURITY CLASS. (of this report): Unclassified
	15a DECLASSIFICATION DOWNGRADING SCHEDULE

16 DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17 DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18 SUPPLEMENTARY NOTES

19 KEY WORDS (Continue on reverse side if necessary and identify by block number)

Solid waste; resource recovery; incinerators

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

Solid waste heat recovery incinerator (HRI) facilities outside the United States, which were capable of 24-hour a day operation, had operated for about a year, and had combustors of between 0.75 and 3.0 ton/hr capacity were identified to permit selection of best facilities for field visits. Of the 40 vendors identified, 21 responses were received. Eleven of the

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

vendors had facilities that fit the above criteria. Facilites of six vendors were selected for field visits.

CONTENTS

SECTION 1

INTRODUCTION

The U.S. Navy has taken a very active role in implementing waste-to-energy systems at their shore based facilities. The level of success of the implemented facilities has been mixed. Because there are comprehensive plans to adopt waste-to-energy programs at many of the other shore based facilities, the Naval Civil Engineering Laboratory at Port Hueneme, California, is actively working on obtaining information on various technologies to ensure the success of future installations.

Currently the Navy is investigating two generic technologies: fuel preparation (RDF) and mass burning. For fuel preparation, the Navy is planning a comprehensive parametric evaluation of various unit processing operations. For the mass burning concept detailed evaluations of existing facilities are planned. From these evaluations "success factors" are to be identified and compiled and made available to the designers of future systems.

As a precursor to the on-site evaluation of the mass burning facilities the Navy has commissioned two surveys of existing technologies. The first survey is limited to those technologies that have been implemented within the U.S. while the second survey is directed to all other implemented facilities (foreign systems). This report presents the results of the Survey of Foreign Systems.

To be considered for this study, the technology must burn mixed municipal waste and meet the following three requirements: (1) the combustor has a capacity of between 0.75 and 3.00 tons per hour (TPH), (2) the facility

is capable of 24-hr/day operation, and (3) the facility has operated at least 1 year during the past 5 years or is operating at this time. Vendors of incineration systems in foreign countries were identified by SYSTECH and, where possible, data concerning their equipment were obtained and analyzed. This data included a description of the technology, types of waste processed, a listing of facilities applicable to this study, and the names and addresses of suppliers in the United States. Although planned, direct interaction with facility operators was not achieved.

SUMMARY

Survey Overview

Through a review of in-house data and published literature and through contact with embassies a total of 40 manufacturers of incinerators was identified. (A bibliography of sources utilized and list of individuals contacted is given at the end of this report.) To obtain information on their technologies and installations, an attempt was made to contact each manufacturer. Where possible, the United States representative of each technology was contacted; otherwise the phone calls and letters were directed to the manufacturer at its home address. A copy of a typical letter is enclosed in the Appendix.

Enclosed with the letter was a survey form requesting detailed information to be supplied by the owner or operator on the facilities built by the vendor for inclusion in this study. It was pointed out by the vendors that responses to such forms would be very slow in returning or not returned at all. A copy of the survey is enclosed in the Appendix. This form was also translated into French and German as they are the languages most widely utilized in western Europe. No responses were received from these surveys at the time of this report preparation. A second letter was sent to the vendors that had not responded to the first inquiry, and supplemental domestic and transatlantic phone calls were placed. The results of the survey are presented in Table 1. The 40 identified vendors are presented, and their

TABLE 1. LIST OF IDENTIFIED FOREIGN MANUFACTURERS OF WASTE INCINERATORS

Firm	Country	Address obtained Y	Address obtained N	Survey response Y	Survey response N	Program applicability Y	Program applicability N	Comments
Alberti-Fonsar	Italy		X					Listed in Resource Planning Assoc. report
Almaco S.A.	Italy		X					Listed in SRI report, no municipal experience
Bronswerk Utrecht	Netherlands	X		X			X	A licensee of Martin
Bruun & Sorensen	Denmark	X		X		X		
Carbonisation Enterprise et Ceramique (CEC)	France							Incineration Technology bought by Seghers Engineering
Cadoux	France	X		X		X		
Chammotte Rijkaart Ind. b.v.	Netherlands	X		X			X	Declined participation
Claudius Peters	F.R. of Germany		X					
Compagnie des Fours D'Incineration-- S.A. Muller	France		X					Listed in SRI report, no municipal experience
Cornel Schmidt	F.R. of Germany	X		X				Industrial and special waste
De Bartolomeis	Italy	X			X			Information has not been received
Destructor	Sweden	X			X			

(continued)

TABLE 1. (continued)

Firm	Country	Address obtained Y	Address obtained N	Survey response Y	Survey response N	Program applicability Y	Program applicability N	Comments
Esslingen	F.R. of Germany		X					
Elboma	Belgium	X		X		X		Most experience with industrial waste
Heenan Environmental	Great Britain	X		X			X	Formerly Redman Heenan Froud, licensee of International Waste Industries, USA
Hoval-Werk A.G.	Liechtenstein		X					Listed in SRI report, Kelly-Hoskinson design
Keller Peukert	F.R. of Germany		X					Has supplied grates to VKW
Kockum Landsverk	Sweden		X					No longer in the incineration business
Kohlenscheidungs-Gesellschaft (KSG)	F.R. of Germany		X					
Krauss-Maffei	F.R. of Germany	X		X		X		Now BKMI-Deutche Babcock
Kunstler Koch	Switzerland		X					
Lambian SHG	F.R. of Germany		X					Designed as bark burner, listed in SRI report
Lurgi	F.R. of Germany	X		X		X		Most experience with sludge

(continued

TABLE 1. (continued)

Firm	Country	Address obtained Y	Address obtained N	Survey response Y	Survey response N	Program applicability Y	Program applicability N	Comments
Josef Martin	F.R. of Germany	X		X		X		
Norsk-Hydro	Norway	X		X		X		Industrial and hospital waste
O.Y. Tampella	Finland		X					Listed in SRI report, no municipal experience
Renirie	Netherlands	X			X			
Seghers Engineering	Belgium	X		X		X		
Stein	France	X		X		X		
Sigoure Freres S.A.	France	X		X		X		
Steinmueller	F.R. of Germany		X					Stoker grate manufacturer
Thune-Eureka	Norway	X		X				Now Kvaerner Brug A/S
Trummer	Switzerland		X					Listed in SRI report
Vereinigte Kesselwerk (VKW)	F.R. of Germany	X		X		X		Part of Deutche Babcock
Venien	France		X			X		
Volund	Denmark	X		X		X		
Von Roll	Switzerland	X		X			X	

(continued)

TABLE 1. (continued)

Firm	Country	Address obtained Y	Address obtained N	Survey response Y	Survey response N	Program applicability Y	Program applicability N	Comments
Vyncke	Belgium	X		X				Industrial waste only
Widmer & Ernst	Switzerland	X		X				
W.S.I. b.v.	Netherlands		X					Wood waste boiler, listed in SRI report

responses or lack or responses, applicability to this study, and pertinent comments are summarized. Of the 40 vendors identified, 21 responded to the letter and phone calls and provided information. Three of the vendors made no response to our contacts, and addresses could not be located for 16. Eleven of the vendors had facilities that fit the criteria for study of this program. The others dealt only with special waste or had built no facilities near the size range required under the scope of this program.

The objective of the survey program was to obtain as much information as possible on the facilities. However, since no responses were received from specific facilities within this time period, a different approach was taken to describe the facilities. This approach involved the vendor's recommendation of facilities to be visited and a discussion of each technology in general, rather than site specific details. The vendors reviewed the questionnaire and recommended facilities that they knew would have the information requested thereon and would allow (with the vendor's assistance) a 1-wk evaluation. SYSTECH reviewed the technologies for similarities and differences.

Technology Survey

The technologies were reviewed for similarities as well as differences in approaches as compared with each other as well as with those commonly utilized in the United States for (1) receiving, storing, and handling the waste; (2) combustion chamber configuration; (3) removal of the residue; and (4) heat recovery. A summary of this review is presented in Table 2. This table prioritizes the technologies for visiting sites based upon suitability to Navy requirements, diversity in process operations, uniqueness in approach compared with technologies in the United States, and number of installations. Diversity in process operation was employed as a criteria so that if only a few facilities are visited, the greatest diversity in approach can be observed.

In reviewing the technologies, the configuration of the combustion chambers, which includes the type of grate system, was found to be the most

TABLE 2. SURVEY OF APPLICABLE FOREIGN INCINERATION TECHNOLOGY

Vendor	Waste handling	Combustion technology			Ash removal	Energy recovery
		Chambers	Grate	Comments		
Sigoure	Pit/crane hopper/ drop chute	2	Revolving carousel	Competitive capital cost with US systems; 9-yr experience in France; Negotiating for a system (3-50 TPD) in MS	Grate bars Wet pit Rack & pinion Drag chain	Waste heat Fire tube
Cadoux	Pit/crane hopper/ hyd. ram	1	Inclined 3-sections oscillating action	Capital cost competitive with US systems; only 2 capacities of units--1 and 1.6 TPH; internal baffle walls rather than separate chambers	Horizontal grate Wet pit Drag chain	Waste heat Water tube
Bruun & Sorensen	Pit/crane hopper/ hyd. ram	2	Inclined 2-sections rocking action grates in blocks	Numerous small units; cyclonic secondary chamber	Wet pit Ejector blade Bunker/ conveyor	Air soot blowing Waste heat Fire tube
Seghers	Pit/crane hopper/ hyd. ram	2	Inclined 1-section sliding lifting action	Air-cooled refractory; tallest secondary chamber of vendors	Wet pit Ejector blade Flat conveyor	Waste heat Water tube
Volund	Pit/crane hopper/ grate	2	Stepped 2-sections rocking action grates in blocks	Numerous small units; internal arch to direct flue gas and stabilize temperature; uses rotary kiln after grates on larger units	Wet pit Ejector blade Flat conveyor	Waste heat Boiler

(continued)

TABLE 2. (continued)

Vendor	Waste handling	Combustion technology			Ash removal	Energy recovery
		Chambers	Grate	Comments		
Von Roll	Pit/crane hopper/ hyd. ram	2	Stepped, 3-sections reciprocating action	Numerous small units in Europe and Japan; replaceable tiles protect refractory in combustion chamber; rapping and mechanical shot for cleaning boiler tubes; waterwall secondary chamber	Wet pit Drag chain	Waterwall boiler mechanical cleaning
Martin	Pit/crane hopper/ grate	2	Inclined 1-section upward action	Not many small units	Roller Wet pit Drag chain	Waterwall boiler
VKW	Pit/crane hopper/ hyd. ram	2	Inclined 1-section opposed action cascade	Uses cascading grates not rollers on small units; grate built by Keller Peukert	Wet pit Drag chain	Waterwall boiler
De Bartolomeis	NA	NA	NA	Data sent out; no response as yet	NA	NA
Lurgi	Pit/crane hopper/ chute	2	Rotary kiln	Usually processes sludge and other industrial wastes; only one municipal plant is listed	Wet pit Drag chain	Waste heat boiler

significant difference between the technologies. The second largest difference was the method of residue removal, and the third was the method of energy recovery. The waste handling and air emissions control approaches were all similar. Detailed discussion of each technology and cross sectional drawings as provided by the vendors are presented in Section 3.

Facility Review

The vendors of each technology deemed applicable to this program recommended one or more facilities to be visited and evaluated. In most cases they also provided a local contact and address. They all recommended that any visit to the facilities be coordinated through them to assure compliance with local protocol. Table 3 presents the history of facilities that could be visited and evaluated. Site contacts and any other information gathered during the survey are presented in Section 3 within the textual discussion of each technology.

TABLE 3. LISTING OF FACILITIES RECOMMENDED BY THE VENDORS OF FOREIGN TECHNOLOGIES FOR EVALUATION

Vendor	Recommended site(s)	Start up date	Capacity Energy recovery
1. Sigoure Freres Roanne, France	Millas, France	1980	2 TPH 150 psig steam
2. Cadoux Paris, France	Contrexeville France	1981	1 TPH 200 psi steam
3. Brunn & Sorensen Aarhus, Denmark	Korsoer, Denmark	1972	2 TPH hot water
4. Seghers Engineering Brussels, Belgium	La-Chaux-de-Fonds Switzerland	1972	3 TPH 680 psi steam/elec
	Besançon, France	1971	1.8 & 3 TPH 350 psi steam
5. Volund Glostrup, Denmark	Thisted, Denmark	1978	3 TPH 100 psi steam
	Videbaek, Denmark	1980	2 TPH ( )
6. Von Roll Switzerland	Deauville, France		2.5 TPH steam

SECTION 2

FACILITY IDENTIFICATION

One of the goals of this program was to obtain information on available technologies through the direct survey of operating facilities. Therefore, one of the first steps was to review published data and to contact other personnel familiar with foreign systems. The two most comprehensive published studies are the ones prepared by Battelle and Resource Planning Associates. Additionally, a reference report by SRI International was reviewed.

In studying these reports it was found that very limited information was contained about the majority of the installations. These reports did not contain sufficient information to allow contact with the facilities directly. In an attempt to overcome this limitation, we contacted the principal authors to inquire about obtaining this information directly from their files. Typically, they indicated that they did not have address information for most facilities, especially those in the size range appropriate to our study. We also attempted to obtain this information through other sources such as the U.S. EPA, Environment Canada, and the ASME Solid Waste Processing Division.

Rather than continue with an approach that showed little promise of success, we decided to try to obtain this information from vendors. A review of published information and other resources identified a total of 38 manufacturers/vendors of waste incineration system. However, for more than 80 percent there were no addresses or contacts presented. The only information provided was the firm name and the country of origin.

We were readily able to obtain the addresses of either the U.S. representative or the home office of 12 firms through a combination of in-house resources and published information. Contact with the foreign embassy for each country listed as having a firm engaged in waste incineration provided addresses for 11 more firms. Through this process we were able to identify and obtain addresses for two additional firms beyond the original 38. However, we were unable to obtain an address or contact for a total of 15 of the 40 firms.

We contacted the identified firms for information on specific facilities. We submitted a form requesting the names and addresses of installations of their systems to permit our direct contact with the operator and requested a description of the facility. We also indicated that it would be acceptable for them to transmit the form directly to these facilities.

A comprehensive nine page survey form was developed for completion by the facility operator. The information requested can be broken down into four general categories. The first requested general site information; name and address of the owner, operator, designer, and vendor; and general information on waste type, operating schedule, system capacity, and recovered products. The second category covered system design parameters such as waste handling, combustion, ash handling, and energy recovery. The third category covered plant economics, while the final category requested information on plant records and availability of testing. Whenever practical the questions developed for this survey were placed in a form to permit a "multiple choice" or yes/no answer. Also, the survey form was translated into both French and German to facilitate response.

For the most part the vendors were cooperative and willing to supply information. Additionally, information dissemination was facilitated when we were corresponding with a U.S. office or licensee of a firm. Through this approach we were able to obtain substantial information on the various technologies, but there was difficulty obtaining sufficient information to permit direct contact with operating facilities. Although there were

exceptions, many firms specifically refused to supply this information at this time. However, they would supply the contact information and complete the forms immediately prior to a visit which could only be scheduled by the vendor. It was only at the very end of the program that we identified the addresses of the facilities, too late to submit individual survey forms and expect a response in time for inclusion in the report.

The information we were able to obtain is consistent with the goals of the program and provides significant data on a number of technologies that may be suitable for the Navy's shore based facilities.

SECTION 3

TECHNOLOGY DISCUSSION

OVERVIEW

The survey identified 40 reported vendors or manufacturers of incineration systems in Europe. The addresses of 15 companies could not be determined. These companies are listed by country in Table 4 and discussed under Unlocated Technologies. Of the 24 companies that sent information, three firms did not respond. Of these, De Bartolomeis of Italy was documented in other reports as having facilities meeting the requirements of this program, so they are included. The other two, Renirie b.v., Netherlands, and Destructor, Sweden, are listed as having constructed only large facilities and were not included in the analysis. Of the 21 responding firms, Chammotte Rijkaart Inc., Netherlands, expressed no interest in participating; CEC of France was purchased by Seghers Engineering of Belgium, and their facilities are listed under that name; and three of the listed vendors are selling equipment manufactured by a U.S. company or another European firm. These include Heenan Environmental, United Kingdom; Bronswerk Utrecht, Netherlands; and Kockum Landsverk (now out of business), Sweden (see Table 1).

Of the located technologies, ten meet the program requirements of capacity, energy recovery, municipal waste, and continuous operation. They are discussed in Applicable Technologies, and their data and brochures are given in the Appendix. They are listed in Table 5.

The remaining seven technologies that responded to the inquiries are viable incineration technologies but have not met all the program

TABLE 4. FOREIGN FIRMS WHERE ADDRESSES WERE NOT LOCATED BY THE SURVEY PROGRAM

Name	Country
Alberti-Fonsar	
Almaco S.A.	Italy
Claudius Peters	Germany
Compagnie des Fours	France
Esslingen	Germany
Hoval-Werk A.G.	Liechtenstein
Keller Peukert	Germany
Kohlenscheidungs-Gesellschaft (KSG)	Germany
Kunstler Koch	Switzerland
Lambian SHG	Germany
O.Y. Tampella	Finland
Steinmuller	Germany
Trummer	Switzerland
Venien	France
WSI b.v.	Netherlands

TABLE 5. FOREIGN TECHNOLOGIES APPLICABLE TO THE SMALL SYSTEMS STUDY PROGRAM

Vendor	Location
De Bartolomeis	Italy
Bruun & Sorensen	Denmark
Cadoux	France
Josef Martin	Germany
Lurgi	Germany
Seghers Engineering	Belgium
Sigoure Freres	France
Vereinigte Kesselwerk	Germany
Volund	Denmark
Von Roll	Switzerland

requirements. Three of those technologies are making attempts to become viable small municipal incineration systems. They have met one or more but not all of the program requirements and warrant future consideration. The firms are Elboma PVBA, Belgium; Kvaerner Brug A/S, Norway; and Norsk-Hydro, Norway. Technical data and information are included in the Appendix on these technologies. They are discussed in more detail in the text under Other Technologies. The remaining four technologies, BKMI, Germany; Cornel Schmidt, Germany; Stein, France; and Vyncke, Belgium, are not deemed appropriate for this program. Their data are included in the Appendix, but they are not discussed.

UNLOCATED TECHNOLOGIES

The literature was reviewed for data concerning the 15 companies whose addresses could not be located. The SRI report listed seven of the companies as manufacturers of incinerators. Their technology was described as being wood/bark burners or industrial waste units, having no experience with MSW, or else were not described. They are Almaco, Italy; Hoval-Werk A.G., Liechtenstein; O.Y. Tampella, A.B. Finland; Trummer, Switzerland; Compagnie des Fours D'Incineration--S.A. Mueller, France; Lambian SHG, Germany; and W.S.I. b.v., Netherlands. These firms were not listed in the Battelle or the Resource Planning Associates reports. Because no information could be obtained to conclude that these firms are in the small municipal systems business, they were dropped from consideration.

Through other information and phone calls SYSTECH found that Keller Peukert, Germany, has sold its grate technology to Deutche-Babcock, and VKW is using it in their small units; and Steinmueller, Germany, has supplied its stoker to Widmer & Ernst for some units in Germany. The firms Alberti-Fonsar, Italy; Kunstler Koch, Germany; and KSG, Germany, were listed in several reports but no facilities less than 4 TPH were indicated. These firms were dropped from consideration because no information could be obtained to suggest their technology was applicable to this program.

No information could be obtained on the remaining three unlocated technologies whose names were listed in the Battelle report. They are Claudius Peters, Esslingen, and Venien. The Battelle report listed Claudius Peters as having a 2.5-TPH unit in Germany and Esslingen as having a 170 TPD unit in Norway. However, we have received an unconfirmed report that these two firms are no longer in the waste incineration business. No facility listing was given for Venien.

APPLICABLE TECHNOLOGIES

The 11 technologies applicable to this study program were found to have at least a total of 97 small incineration facilities burning municipal solid waste. Capacities range from 1 to 3 TPH, but not all of the facilities have energy recovery, particularly the 1 or 2 TPH units. Several of the 3-TPH units produce high pressure steam and electricity. The following paragraphs present a brief discussion on the technologies of these 11 firms.

De Bartolomeis, Italy

Current information on this technology has not been received. The original request for information was sent to the wrong address (as supplied by the Italian Embassy) but was correctly forwarded at a later date.

The technology is listed in the literature as being utilized at three facilities. However, none of the reports reviewed presented a discussion on the technology of this firm. Therefore, unless additional information is obtained to the contrary, this technology is not recommended.

Bruun & Sorensen, Denmark

The Bruun & Sorensen Environmental Engineering Company has two designs for small municipal incineration system. The Type W grate system has been used extensively in the last 10 years. It consists of inclined rocking grates grouped together in blocks. One set of blocks rotates through 60 degrees

clockwise while the next set rotates 60 degrees counter clockwise. Units from 1- to 5-TPH capacity have been built. The other hearth, Type SR, is a flat grate system in two steps. With both units, the primary combustion chamber is followed by a cyclonic secondary chamber where additional air turbulence and residence time allows complete combustion of the gases. Energy is generally recovered in waste heat boilers. Most of the Bruun & Sorensen systems have been built in Denmark and Sweden where the majority of the installations are connected to district heating systems. Bruun & Sorensen also has larger systems supplying high and low pressure steam.

This technology is recommended for a site visit because of the following factors:

1. The vendor has considerable experience in the size range relevant to the Navy's requirement

2. None of their installations, regardless of size, are located in the United States.

3. The rocking action of the grates and the tangential secondary chamber can be considered a unique feature not found in other recommended technologies.

4. A package fire-tube waste heat boiler is typically used to recover energy. This is different from the other grate manufacturer.

5. The facility recommended removes the ash by means of a vibrating pan conveyor rather than a drag chain.

As presented in the Appendix, we have received location and contact information from the manufacturer on a facility to be visited.

Cadoux, France

The Cadoux technology employs a combustion chamber with a grate system and several vaults or refractory baffles. The waste is fed into the combustion chamber by a ram/hopper system much like the common U.S. systems. The grate is in three sections, two inclined and one horizontal. The first dries the refuse, the second burns, and the third controls the discharge of ash. The baffles cause the gases to change direction and reduce velocity to allow the entrained particulate to drop. The vault or baffle located over the combustion chamber forces some of the hot gases over the new refuse on the first hearth. This facilitates drying and ignition. The gases then go into a water-tube boiler that has a soot blowing system that utilizes compressed air to remove the particulate.

Cadoux manufactures incinerators of this design in only two sizes, 1 and 1.6 TPH. Larger facilities are constructed by adding units. They list 19 facilities with the earliest having been built in 1976. This technology is recommended for a visit for because of the following factors:

1. The system is modular.

2. Based upon the bid submitted at Pascagoula, Mississippi, the technology appears cost competitive with U.S. modular systems, at least on a capital cost basis.

3. The technology has not been extensively discussed in the literature.

4. None of their installations, regardless of size, are available in the United States.

5. Energy recovery by use of a flash tank is unique.

6. Other aspects of the combustion chamber are not duplicated in other technologies.

Josef Martin, Germany

The Martin technology has been utilized on many large incineration facilities and a few small units. This system employs a patented, high alloy, refractory metal, inclined grate system. The action of the grates is reverse or upward to the inclined hearth. This action causes the refuse to roll down the hearth. The refuse is fed into the unit by means of a preliminary grate system at the bottom of the long feed chute. The refuse is carried from the bottom of the chute into the furnace and dried on this grate before it drops onto the inclined grate. The secondary chamber is a waterwall boiler section.

The Martin technology is not recommended with a high priority for a site visit for the following reasons:

1. Their primary market thrust has been with large systems. Therefore, the literature has mentioned only three small systems, and only one is applicable to the program.

2. Although much larger in capacity than of interest for this program, Martin does have U.S. installations.

3. Much of the innovative aspect of the Martin design has been previously reported.

4. The general facility layout is similar to other technologies.

Lurgi, Germany

The Lurgi technology has one facility listed where municipal solid waste is burned to dry sewage sludge. The Lurgi rotary, inclined kiln technology is most often utilized for bulk waste and sludges. The waste is dropped through a chute into the upper end of the refractory lined kiln. The residue drops into a wet pit, and a drag chain removes the quenched ash. The combustion system is followed by a waste heat boiler.

Although technically viable, this system is not recommended with a high priority for a site visit for the following reasons:

1. The literature only reports one system currently in operation. It was built 13 years ago. We were unable to obtain any current information on the operation or status of the facility.

2. The technology is not new, and similar units are available in the United States which are being marketed for municipal solid waste incineration.

3. The use of a continuous rotary kiln on municipal solid waste has been reported.

Seghers Engineering, Belgium

The Seghers technology was purchased from Carbonisation Enterprise et Ceramique (CEC). They have built field erected units in the 2- to 12-TPH capacity range, and several of the facilities have been in operation since the 1960's. The same technology is utilized for the small units as well as for the large facilities. The waste is fed into the combustion chamber by a ram at the bottom of the loading hopper. The single section of inclined grate has two actions, rocking and lifting, to move and tumble the waste. The secondary chamber is the tallest of all the technologies. This is to assure combustion of all the gases and to provide refractory mass so as to moderate the temperature of the flue gases. The refractory is cooled by drawing the combustion air between the refractory and the chamber shell. A custom built water-tubed boiler is utilized to recover the energy. Several 3-TPH units have been built to generate high pressure steam for electricity production.

This technology is recommended for consideration for a site visit for the following reasons:

1. The vendor has identified a total of seven facilities applicable to the program.

2. The technology has not been extensively reported in the past.

3. There are no installations, regardless of size, located in the United States.

4. In many regards a general arrangement similar to other systems is employed.

5. Two unique aspects of the technology are the very high secondary chamber and the two actions of the grate.

6. The capital costs and operations and maintenance costs are expected to be typical of similar grate systems.

7. The boiler system is a unique package, designed by Seghers.

As presented in the Appendix, the Belgian office has supplied address and contact information on two installations. Additionally, the U.S. licensee is actively marketing this technology.

Vereinigte Kesselwerk (VKW), Germany

The VKW technology is best known for its roller grate system. However, in smaller units, 1 to 5 TPH, the Keller Peukert opposed motion cascade grate system is used. This grate utilizes pivoting grates that lift and tumble the refuse down the incline. The refuse is delivered into the furnace by a feed ram at the bottom of the feed shaft. Variable speed of the ram ensures continuous feeding of the refuse. The secondary chamber completes combustion of the gases before they enter the waste heat, water-tube boiler. The ash is discharged via a wet pit. The same pit extends beneath the grate system to quench the siftings that fall through the grate. A drag chain removes the residue.

Although technically viable, the VKW system is not given a high priority for a site visit for the following reasons:

1. Although outside of the size range of this project, VKW does have installations in the United States.

2. The primary market thrust of the firm is toward large systems.

3. Much of the innovative aspect of the VKW design has been reported by others.

4. The general facility arrangement is similar to other technologies.

5. Although they do have two facilities applicable to this program, the U.S. representative declined participation in the program. Thus, additional difficulty is expected in obtaining access to the installations.

6. Capital and operation and maintenance costs are expected to be similar to other grate technologies.

7. No information unique from previously recommended technology is expected from an evaluation.

Von Roll, Switzerland

The Von Roll technology utilizes an inclined step grate with a reciprocating motion to agitate and convey the refuse. The secondary chamber is a waterwalled section with part of the tubes covered with refractory plates for protection. The ash drops into a wet pit and is removed by a drag chain. The refuse is fed into the furnace by means of a ram at the bottom of the feed chute.

The Von Roll technology is recommended for a site visit for the following reasons:

1. They employ a unique waterwall technology for energy recovery with mechanical cleaning of the boiler tubes.

2. They have 11 identified facilities applicable to this program which is more than the other "similar" technologies combined.

3. For study purposes, they can be considered representative of the waterwall technology.

4. Their combustion chamber configuration is similar to other waterwall incineration systems.

5. They utilize a wet pit and drag chain versus the ejector blade of the other recommended grate technologies.

The U.S. office of Von Roll has expressed interest in participation in this program. However, as of this writing they have not supplied information on a recommended site for visitation.

Volund, Denmark

Volund has been building small facilities since 1964. Numerous units with 1- to 6-TPH capacities have been built. Small units utilize a 2-section stepped grate while units larger than 6 TPH have a rotary kiln after the grates to complete the combustion of all the carbon materials. The grates are assembled in blocks. The bars within each block are individually removable. An arch over the grate system serves two purposes: the first is to direct hot gases over the incoming refuse for drying, and the second is to uniformly distribute the temperature across the combustion bed. The gases pass into a secondary chamber to complete combustion and drop out particulate before entering a waste heat, fire-tubed boiler.

The Volund technology is recommended for a site visit for the following reasons:

1. Although this technology has been subject to review by others, little effort has been directed towards their smaller systems.

2. They have numerous applicable facilities that generate hot water or steam.

3. They are the only manufacturer that employs an arch within the combustion chamber.

4. The refuse is fed into the furnace by a grate rather than a ram as in the other recommended facilities.

The U.S. office of Volund has expressed interest in participation in this program. However, as of this writing they have not supplied information on a recommended site for visitation.

Sigoure Freres, France

The Sigoure system is a factory assembled, modular, vertical, rotary hearth incinerator. The waste is fed through a double door and drop chute system above the vertical primary chamber. The horizontal grate within the chamber rotates 20 degrees with each load. After completing about 300 degrees of rotation, the remaining ash is raked into a wet pit by a grate bar system. The primary chamber is a substoichiometric combustion chamber. The volatile gases are burned in the vertical secondary chamber. The flue gases then pass into a fire-tube boiler.

Sigoure Freres has 9 years of experience with units located only in France. The units have been built in sizes ranging from 2 to 10 TPH. The U.S. licensee of Sigoure is negotiating to build two 75-TPD units in Pascagoula, Mississippi. That contract is expected to be signed by January

1983. The local engineer for the City of Pascagoula has traveled to France and visited three of the Sigoure facilities.

The Sigoure technology is recommended for a site visit for the following reasons:

1. The use of a "stepped" revolving grate technology is different from other technologies.

2. They have not been extensively reported by others.

3. Based upon the bid submitted at Pascagoula, Mississippi, they can be considered cost competitive with U.S. systems.

4. No systems, regardless of size, are presently located in the United States.

5. They utilize a packaged fire-tube boiler for energy recovery.

6. A rack and pinion drag chain is utilized to remove the ash from the wet quench pit.

OTHER TECHNOLOGIES

These technologies were deemed to have some merit, but they could not meet all the program requirements. The size and energy recovery were appropriate, however operation on the type of waste and/or the continuous operation requirements were not adequately proven.

Elboma PVBA, Belgium

The Elboma technology employs a reciprocating stepped grate to agitate and convey the waste. Combustion is essentially completed in the furnace chamber. However, a secondary chamber provides additional retention time for

gaseous products combustion. The furnace is usually followed by a fire-tubed boiler with three passes. The units are fed manually through a double bomb-bay door system. The ash drops into a wet pit, and a drag chain removes the quenched material. Most of these units are burning industrial, hospital, and apartment house waste. Only one municipal system was listed. Their capacity is limited with the largest being 0.75 TPH. The units are modular, and some factory assembly is utilized.

This technology is not recommended for review at this time. Contact with the U.S. licensee should be actively maintained and the program on municipal waste applications monitored.

Kvaerner Brug A/S, Norway

Kvaerner Brug is the parent company of Thune-Eureka which has been marketing small municipal incineration systems in the Netherlands. Current information was not obtained since the information sent to Thune-Eureka was not forwarded to Kvaerner. Additional time is required to obtain their response. Information provided to SYSTECH last year by Thune-Eureka indicates that up to three facilities have been built. They all recover energy in the form of hot water. The units are claimed by the manufacturer to be cost effective and inexpensive to operate.

The refuse is dumped directly into the primary combustion chamber. When full, the chamber is closed and the refuse ignited. Controlled air incineration in two chambers processes the refuse over a 16-hr period. An 8-hr burn down period then occurs, and the remaining ash is automatically ejected from the chamber. The chamber is then recharged. Two units would provide continuous energy output. The capacity of the units is stated as being from 5 to 20 TPD per chamber. If current data can be obtained as to the status of the three sites and if additional sites have been built, this technology should be reconsidered for evaluation.

Norsk-Hydro, Norway

This technology is a factory constructed modular incinerator. They have some experience with municipal type waste from apartment complexes. The units have two combustion chambers. The refuse, in small charges, is loaded into the top and one end of the primary chamber. The ash is pulled through the unit by an auger in the bottom of the primary chamber. The gases pass into the secondary chamber to complete combustion. The units are built with a capacity of 300 to 2000 lb/hr.

Experience with municipal type waste is limited, but the manufacturer is attempting to expand this experience. The system does have a shipboard version of the combustor. Their experience seems to be on homogeneous sized waste or household bags of refuse. Problems are anticipated if they were to process large boxes, branches, wires, and metal objects normally found in municipal waste.

BIBLIOGRAPHY

1. Refuse Fired Energy Systems In Europe: An Evaluation of Design Practices, Executive Summary, Volume 1 and Volume 2, U.S. EPA SW771, November 1979 (Battelle Columbus Laboratories.)

2. Proceedings of the International Conference on Prepared Fuels and Resource Recovery Technology, February 10-13, 1981, Nashville, Tennessee, U.S. DOE, April 1981.

3. European Waste to Energy systems, An Overview, Resource Planning Association, June 1977.

4. European Developments in the Recovery of Energy and Materials from Municipal Solid Waste, W. David Conn, California University, Los Angeles, May 1977.

5. Naval Facilities Energy Conversion Plants as Resource Recovery System Components, Arlie G. Capps, SRI International, Civil Engineering Laboratory, Port Hueneme, California, CR80.002, January 1980.

6. European Technology for Obtaining Energy from Solid waste, Edited by D. J. DeRenzo, Noyes Data Corporation, Park Ridge, New Jersey, 1978.

TELEPHONE AND/OR WRITTEN COMMUNICATIONS

General

Battelle Columbus Labs
505 King Avenue
Columbus, OH 43201
Chris Stotler (614) 424-4721
Philip Beltz (614) 424-4697

U.S. Air Force
Foreign Technology Division
Wright Patterson Air Force Base
Ohio 45433
Eugene P. Steinmetz (513) 257-2756

U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460
David Sussman (202) 382-4692

SRI International
Menlo Park
California 94025
Jerry Jones (415) 326-6200

Comtro Division
Sunbeam Equipment Corporation
180 Mercer Street
Meadville, PA 16335
Fred Muller (814) 724-1456

U.S. Department of Commerce
Cincinnati
Ohio
Harry Weinstock (513) 684-2944

Environment Canada
Environmental Protection Service
Waste Management Branch
Ottawa, Ontario K1A 1C8
Canada
Chris Banwell (819) 997-4334

Anreg
42 Rue D'Cambronne
7505
Paris, France

Compton Engineering
P.O. Box 686
Pascagoula, MS 39567
David Compton (601) 762-3970

Foreign System Technology Manufacturers and Vendors and U.S. Representatives

BKMI (formerly Krauss-Maffei)
Industrieanlagen GMBH
Sapporobogen 6-8
D-8000 Munchen 40
Federal Republic of Germany
Mr. Orlon 089 12 40 1

Ford, Bacon and Davis Inc.
375 Chipeta Way
Salt Lake City, UT 84108
J. Edward Immergluck (801) 583-3773
Kurt Kugler

Bronswerk Utrecht
Bronswerk Ketel-en Apparatenbouw B.V.
Tractieweg 40-41
P.O. Box 2435
3500 GK Utrecht
The Netherlands
J.C. Stoeltie 030-4492 11

Bruun & Sorensen AS
B&S Environmental Engineering
Aaboulevarden 11
DK 8000 Aarhus C
Denmark
Niels T. Holst 45 6 12 44 33
Mr. Andersen

Bruun & Sorensen, USA
3030 Bridge Avenue
Suite 217
Sausalito, CA 94965
Flemming Fischer (415) 332-5052

Cadoux-Athanor
7 Rue Galile'e
75116 Paris
France
723-61-52

Cadoux Inc.
5349 Estate Office Drive
Number 2
Memphis, TN 38119
Gerard Rateau-Holbach (901) 767-0676

Chammotte Rykaart Industrieel BV
P.O. Box 2
4190 CA Geldermalsen
The Netherlands
M. VanEssen 3455-3441

Cornel Schmidt
CS JABV
PYROLYSETECHNIK VERTRIEBS GMBH
VonKetteler Strasse 1
D5090 Leverkusen 1
Federal Republic of Germany
Mr. Bayer 02241 42071

Elboma PVBA
Engineering Works
Fratersplein 10-11
B-9000 Gent
Belgium
Eric Bolen 091-257745

Industrial Boiler Company
Elboma Inc.
221 Law Street
P.O. Drawer 2258
Thomasville, GA 31792
Paul Goggins (912) 226-3024
Welch Goggins
Julian Holland

Heenan Environmental Systems
P.O. Box 14
Shrub Hill Road
Worchester WR4 9HA
England
A.J. Harrison 0905 23461

Lurgi Umwelt und Chemotechnik GMBH
Bereich Awalu
D-6000 Frankfurt am Main 2
Federal Republic of Germany
06-11-15-71

Lurgi Corporation
66 Kinderkamack Road
River Edge, NJ 07661
John Vetter (201) 967-4914

Josef Martin Feverungsbau GMBH
Postf 40 12 29
8 Munchen 40
Federal Republic of Germany

UOP Inc.
Environmental Systems Group
40 UOP Plaza
Algonquin and Mount Prospect Roads
Des Plains, IL 60016
Paul Walker (312) 391-2086

Norsk Hydro
Oslo
Norway

Stock Equipment
Energy Systems
16776 Bernardo Center Drive
San Diego, CA 92128
James Siltanen (714) 485-9864

Renirie BV
Havenlaan 1
5433 NK Cuijk
The Netherlands
F. Renirie 8850-12688

Seghers Engineering
Genevestraat 10, Box 14
B1140
Brussels, Belgium
Alain Sommers 02 242 1555

Katy Seghers Incinco Systems
3844 Walsh Street
St. Louis, MO 63116
Art Beckman (314) 752-2400

Sigoure Freres SA
Z.I. Riorges
42309 Roannne
France
Claude Maille 77 71 67 63

Sigoure USA
1735 I Street
Washington, DC 20006
Paul Summerall (202) 331-1850

TELEPHONE AND/OR WRITTEN COMMUNICATIONS (continued)

Sigoure (continued)

Town Services
P.O. Box 9577
Jackson, MS 39206
Dave Shankas (601) 362-4110

Stein

Trans Energy Systems
Suite 101
14711 NE 29th Place
Bellevue, WA 98007
Ronald J. Stryer (206) 881-8500

Thune Eureka
Kvaerner Brug A/S
Mollerct 12
Oslo 1
Norway
B. Fagerhaug 47 1 67 69 70

VKW
Browning Ferris Industries
P.O. Box 3151
Houston, TX 77001
Edmond A. Joran (713) 870-8100

Volund
11 Abildager
Glostrup 2600
Denmark
01 95 22 00

Volund, USA
900 Jorie Blvd.
Oak Brook, IL 60521
Gunnar Kjaer (312) 655-1490

Von Roll Ltd.
Environmental Engineering Division
P.O. Box 8037
Zurich, Switzerland
A. Scharsach 01 44 12 41

Von Roll USA
25 Commerce Drive
Cranford, NJ 07016
Rolf T. Baumgartner (201) 272-1555

Von Roll (continued)

Wheelabrator Frye Inc.
Liberty Lane
Hampton, NH 03842
Chris Ganotis (617) 777-4412

Vyncbe Pvba
Nievwe Vaart 51
D 900 Gent
Belgium

Steelcraft-Vyncke Corporation
P.O. Box 12508
Memphis, TN 38112
Eric D. Johnson (901) 452-8094

Widmer & Ernst
Zentralstrasse 74
5430
Wetteingen, Switzerland
Mr. Nigg 056 26 31 41

Embassies Contacted

Danish	(312) 329-9644
Belgian	(202) 333-6900
Finnish	(202) 363-2430
French	(202) 328-2600
Netherlands	(202) 244-5300
Norweigan	(202) 333-6000
Swiss	(202) 462-1811
British	(202) 462-1340
Italian	(202) 328-5500
West German	(202) 298-4000

APPENDIX

SYSTECH®

specialists in environmental technology
SYSTECH CORPORATION
245 North Valley Road
Xenia, Ohio 45385
513/372-8077
513/429-2533

September 3, 1982

Mr. Niels T. Holst
Brunn and Sorensen A/S
The Waste Treatment Department
Aaboulevarden 22
8000
Aarhus C. Denmark

Subject: U.S. Navy Survey
SYSTECH Project 570

Dear Mr. Holst:

Based upon conversations with the Danish Embassy in Washington, D.C., USA, and a review of the report written by the staff of the Battelle Columbus Laboratories, I am sending you this letter to request your assistance on a program we are conducting for the U.S. Navy. For your information, SYSTECH Corporation is a consulting engineering firm engaged primarily in providing technical assistance to public and private agencies in the proper management of solid waste. We have been active in assisting communities in implementing waste-to-energy systems, primarily in the size range of less than 200 tonnes per day. We are currently working with the U.S. Navy to assist them in identifying and collecting information on incineration systems that might be suitable for their shore based facilities. They have asked us to investigate facilities which meet the following criteria:

1. Facilities in which individual incinerators are designed to burn between .75 and 3.0 tons/hr.

2. The incinerator should be capable of operating 24 hr/day.

3. The incinerator is designed to burn municipal types of waste and recover energy.

4. The technology or design of the incinerator has not been installed in the United States in the size of .75 to 3.0 tons/hr.

Based upon the report prepared by Battelle, we understand that Brunn and Sorensen incinerators have been installed in the following cities:

1.	Ebeltoft, Denmark	One 1 MT/hr unit
2.	Frederikshaven, Denmark	One 3 MT/hr unit
		One 4 MT/hr unit
3.	Herning, Denmark	Two 3 MT/hr units
		One 4 MT/hr unit
4.	Hojetastrup, Denmark	One 3 MT/hr unit
5.	Holstebro, Denmark	One 3 MT/hr unit
		One 4 MT/hr unit
6.	Kolding, Denmark	Two 3 MT/hr units
7.	Korser, Denmark	One 2 MT/hr unit
8.	Middelfart, Denmark	Two 2 MT/hr units
9.	Nyborg, Denmark	One 3 MT/hr unit
		One 4 MT/hr unit
10.	Ringsted, Denmark	One 2 MT/hr unit
11.	Struer, Denmark	One 2 MT/hr unit
12.	Taastrup, Denmark	One 3 MT/hr unit
13.	Sadra, Sweden	One 2 MT/hr unit

I would like your assistance in contacting the owners/operators of these and any other appropriate installations that have operating incinerators of the Brunn and Sorensen design. Enclosed with this letter is a survey form that we have developed that shows the type of information we are requesting on these facilities. You would be of great assistance to us on this project if you would either send a copy of this form to these facilities or send us information that would permit our contacting them directly. In either case, we would like you send us the proper name and address of each of these facilities to permit our follow up at a later date.

Upon receipt of the information from the various installations, we will submit a report to the Navy. It is important to note that our contract requires only the submittal of the type of information requested in the questionnaire, and we will not be performing any comparative assessment of various technologies. Enclosed is a copy of the Statement of Work of our contract with the Navy to provide you with additional background information. Also, at a later date, the Navy, under a separate contract, may ask permission to visit several incinerators and perform a week long evaluation at each.

In closing, thank you in advance for your assistance on this program. If you have any questions or if I can be of any assistance, please call me at (513) 372-8077. My deadline for preparing the report is November 1, 1982.

Sincerely,

SYSTECH CORPORATION

Brian A. Hausfeld, Manager
Engineering and Consulting Services

BAH/nr

Enclosures

SYSTECH CORPORATION

WASTE-TO-ENERGY INCINERATOR DATA SHEET

FOR U.S. NAVY STUDY OF SYSTEMS OUTSIDE OF THE UNITED STATES

1. FACILITY IDENTIFICATION

(please mark appropriate boxes or fill in the blank spaces)

1.1 Location: City _____ Country _____

1.2 Title of facility _____

1.3 Facility owner: Name _____

Address _____ City _____

Contact person _____

Title _____ Telephone _____

1.4 Facility operator: Name _____

Address _____ City _____

Contact person _____

Title _____ Telephone _____

1.5 Facility designer: Architect _____

City _____ Country _____

Engineer _____

City _____ Country _____

Incinerator manufacturer _____

Address _____

City _____ Country _____

Boiler manufacturer _____

Address _____

City _____ Country _____

2. FACILITY OPERATION

2.1 Date of opening _____

Is it still operating? Yes No

If no, date of closing _____ and

Reason for closing _____

2.2 Types of waste burned, source, and percentage of total by weight

Household: Yes No Source _____ Percent _____

Commercial: Yes No Source _____ Percent _____

Industrial: Yes No Source _____ Percent _____

Other: Yes No Source _____ Percent _____

2.3 Total plant design capacity _____ tonnes/hr _____ tonnes/day

Design capacity for each

process line: No. 1 _____ tonnes/hr _____ tonnes/day

No. 2 _____ tonnes/hr _____ tonnes/day

No. 3 _____ tonnes/hr _____ tonnes/day

2.4 Actual operating capacity

for plant _____ tonnes/hr _____ tonnes/day

Actual operating capacity

for each process line: No. 1 _____ tonnes/hr _____ tonnes/day

No. 2 _____ tonnes/hr _____ tonnes/day

No. 3 _____ tonnes/hr _____ tonnes/day

2.5 Operating schedule _____ hours/day _____ days/week

Receiving _____ hours/day _____ days/week

Processing _____ hours/day _____ days/week

Combustion _____ hours/day _____ days/week

2.6 Recovered products

Steam: _____ tonnes/hr @ _____ °C and _____ ATM

Hot water: _____ M^3/sec @ _____ °C and _____ ATM

Electricity: _____ kWh

Materials: Fe _____ tonnes/_____

Al _____ tonnes/_____

Glass _____ tonnes/_____

Other _____ tonnes/_____

3. FACILITY DESIGN

3.1 Concept of design for the incinerator

Type of incinerator:

Substoichiometric primary chamber and afterburner combustion

Rotary kiln

Waterwall

Refractory lined

Other

Manufacturing: site assembled

factory assembled

Is a design schematic or descriptive brochure available?

Yes No Enclosed

3.2 Waste receiving:

Pit Tipping floor

Other _____

3.3 Is the waste burned as it is received or is it processed to improve its quality, protect equipment, recover materials, or for other reasons? Yes No

If yes: A. Why is it processed? _____

B. What preprocessing steps are employed and their sequence?

Manual separation _____

Shredding _____

Screening _____

Air classification _____

Other _____

3.4 Method of conveying waste from receiving area and into incinerator:

Crane

Front end loader

Mechanical conveyor

Pneumatic conveyor

Auger

Hydraulic ram

Other

3.5 Furnace data:

Type of grates:

Rotary | Fixed bed with rams

Reciprocating | Other

Traveling

3.6 Combustion air control

Primary chamber

Air source _____

Dampers: None Manual Automatic

Automatic and modulating

Air flow control point: Chamber temp. Refuse feed rate

Boiler temperature or pressure Stack pressure

Other _____

Overfire air

Air source _____

Dampers: None Manual Automatic

Automatic and modulating

Air flow control point: Chamber temp. Refuse feed rate

Boiler temperature or pressure Stack pressure

Other _____

Secondary chamber: Does not have a secondary chamber

Air source _____

Dampers: None Manual Automatic

Automatic and modulating

Air flow control point: Chamber temp. Refuse feed rate

Boiler temperature or pressure Stack pressure

Other _____

3.7 Auxiliary fuel use

Type used: Oil Gas Other

Used in primary chamber for: start up low temperature

continuously other _____

Used in secondary chamber for: start up low temperature

continuously other _____

3.8 Heat recovery boiler

Radiant Water tube Fire tube

Superheat section Economizer

How many passes do the gases make? _____

Type of soot blowing

None Air Steam Mechanical

3.9 Emission control equipment

What types of emission are controlled

Particulate SO_x HCl Other _____

What type of emission control equipment is used?

None Cyclone Fabric filter ESP Scrubber

Other _____

3.10 Bottom ash removal system

How is the bottom ash removed?

In a batch every _____ hours

Continuously

For continuous removal, how is it removed from the incinerator?

Grates Ram Other _____

Is it removed wet or dry? Wet Dry

How is the ash conveyed? Drag conveyor Belt conveyor

Pan conveyor Bucket conveyor Other _____

Is the ash conveyor combined with other incinerators in the facility?

Yes No N/A

How is temporary storage of the ash at the facility accomplished?

Box Truck Storage pad Other _____

3.11 Electrical power consumption

_____ kWh used/_____ (time period or tonnes processed)

4. PERSONNEL

4.1 Personnel

(Please list the number of workers at the facility by classification and shift.)

	Shift				
Classification	First	Second	Third	Other	Total
Operators					
Maintenance					
Administration					
Clerical					
Other					

4.2 Maintenance

What has been found to the be primary maintenance items and their frequency? The following is a guide to possible areas:

Preprocessing system	Task	Frequency
Shredder		
Air classifier		
Screens		
Conveyor		
Others		

Incinerator system	Task	Frequency
Crane		
Grates		
Refractory		
Boiler tubes		
Feed water pumps		
Emission control equipment		
Ash conveyor		
Other		

Comments _____

_____

_____

_____

For what systems are spare parts stocked, what are the major parts, and what is their monitory value?

System	Parts	Value

4.3 System budget and costs

Capital costs

What were the original capital costs for the following categories and what is their 1982 estimated cost?

	Engineering	Land	Equipment
Original cost			
Year purchased			
1982 est. cost			

Annual costs

What is the annual budget or cost for operating the facility?

Item	Cost
Debt service	_____
Labor	_____
Maintenance & supplies	_____
Utilities	_____
Residue disposal	_____
Other _____	_____
Total	_____

Annual revenues

What are the annual revenues for the facility?

Item	Amount
Energy	_____
Materials	_____
Disposal fee	_____
Other _____	_____
Total	_____

4.4 Other information

What other information about your facility can you supply? _____

_____

_____

_____

_____

_____

What are the normal (daily, weekly, etc.) records that are kept about the facility's operation? _____

_____

_____

_____

What is unique or innovative about the design of this system? (for example, improvements in design over previous installations)

What design modifications have been made to the original system design?

Would you permit a test team to visit your facility and perform a detailed evaluation over a 1-week period?

SYSTEM DATA SHEET

Name:	S. P. A. Fornie Impianti Industriali
Address:	Ingg. De Bartolomeis Via Settembrini, 7 20124 Milano, Italy
Contact:	Telephone: 02/2774 Telex: 311267 DBMI 1
U.S. Office:	None reported
U.S. Licensee:	None reported
Comment:	This technology has facilities listed in the Battelle Labs survey and the De Renzo overview. However, no contact could be made with the vendor and mailing address could be obtained for the sites. The wrong address was supplied for original vendor contact. However, the survey data sheet was forwarded to the correct address, but no response has been obtained.

VENDOR De Bartolomeis

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Locarno, Switzerland	2	2.05	100	1969	Hot water
Monthey, Switzerland	2	3.75	180	1975	Electricity
Cava Dei, Italy	2	1.6		1975	Steam

SYSTEM DATA SHEET

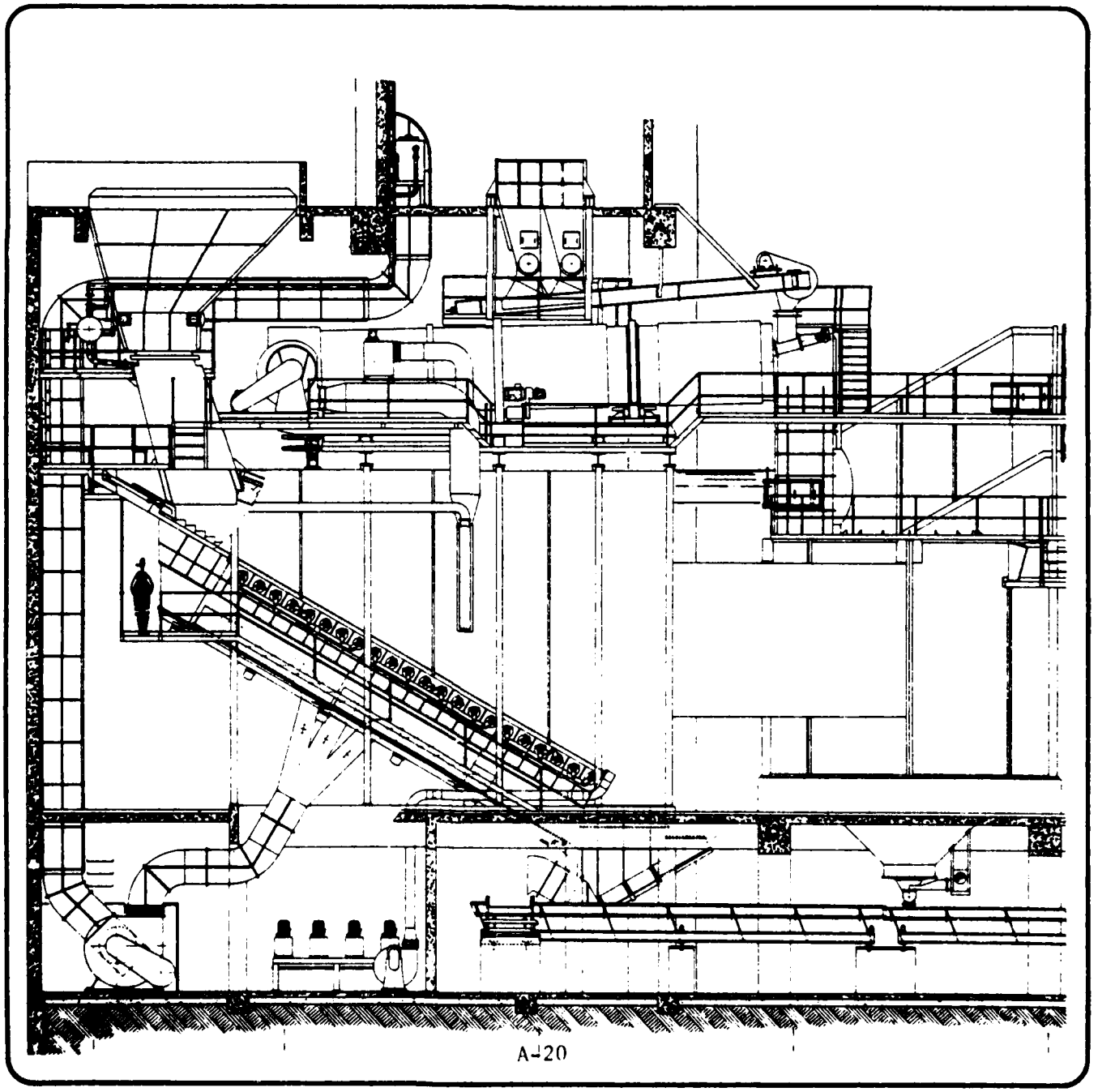
Name:	Bruun & Sorensen Environmental Engineering
Address:	Aaboulevarden 11 DK-8000 Aarmus Denmark
Contact:	Niels T. Holst
U.S. Office:	Bruun & Sorensen, USA 3030 Bridge Avenue Suite 217 Sausalito, CA 94965
Contact:	Mr. Flemming Fischer (415) 332-5052
U.S. Licensee:	None reported
Technology Description:	Bruun & Sorensen has two types of incineration systems in the size range applicable to Naval facilities. The Type W system employs inclined grates and has a capacity ranging from 1.0 to 121.5 TPH with five sizes less than 3 TPH. The Type SR system is a step grate system. Common to both of these designs is a refractory wall construction and a cyclonic secondary or post combustion chamber. The Type W design is a rocking grate inclined on a 28 degree angle with alternating grates counter rotating with respect to the adjacent.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	Korsoer, Denmark Nordbrinken DK-4220 Korsoer Telephone: +45-3-573536
Contact:	Mr. Mogens Samer Odense, Denmark Varmecentralen, J. B. Windslevsvej DK-5000 Odense
Contact:	Mr. J. C. Schmidt Telephone: +45-9-133333, Extension 2901
Facility listing:	Attached X N/A
Other:	The Type SR has not been built recently (last 10 years). The Type W is the preferred option by the manufacturer. The Korsoer facility was reviewed in 1975.

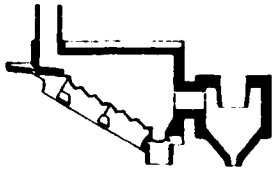
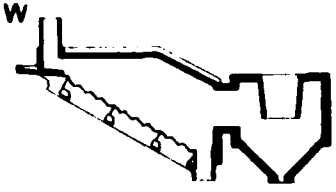
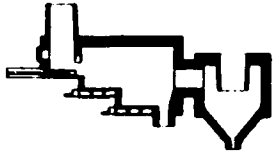
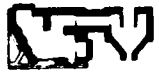
VENDOR Bruun & Sorensen

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Holstebro, Denmark	1	3.0	72	1970	Hot water
Herning, Plant No. 2, Denmark	1	3.0	72	1971	Hot water
Slagelse, Denmark	1	3.0	72	1971	Hot water
Korsoer, Denmark	1	2.0	48	1972	Hot water
Middlefart, Denmark	1	2.0	96	1972	Hot water
Middelfart, Furnace No. 2, Denmark	1	2.0	96	1975	Hot water
Skagen, Denmark	1	2.0	48	1978	Hot water
Solrød, Denmark	1	2.0	48	1978	Hot water
Auesta, Sweden	2	2.0	144	1980	Hot water
Mora, Sweden	1	3.0	72	1981	Hot water
Hobro, Plant No. 2, Denmark	1	3.0	72	1981	Hot water
Herning, Denmark	1	3.0	72	1963	Hot water
Bredäng, Stockholm, Sweden	1	3.0	72	1964	Hot water
Frederikshaven, Denmark	1	3.0	72	1965	Hot water
Frederica, Denmark	2	2.3	110	1966	Hot water
Struer, Denmark	1	2.0	48	1967	Hot water
Høje-Taastrup, Denmark	1	3.0	72	1967	Hot water
Ringsted, Denmark	1	2.0	48	1969	Hot water
Kolding, Denmark	1	3.0	144	1969	Hot water
Nyborg, Denmark	1	3.0	72	1970	Hot water
Sønderborg	1	3.0	72	1970	Hot water
Kolding, Furnz, Denmark	1	3.0	144	1972	Hot water

STANDARD PROGRAMME

B&S INCINERATOR SYSTEM



WASTE TYPE	WASTE SOURCE		INCINERATOR TYPES	CAPACITY QUANTITY	CAPACITY CALORIFIC VALUE Hi kcal/kg	RECOVERABLE HEAT	ENERGY RECOVERED HEAT GENERATION AT AN EFFICIENCY OF 65 %	ENERGY RECOVERED OR ELECTRIC POWER GENERATION AT AN EFFICIENCY OF 20 %	TYPE OF OPERATION
HOUSEHOLD REFUSE TRADE AND OFFICE REFUSE COMBUSTIBLE INDUSTRIAL REFUSE	PRIVATE HOUSEHOLDS COMMERCIAL ENTERPRISES AND OFFICES HOSPITALS INSTITUTIONS INDUSTRIES	W 	W 100 W 125 W 160 W 200 W 250 W 315 W 400 W 500	t/h 1.0 1.25 1.6 2.0 2.5 3.15 4.0 5.0	kcal/kg 2400 2400 2400 2400 2400 2400 2400 2400	Gcal/h 2.4 3.0 3.8 4.8 6.0 7.5 9.6 12.0	Gcal/h 1.56 1.95 2.5 3.24 3.9 4.9 6.2 7.8	MW 1.4 1.7 2.2 2.8	CONTINUOUS OR INTERMITTENT
COMBUSTIBLE BUILDING AND CONSTRUCTION REFUSE COMBUSTIBLE GARDEN AND PARK REFUSE	BUILDING AND CONTRACTOR FIRMS GARDEN PLOTS AND PARKS	W 	W 630 W 800 W 1000 W 1250	t/h 6.3 8.0 10.0 12.5	kcal/kg 2400 2400 2400 2400	Gcal/h 15.0 19.2 24.0 30.0	Gcal/h 9.8 12.5 15.6 19.5	MW 3.5 4.4 5.5 6.9	CONTINUOUS OR INTERMITTENT
		SR 	SR 10 SR 12 SR 20 SR 24 SR 30 SR 36	t/h 1.0 1.2 2.0 2.4 3.0 3.6	kcal/kg 2000 2000 2000 2000 2000 2000	Gcal/h 2 2.4 4 4.8 6 7.2	Gcal/h 1.3 1.5 2.6 3.0 3.9 4.6		CONTINUOUS OR INTERMITTENT
		FR 	FR 28 FR 48 FR 68	kg/h 250 500 750	kcal/kg 2400 2400 2400	Mcal/h 600 1200 1800	Mcal/h 390 780 1170		MAXIMUM 16 HOURS PER DAY
		P 	P 50	kg/h 100 50	kcal/kg 2000 4000	Mcal/h 200			MAXIMUM 16 HOURS PER DAY
REFUSE TO BE DESTROYED TO UNIDENTIFIABLE STERILE ASHES FOR EXAMPLE: PATHOLOGICAL REFUSE BIOLOGICAL REFUSE OFFAL COARSE SOLIDS	HOSPITALS, INSTITUTIONS, LABORATORIES SLAUGHTER HOUSES SEWAGE PLANTS	D 	D 10 D 30 D 60 D 100 D 200 D 300 D 500	kg/2 h 20 60 100 200 400 600 1000	kcal/kg 2000 2000 2000 2000 2000 2000 2000	Mcal/h 20 60 200 400 800 1200 2000	Mcal/h 520 780 1300		MAXIMUM 16 HOURS PER DAY

SYSTEM DATA SHEET

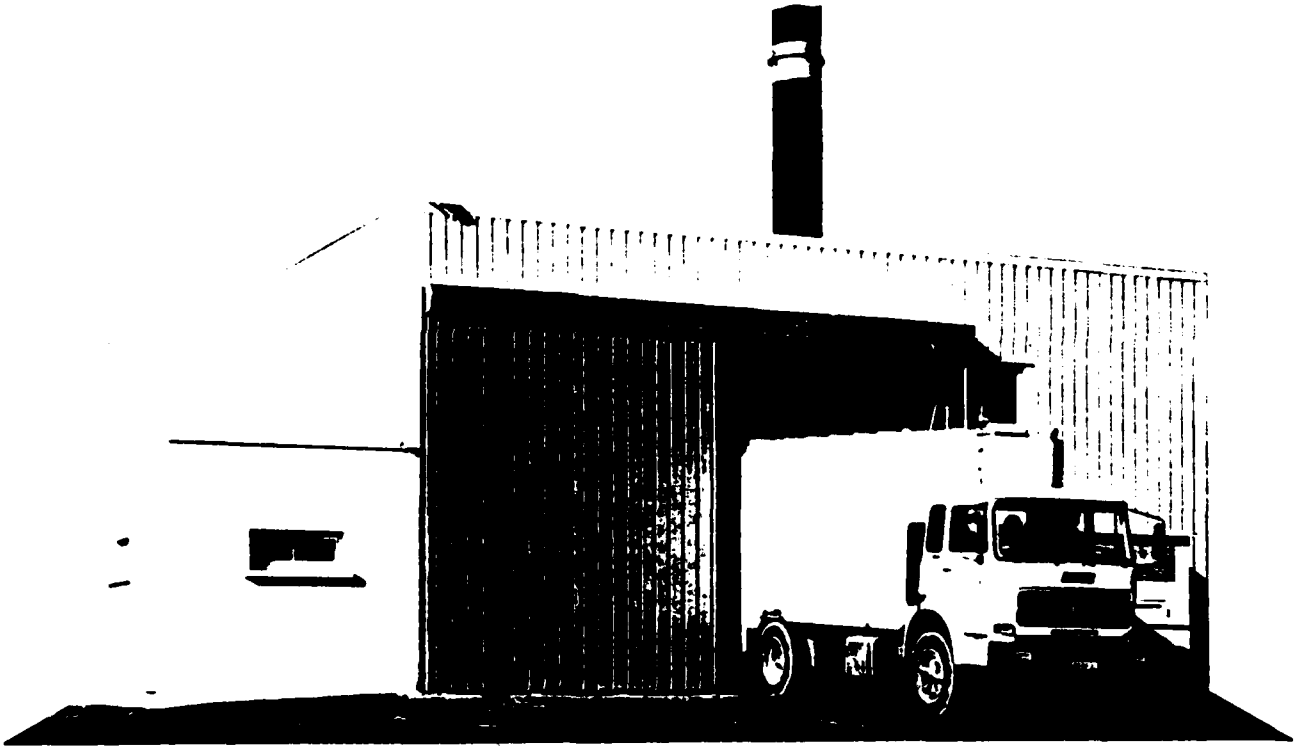
Name:	Cadoux
Address:	7 Rue Galilée/Cadoux-Athador 75116 Paris France Telephone: 723-61-52
U.S. Office:	Cadoux Incorporated 5349 Estate Office Drive, No. 2 Memphis, TN 38119 Telephone: (901) 767-0676
Contact:	Gérard Rateau-Holbach
U.S. Licensee:	None reported
Technology Description:	Cadoux supplies two incinerators of a nominal 1.0- and 1.6 TPH capacity. Both are a refractory lined, inclined grate system. the grates are of refractory steel and are in four segments. Three are inclined at 22 1/2 degrees and oscillate while the fourth is horizontal and rotates 90 degrees for ash/clinker removal. The waste is dried on the first grate section by the counterflow of hot gases. The hot gases then enter a postcombustion chamber with a 3-second retention time to assure complete combustion and to allow the larger particulates to fall out.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	City of Contrexeville City Hall 88-Contrexeville France
Contact:	M. Bidaud, Mayor of the City of Xertigny
Facility listing:	Attached ___Yes___ N/A _____

VENDOR Cadoux

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Sity of Avesnes/Help Country, France	2	1.0		1981	
City of Contrexeville, France	1	1.0		1980	Steam, 200 psig
City of Xertigny, France	1	1.0		1981	
Bauchy & Lagos, Nigeria	3	1.0		1982	
	2	1.6		1979	
Avize, Marne (51)					
Ste Menehould, Marne (51)		1.0		1976	
Cmateau-Chinon, Nivere (58)		1.0		1976	
Mezieres/Oise, Aisnes (02)		1.0		1976	
Mane, Haute Garonne (31)		1.0		1977	
Isle Sur Serein, Yonne (89)		1.0		1977	
Lectoure, Gers (32)		1.0		1978	
Lezignan, Aude (11)		1.0		1979	
Corbigny, Nieure (58)		1.0		1979	
Mont Guyon Charente Maritime (17)		1.0		1979	
Dol De Bretagne, Ille et Villaine (35)		1.0		1979	
Lerain, Vosges (88)		1.0		1979	
Saint-Cére, Lot (46)		1.0		1979	
Figeac, Lot (46)		1.0		1981	
Lezignan, Aude (11)		1.0		1979	

CADOUX
ATHANOR INCINERATORS

The Simplest, Cheapest, Best Waste Disposal with Energy Recovery



Simplest
design

The Cadoux Athanor is small. Designed for use alone or in modular combination, our #900 and #1400 units offer flexibility in operation to meet any changing waste disposal needs.

Cadoux Athanors are self-contained units requiring minimum handling of refuse outside the furnace itself. From truck to ash, one operator can control the entire system.

Cheapest
operation

The Cadoux Athanor needs power *only* to start the furnaces. With normal refuse, the units are capable of autocombustion.

One man can operate two units per shift and maintenance requirements are minimal.

Best
system

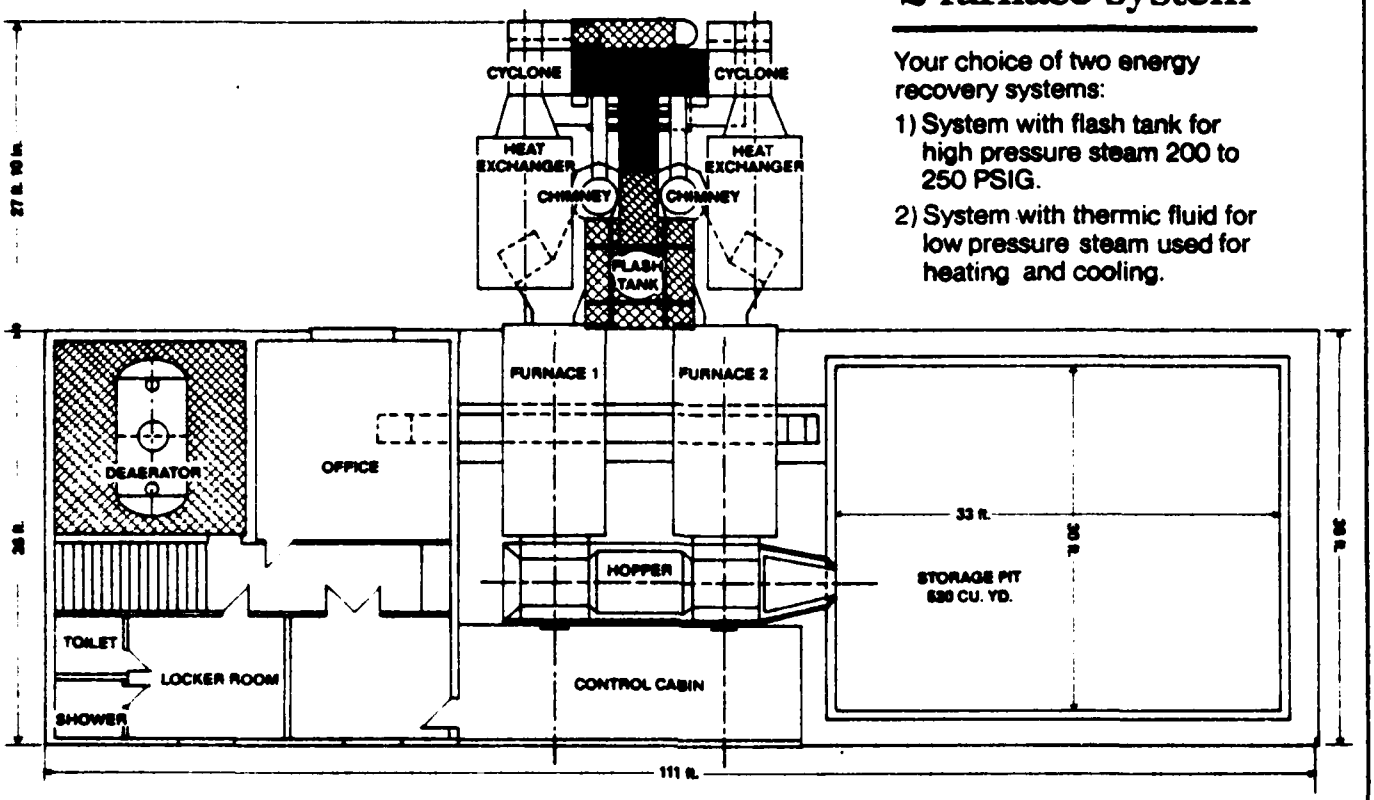
The Cadoux Athanor's unique, clean-burning design easily complies with rigid pollution and environmental standards. Cadoux Athanor Energy Recovery systems generate high quality steam to produce "Free" power.

Worker safety has been carefully designed into the Cadoux system.

Example of a 2 furnace system

Your choice of two energy recovery systems:

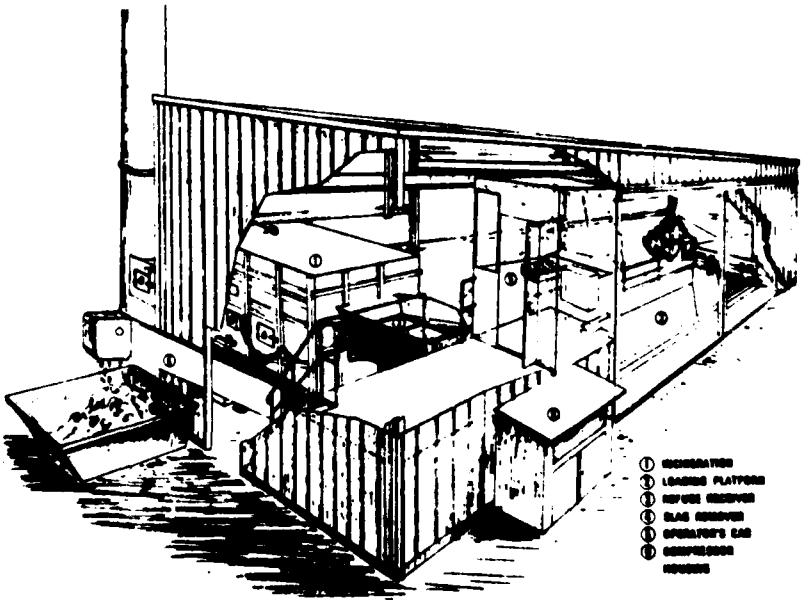
1) System with flash tank for high pressure steam 200 to 250 PSIG.
2) System with thermic fluid for low pressure steam used for heating and cooling.



CADOUX
ATHANOR PERFORMANCE

The Cadoux Athanor #900 processes 1 Ton of waste per hour and can generate 1½ Tons of steam per Ton of waste at 200+ pounds of pressure. Up to 4 Modular units can be used to incinerate from 24 up to 96 Tons per day.

The Cadoux Athanor #1400 processes 1.6 Tons of waste per hour and can generate more than 3.2 Tons of steam. Modular units can be used to range from 38 Tons per day to more than 150 Tons.



For more information, write or call:

CADOUX
Incorporated
5349 Estate Office Drive, #2
Memphis, Tennessee 38119
901/767-0676

PUTTING ON THE GROUND	:	by brush on the rail
Feeding from the long pulley carriage 30 ft.	:	by flexible garland cables
from long bridge-75 ft.	:	" " " "
Electric security control on bridge	:	by stop and start
Rolling road	:	IPN 200 x 98
	:	total length 75 ft.
	:	by 15' span
SECURITY COEFFICIENT	:	arrow interior by 1/600
Paint	:	Primary coat and finishing

PARTICULAR CHARACTERISTICS

- Lorraine pulley equipped with cable pressor or similar
- Portection of all motors by thermic replays
- Clamshell feed by roller fixed to the pulley
- Pulley box with supplementary contact for the clamshell

CHARACTERISTICS OF THE CLAMSHELL

Hydro - electric type with four shells with a capacity of 158 gallons each.

Open diameter 6.5 ft.

Motor power: 6HP at 1,500 rpm

The monorial beam and the grabbing clamshell are operated by push button control located in the control cabin.

7 - THE INCINERATION FURNACE AND ITS ACCESSORIES (DESCRIPTION OF ONE FURNACE)

1 - FEEDING

The feeding system is composed of one waste reception hopper of 475 gallon capacity.

A pusher mounted on friction rollers and transferred by a hydraulic motor, pushes the wastes to the furnace interior. Inside the pusher are two sets of three forks operated by a hydraulic jack which distribute the waste inside the furnace.

II - GRILLS

The furnace is equipped with six rows of inclined grills at 22.5 degrees and with a fourth horizontal row of grills.

The six inclined rows oscillate. This oscillation is controlled by push buttons in the control cabin and with the aid of two hydraulic jacks.

The fourth row or cinder removal row allows for evacuation of the large slag towards a small wagon. This oscillation is controlled manually up to 90 degrees.

All the grills are made of refractory steel.

Primary air is injected at grill level by three casings with multiple air openings to aid combustion.

The usuable surface of the grills is 68 sq. ft. not including the cinder removal grills.

III - 1 COMBUSTION CHAMBER

The furnace is comprised of one combustion chamber 17 cu. yd. with vault and counter vault, this counter vault makes the hot gases coming from combustion pass over the newly introduced wastes and de-hydrates them

The furnace is surrounded by steel sheet metal .2 inches thick with reinforcement profiles. The refractory brick doors allow access to the grills and allow for surveying the combustion process.

2 POST COMBUSTION CHAMBER

The post combustion chamber is completely lined with bricks and refractory concrete and also serves as a dust remover.

This chamber is made up of compartments which make the gases go in different directions brusquely; in the last chamber the gases are held for a time. In this manner the dust settles to the base of the compartments.

Traps regulated manually allow secondary air to gases.

IV - CHIMNEY

The gases leaving the post combustion chamber are forced toward the chimney which is 69 ft. high and made of Corten steel and lined with refractory concerte.

V - INCINERATOR LINING

V-1 COMBUSTION CHAMBER AND POST COMBUSTION CHAMBER

- Refractory brick coating 5.3 in. thick, interlocked sides, 42/44% quality aluminum supercompressed HF (high furnaces).
- Refractory coating 2.4 in thick, insulation in ISOBLOCK 9 concrete, maintained against the casing by steel anchorings 25/20.
- Insulating coating in PYRAL panels, 1.6 in. thick.

The total thickness of the lining is 9.3 in.

V-2 DOOR LINTELS

Made of refractory concrete STRONG MIX 140 cast on steel anchorings 25/20.

V-3 VAULT ABOVE THE FURNACE

Made of squares and wedges 9.06 in. thick, MU 42 HG quality with AP8 brick insulation 2.4 in thick and vermiculite concrete.

V-4 COUNTER VAULT

Made of squares 230 x 230 67/59, - S - 60 quality (58% aluminum).

V-5 CHIMNEY

Lined with refractory concrete KAST-O-LITE insulation, 3.15 in. thickness for the entire height cast on steel anchorings 25/20.

The total weight of the lining is around 40 tons.

VI - CINDER REMOVAL

The cinders are recovered in the inferior part of the combustion chamber by continuous wet process.

The cinder remover is comprised of a tank full of water where the cinders are extinguished, the extinguished cinders are extracted by a chain of scrapers, DVHR quality made of treated steel 350/400 Brinnel, thread 0.7" pitch 2.36" with rupture resistance of 30 tons. This chain is operated by a moto-reductor group of CV with coupler provided with fusible plus and reducing gear in mesh in oil bath splash.

- Inside width 27.6 in or 2.3 ft.
- Unevenness 4.6 ft.
- Jetty level 5.74 ft.
- Speed 1.2 ft./mn
- Motor-reducer power 2 HP

VII - MEASURING DEVICE - CONTROL AND REGULATION

Our furnaces are equipped with a temperature regulator hooked up to a thermo-electric couple in the combustion chamber.

This regulator, placed near the operator, allows for surveying the combustion and allows for the automatic starting and stopping. A temperature register allows for the continuous measuring of the furnace and post-combustion temperatures.

VIII - EQUIPMENT

Hydraulic power generator for the jacks and hydraulic motor.

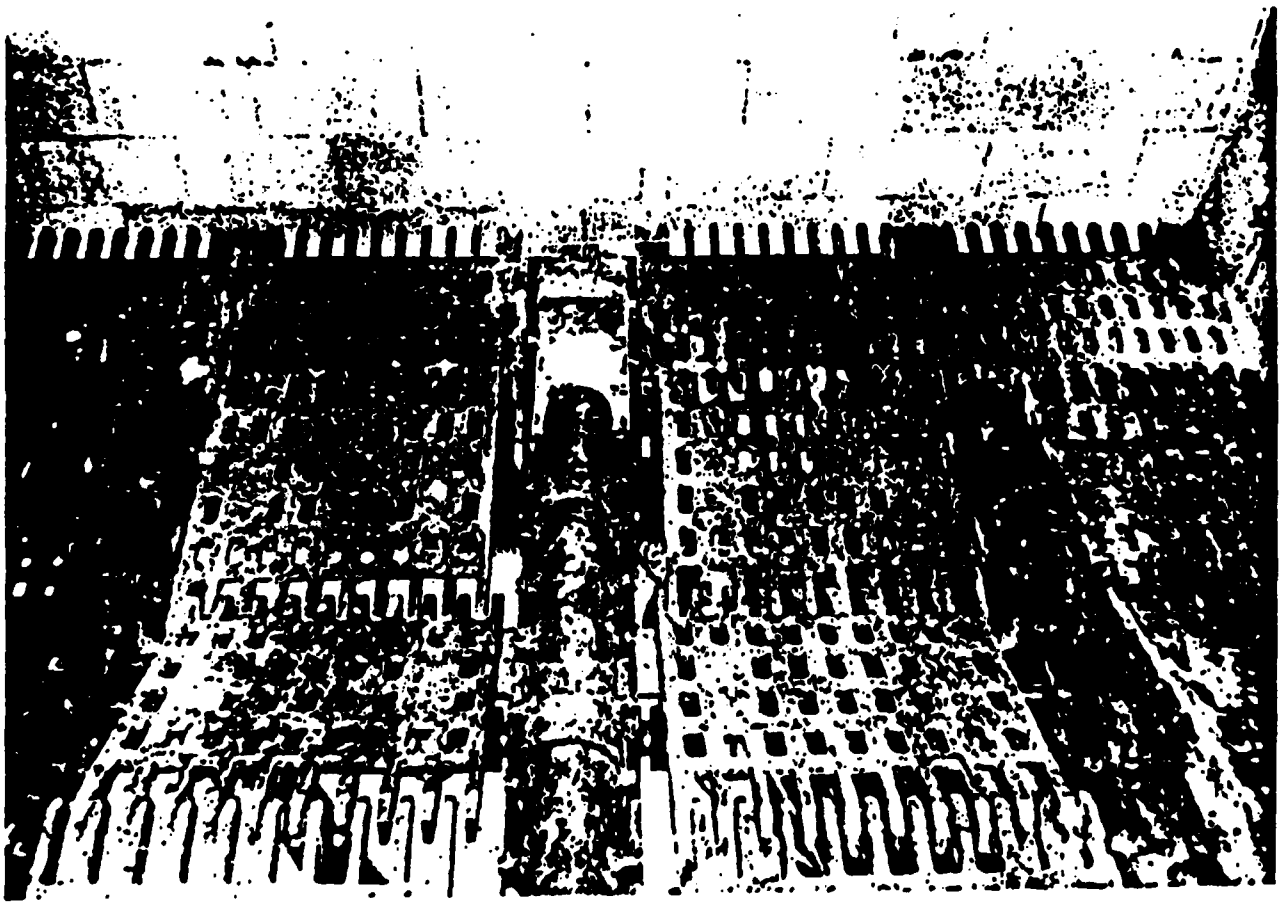
Output	12 gal.
Pressure	100 atm.
Service pressure	90 atm.
Motor	12 HP at 1,500 rpm
Hydraulic rolled pusher motor	21 CU. IN. / prm
Rotation speed	14.5 rpm
2080 IN. LB couple	under 50 atm.

PRIMARY AIR VENTILATOR

A steel air ventilator with support and ensemble comprising:

Output	2,615 yd./hr
Total pressure	12 in. WC at 68 F degrees C
Rotation speed	3,000 rpm

INSIDE THE COMBUSTION CHAMBER



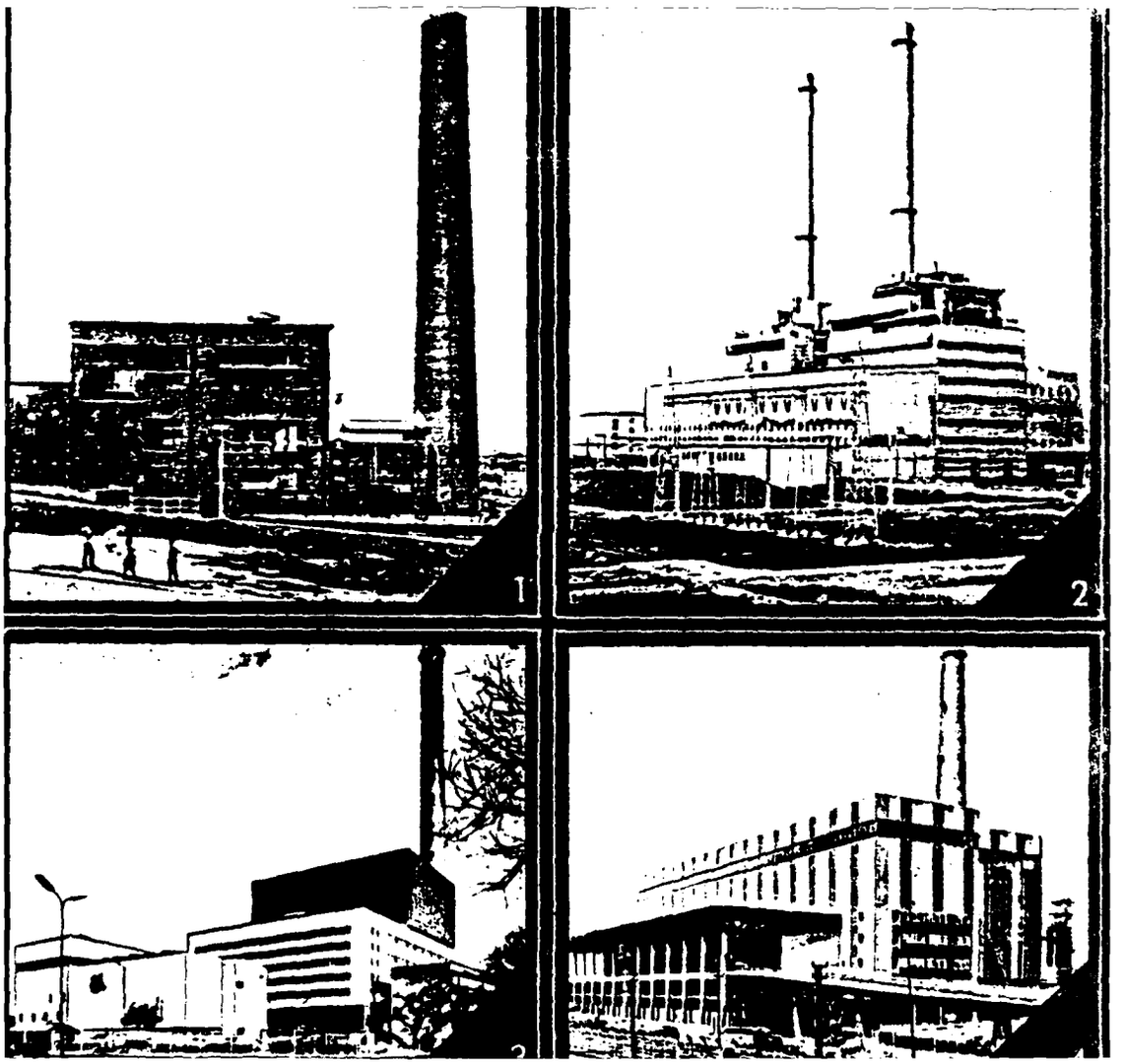
View of the grates and casings

SYSTEM DATA SHEET

Name:	Josef Martin Feuerungsban GMBH
Address:	Post Office Box 401229 8000 Munchen 40 Federal Republic of Germany
U.S. Office:	None reported
U.S. Licensee:	UOP, Inc. Environmental Systems Group 40 UOP Plaza Algonquin and Mt. Prospect Roads Des Plaines, IL 60016
Technology Description:	Inclined grate and reverse action of rockers causes refuse to roll up and over rather than down and over. The alloy grate lasts many years. A second grate system feeds the waste from the feed hopper into the furnace.
Recommended facility:	Zermott, Switzerland
Contact:	UOP Limmattal, Switzerland
Contact:	UOP
Facility listing:	Attached ___Yes___ N/A _____

VENDOR Jopsef Martin

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Zermott, Switzerland	1	1.84	44	1964	None
Limmattal, Switzerland	2	2.54	121	1971	Steam
Kirchber, Switzerland	2	3.5		1976	Steam



odourless and meet the most stringent emission standards.

The well burnt-out combustion residue yields scrap metal and is a valuable material for road construction and similar civil works applications.

Essential features of MARTIN plants:

Best possible clinker burn-out (less than 5% carbon and less than 0.2% putrescible matter)

High operational availability

Long periods of continuous operation between maintenance shutdowns

Low-wear, easy-to-maintain equipment

Low operating personnel cost

High energy recovery, through high efficiency and low in-plant consumption

Minimum water consumption

Gas and dust emissions in keeping with statutory requirements

Central control room for the whole plant

No neighbourhood nuisance as all parts of equipment are enclosed in buildings

Compact layout, which means low construction cost and minimum land requirement

Pleasant architectural design and attractive plant landscaping to harmonize with city skyline.

The vehicles dump the refuse into the storage pit without any previous sorting or shredding except for bulky material. Overhead cranes transfer the refuse from the pit into the furnace feed hopper and a ram-type feeder moves it onto the Martin Stoker.

The MARTIN "Reverse-Acting" Stoker grate is inclined downward from the feed end towards the clinker discharge end and comprises alternately fixed and moving steps of grate bars. The activated steps move slowly counter to the downhill refuse movement, thus the fuel bed is constantly agitated and again leveled out while glowing mass is pushed back from the main burning area towards the front end of the grate. The different phases of combustion i. e. drying, volatilization, ignition, and burn-out thus take place at the same time.

The MARTIN Stoker is subdivided lengthwise into several compartments to which undergrate air is admitted.

The grate bars consist of a wear and heat resisting high-chrome steel alloy. Undergrate air entering the grate bars passes through the air slot (less than 2 mm wide) between adjacent bars into the fuel bed.

Above the main burning zone, the combustion gases (about 900/1000 °C) are turbulated by air jets.

The burned-out residue travels slowly down the grate. After reaching the grate end, a slowly rotating clinker roll seizes the residue and dumps it into the MARTIN Ash Discharger where it is quenched.

MARTIN Stoker grate

View on grateruns of Martin Stoker in Munich-North Plant

SYSTEM DATA SHEET

Name:	Lurgi Umwelt und Chemotechnik GMBH
Address:	Bereich Awalu Gervinusstrabe 17/19 D-6000 Frankfurt am Main Federal Republic of Germany Telephone: [06 11] 1571
U.S. Office:	Lurgi Corporation 666 Kinderkamack Road River Edge, NJ 07661 Telephone: (201) 967-4914
Contact:	Mr. John Vetter
U.S. Licensee:	None reported
Technology Description:	Specialty technology. Fluidized bed and rotary kiln technologies for industrial solid and liquid waste. Applicability for this program is marginal.

VENDOR Lurgi

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Bucach, Switzerland	2	2.25	108	1969	Sludge drying

LURGI:
an engineering group originating from the Metallurgische Gesellschaft AG (founded in 1897) and a subsidiary of the Metallgesellschaft AG Group.

Lurgi Chemie und Hüttentechnik GmbH
Divisions: Inorganic Chemistry · Ferrous Metallurgy · Non-ferrous Metallurgy.

Lurgi Kohle und Mineralöltechnik GmbH
Divisions: Coal Technology · Gas Technology · Petroleum Refining · Petrochemistry · Fiber Technology.

Lurgi Umwelt und Chemotechnik GmbH
Divisions: Dust Collection and Emission Control · Waste Gas, Water, Air · Thermal Processes · Cellulose and Biotechnology · »Gotek« (Surface Coating) · Workshops.

Organization Abroad:
Subsidiaries in Amsterdam, Bruxelles, Johannesburg, London, Madrid, Melbourne, Mexico D.F., Milano, New Delhi, New York, Paris, Rio de Janeiro, Stockholm, Toronto, Wien, Zürich;

Branch Offices in Tehran, Tokyo;

Representations
in Caracas, Kuwait, Manila, Moscow, Riyadh.

Agents in more than 40 countries.

Services:
Design, supply and construction of turnkey plants, individual units or equipment based on Lurgi processes, licensed or standard processes, erection and start-up of plants including proof of fulfilment of guarantees, development and licensing of processes and equipment.

Lurgi itself is not a manufacturer of machinery and equipment and selects the most appropriate suppliers in Germany and abroad for each individual project.

Applications

The Lurgi rotary kiln is suitable for the incineration of

Liquid Wastes:
• thickened sludge from mechanical, biological and chemical waste water treatment plants, • waste oil, • emulsions, • toxic waste water, acids and alkaline solutions, • chlorinated hydrocarbons, • still bottoms, • waste water containing organic substances and salts.

Pasty Wastes:
(with solids content from 15 to 50 %)

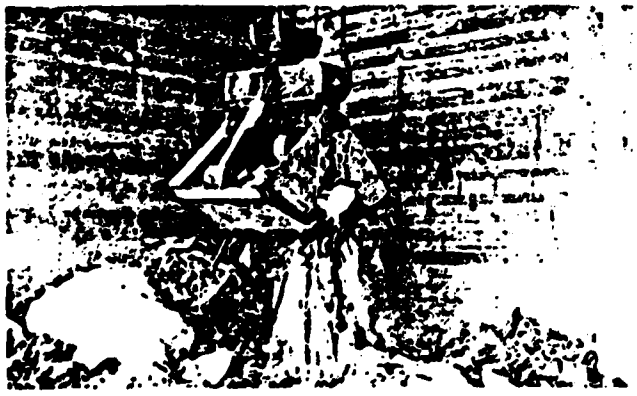
• dewatered sewage sludge, oily sludge, sludge from neutralisation plants, abrasive slurries, • hydroxide and acid sludge, sludge from hardening and galvanizing plants, • tank cleaning sludge, • colour and varnish residues, fats, resins, bitumen.

Solid Wastes:

• packing material, polymer wastes, wood, textiles, • metal and plastic barrels, • wastes from laboratories and production units, • municipal refuse, waste from canteens, • rubber and tyres, • contaminated soil. filter cakes, • hospital wastes.

Gaseous combustibles

• in exhaust air from production and storage rooms, • in vent gases from tanks and liquid handling plants, • in vent gases from production units.



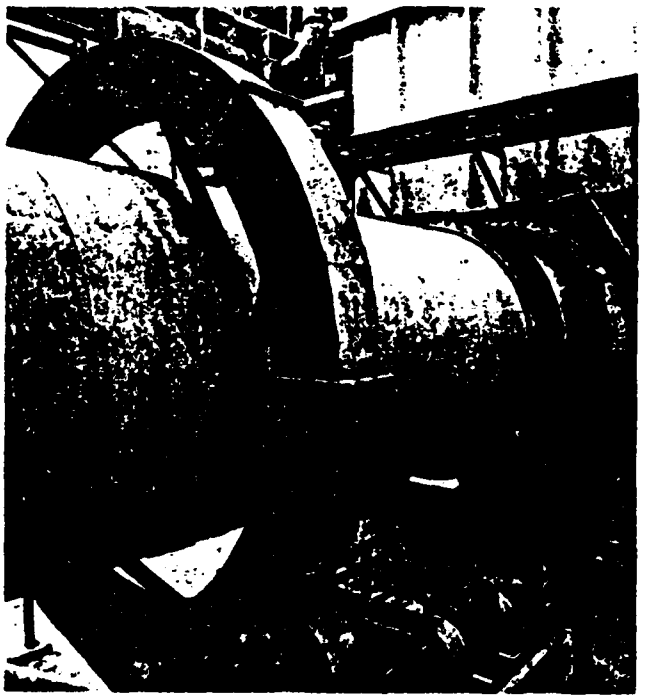
The Lurgi rotary kiln can, of course, also incinerate mixtures of solid, pasty and liquid wastes. The products are

• ash and residue suitable for landfill, • flue gas meeting the respective emission standards, • steam, hot water and electrical energy, if required.

◁ Mullbeschickung Refuse handling

Process and Design

The design of the Lurgi rotary kiln for waste incineration is based upon numerous rotary kiln systems which have been developed by Lurgi since the turn of the century, i.e. for roasting of sulphide ores, magnetizing roasting of iron ores, the Waelz processes of the non-ferrous metallurgy, direct reduction of iron ore and many other fields of application. The kilns operate continuously with co-current flow of solids and gas; control of the plant is largely automatic. In endothermic processes, the air is pre-heated by hot flue gases or by



steam from the waste heat boiler, which results in low consumption of supplementary fuels (such as gas, fuel, oil, etc.). The heat of the flue gas is used to generate saturated steam, superheated steam or hot water.

The incineration temperature depends upon the type of waste and its heat of combustion. Owing to the rotary motion of the kiln, the waste is thoroughly mixed and complete incineration is achieved so that the legal standards for ash and flue gas are always met.

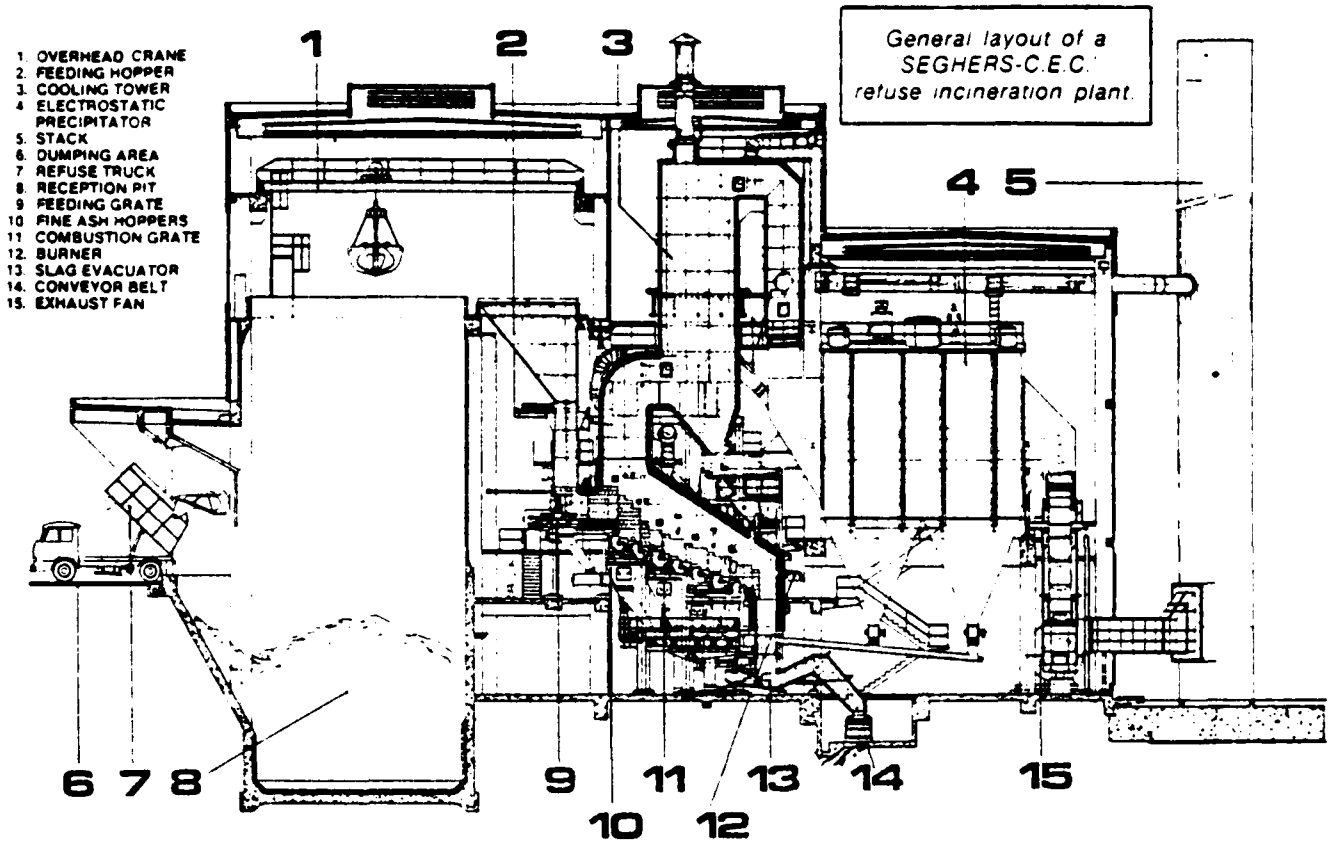
The selection of equipment and the configuration of the complete plant depend upon the type and ratio of waste to be incinerated, above all upon its mechanical, thermal and chemical properties. The rotary kiln, for example, is complemented by special combustion chambers where high percentages of liquid wastes are handled, and fluidized bed incinerators are installed additionally for disposing of larger quantities of dewatered sludge. Such combined systems offer an advantage in that sludge drying and sludge incineration as well as the treatment of the different flue gas streams are considerably simpler and, thus, more economic. Flue gases can be treated by means of various dry or wet cleaning processes, including scrubber effluent treatment as well as dewatering of the resulting sludge.

SYSTEM DATA SHEET

Name:	Seghers Engineering
Address:	Venevestraat 10, Box 14 B 1140 Brussels, Belgium
Contact:	Mr. Alain Sommers
U.S. Office:	None reported
U.S. Licensee:	Katy Seghers Incinco System Division of Fulton Iron Works Co. 3844 Walsh Street St. Louis, MO 63116
Contact:	Mr. Arthur H. Beckman, P.E.
Technology Description:	The Seghers incineration system used a field erected, refractory lined, grate technology. Heat recovery is accomplished through a waste heat boiler that relies primarily on convective heat transfer. The combustion of the waste takes place on inclined (21 degrees) grates that employ a combined sliding and lifting action. The control of the grates is by hydraulics, and the movement can be varied to reflect both feed rate and Btu content. Combustion is excess air with control for both underfire and overfire air. Ash is ejected by an extractor. There is no drag chain. There is a large refractory lined chamber to balance the heat load to the boiler. The refractory walls are air cooled.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	Cridor S. A. 30 Rue du Collège La Chaux de Fonds Switzerland
Contact:	Mr. Stoucky, Manager SECIP Rue Edouard Belin, 9 25000 Besancon, France
Contact:	Mr. Aizepitarte, Manager
Facility listing:	Attached ___Yes___ N/A _____
Other:	The technology used by Seghers was purchased from Carbonisation Enterprise et Ceramique (CEC) of France.

VENDOR Seghers Engineering

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Belforte, France	2	2	96	1937	
Le Plessir Robinson, France	1	1.5	36	1965	
Besancon, France	2	2.1	100	1971	Steam, 368 psig, 482°F
Lokeren, Belgium	2	1.8	100	1971	None
La Chaux de Fonds, Switzerland	2	3	144	1972	Steam/electricity, 680°F
Arcachon, France	2	3.6	173	1974	None
Besancon, France	2	3	72	1974	Steam, 368 psig, 482°F



General layout of a SEGHERS-C.E.C. refuse incineration plant.

SEGHERS-C E C INCINERATION SYSTEM OF DOMESTIC REFUSE

INCINERATION = elimination of solid waste.

Various techniques are used for treating domestic refuse incineration is however the most common process in treating solid wastes for various reasons

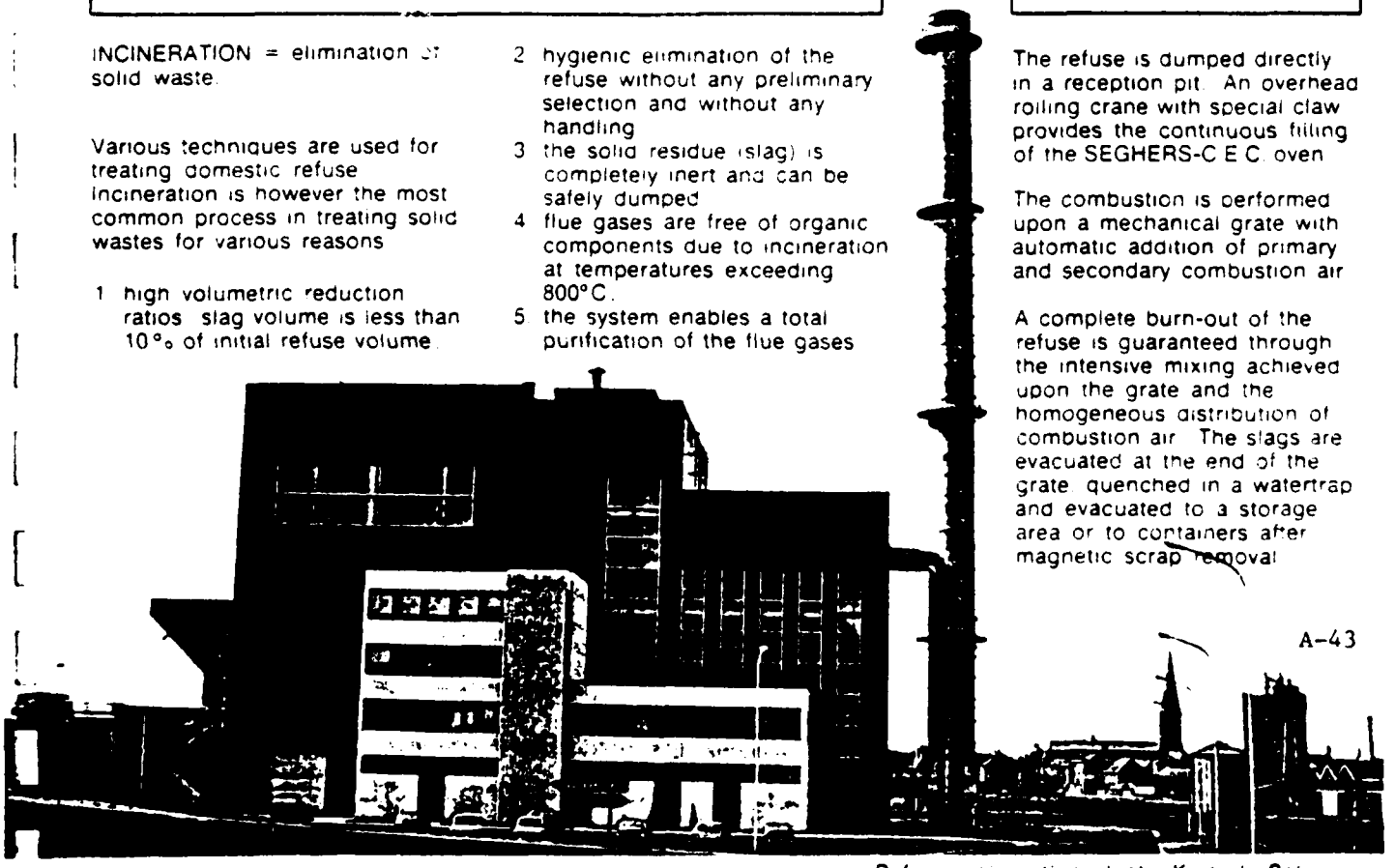
1 high volumetric reduction ratios slag volume is less than 10 % of initial refuse volume
2 hygienic elimination of the refuse without any preliminary selection and without any handling
3 the solid residue (slag) is completely inert and can be safely dumped
4 flue gases are free of organic components due to incineration at temperatures exceeding 800°C.
5 the system enables a total purification of the flue gases

BASIC LAYOUT

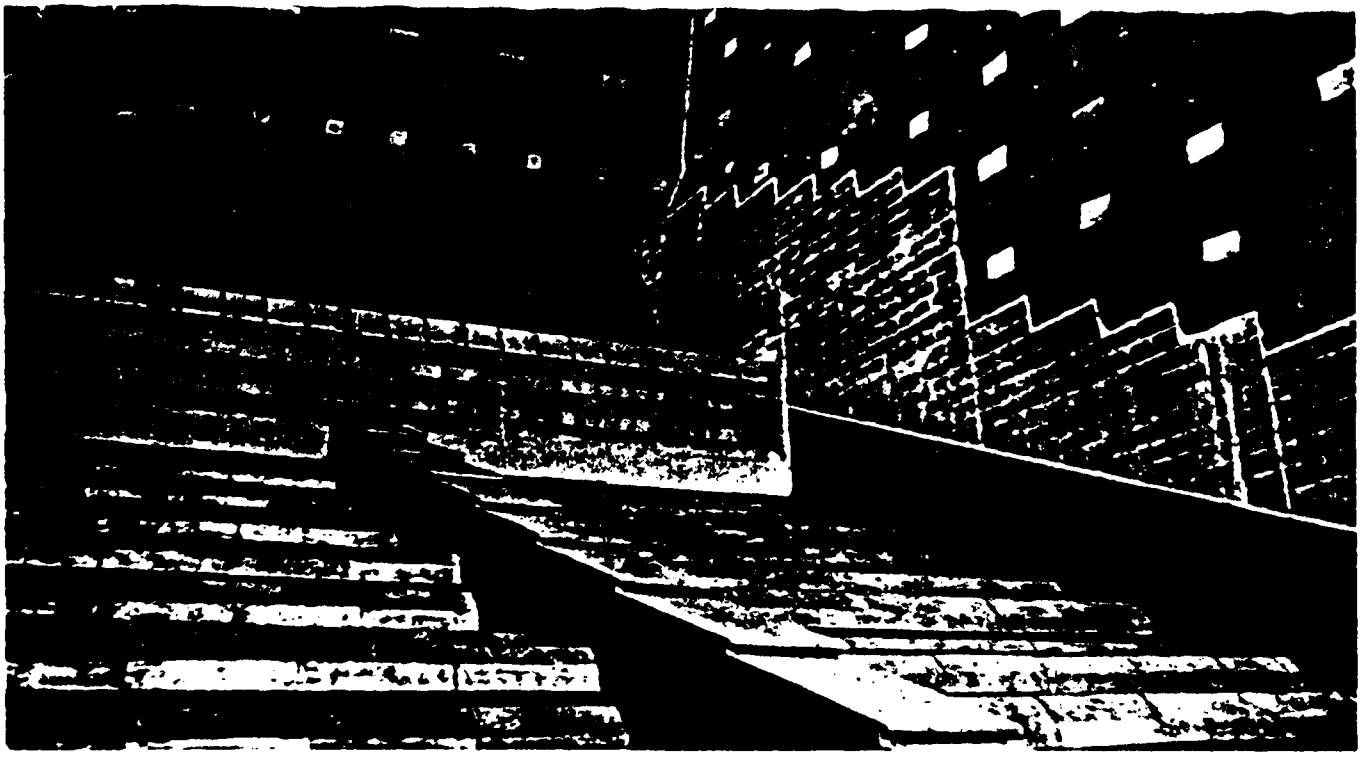
The refuse is dumped directly in a reception pit. An overhead rolling crane with special claw provides the continuous filling of the SEGHERS-C E C. oven

The combustion is performed upon a mechanical grate with automatic addition of primary and secondary combustion air

A complete burn-out of the refuse is guaranteed through the intensive mixing achieved upon the grate and the homogeneous distribution of combustion air. The slags are evacuated at the end of the grate quenched in a watertrap and evacuated to a storage area or to containers after magnetic scrap removal



Refuse incineration plant - Kortrijk, Belgium.



Inside view of the oven

The mechanical combustion grate of the SEGHERS-C E C -system is perfectly adapted to the special requirements of refuse burnout. It consists of several identical elements. Each element consists of:

— two fixed sections

— two sliding sections

— two lifting sections.

The sections are composed of graterods, separated by a narrow gap only, thus reducing sifting of ashes to a minimum. Each section covers the whole width of the oven.

An automatic hydraulic system actions the grate. The grate is inclined at 21°. High quality refractory steel is used as grate material.

The durability of the 'SEGHERS-C.E.C. system' grate is guaranteed through its special construction.

— the efficient cooling of the various grate elements by the combustion air;
— the lack of any relative motion of adjacent graterods;
— the cleaning of the upper part of the moving grate parts by a rake mechanism of nodular graphite cast iron.
— the use of high quality materials and the severe quality control

The various motion sequences of sliding and lifting sectors are set in the control room via a special programmer. In doing so, any type of refuse, domestic or mixed-industrial, can be incinerated in conditions of optimum cycle duration and burn-out.

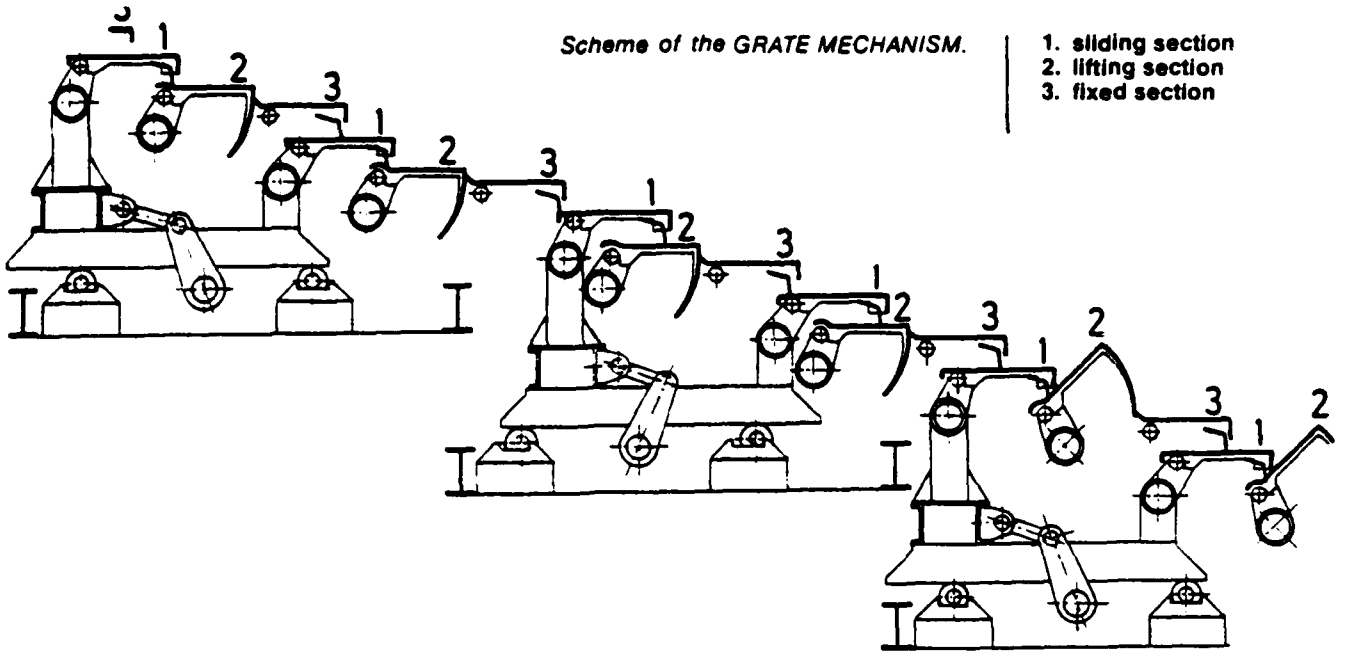
Grate motion and quantity of combustion air are regulated separately per grate element, thus yielding a supplementary guarantee for COMPLETE BURN-OUT in the SEGHERS-C E C system.

Feeding the oven by means of a special claw.

◀

▶

Detail of the combustion grate - various elements.



Scheme of the GRATE MECHANISM.

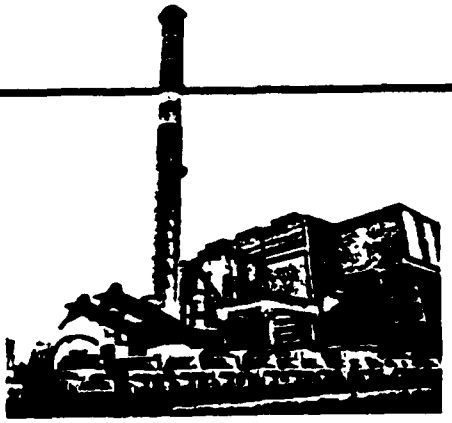
1. sliding section
2. lifting section
3. fixed section

The flue gases leave the oven at approx 1000°C. If no heat recovery is required, the flue gases are water quenched to such a temperature (approx 250°C) that efficient flue gas purification can be performed. Either electrostatic precipitators (98 % yield minimum) or gas scrubbers are used. In wet scrubbing, a major reduction in harmfull gaseous components, such as chlorine and sulphuric compounds, is achieved. The flue gases are thereafter evacuated through the stack.

The extended control equipment and the total automation of the SEGHERS-C.E.C. system guarantee a safe exploitation.

THE SEGHERS-C.E.C. SYSTEM OVEN AND COMBUSTION GRATE.

The refuse is extracted from the feeding chute by the extraction grate which regulates the flow of the refuse. Firstly, the refuse is dried on a support of refractory bricks (high alumina content) by the radiation of the ceiling and the countercurrent stream of the hot flue gases. Thereafter, the dried refuse is spread over the combustion grate where combustion starts.



Supply of the refuse to the incineration plant.

Refuse reception in the reception pit.

LA CHAUX DE FONDS

a. **Location:** La Chaux de Fonds, Switzerland

b. **Contracting Parties:** C.E.C.

c. **Name of Plant Owner:** Cridor S.A.

d. **Name of Site Owner:** Ville de La Chaux de Fonds

e. **Name of Client's Person to Contact:**

Mr. Stouky
30 Rue Du College
La Chaux de Fonds, Switzerland
Telephone: (3g) 21.11.05

f. **Operational Date of Plant:** May, 1974

g. **Description of Process:** Incineration of domestic refuse with energy recovery

h. **Redundancy of Process Equipment:** 100%

i. **Disposal capability of plant (tons/day):** 144 TPD
   1. Design capacity: 2 x 72
   2. Highest recorded to date (one week base period): 144 TPD
   3. Average: 72 TPD (One oven stand-by)

j **Operating Level of plant:** 72 TPD

k. **Waste source (residential, commercial, industrial, other):** Residential - Commercial - Waste Oils

l. **Percentage of the waste stream in the area being served which is processed by the system:** 100%

m. **Percentage of incoming waste stream ultimately placed in the landfill:** None-Inert slags 10% by vol., 20-25% by wt.

n. **Recycled materials: Process used to recover product, quantity recovered, percent efficiency of each operation, and price received:**

None

o. **Sale of energy, type and quantity of energy recovered, customer for energy, length of contract, and price paid for energy.**

Waste heat boilers—39 ATM—360°C—680°F
Electricity Production (6.087 Mwh in 1978) $195,445.65
Distant Heating = (4156 G Cal.) $116,713.90
Connected to public network
Operated by city of La Chaux de Fonds
(Refuse Plant—Electricity and Distant Heating)

p. **Required compliance with all pollution control laws:**

150 MB/Nm^3
in compliance with
Swiss air pollution
regulations

BESANCON

a. **Location:** Besancon. Rue Edouard Belin. (25000) France

b. **Contracting Parties:** City of Besancon

c. **Name of Plant Owner:** City of Besancon

d. **Name of Site Owner:** City of Besancon

e. **Name of Client's Person to Contact:**
Mr. R. Schwindt
Senateur-Marie
Mairie de Besancon
Telephone: (81) 81.80.12

f. **Operational Date of Plant:** 1971

g. **Description of Process:** Incineration of domestic refuse with energy recovery.

h. **Redundancy of Process Equipment:** 2 x 2,1 TPH
1 x 3,0 TPH (1974)

i. **Disposal capability of plant (tons/day):**
1. Design capacity: 172 TPD
2. Highest recorded to date (one week base period): 185 TPD
3. Average: 110 TPD

j **Operating Level of plant:** 172 TPD

k. **Waste source (residential, commercial, industrial, other):**
Residential + Commercial Waste

l. **Percentage of the waste stream in the area being served which is processed by the system:** 100%

m. **Percentage of incoming waste stream ultimately placed in the landfill:** Fresh Waste = 0%, Slag = 25%

n. **Recycled materials: Process used to recover product, quantity recovered, percent efficiency of each operation, and price received:**
No recycling.

o. **Sale of energy, type and quantity of energy recovered, customer for energy, length of contract, and price paid for energy:**
Waste heat boilers—25 ATM—250°C—482°F
Connected to distant heating network of Besancon (Zup-La Planoise)
Owned by City of Besancon
Note: Refuse plant is operated by private firm (Cofreth) with a long term contract.

p. **Required compliance with all pollution control laws:**
150 Mg/Nm^3
In compliance with
French air pollution
regulations

SYSTEM DATA SHEET

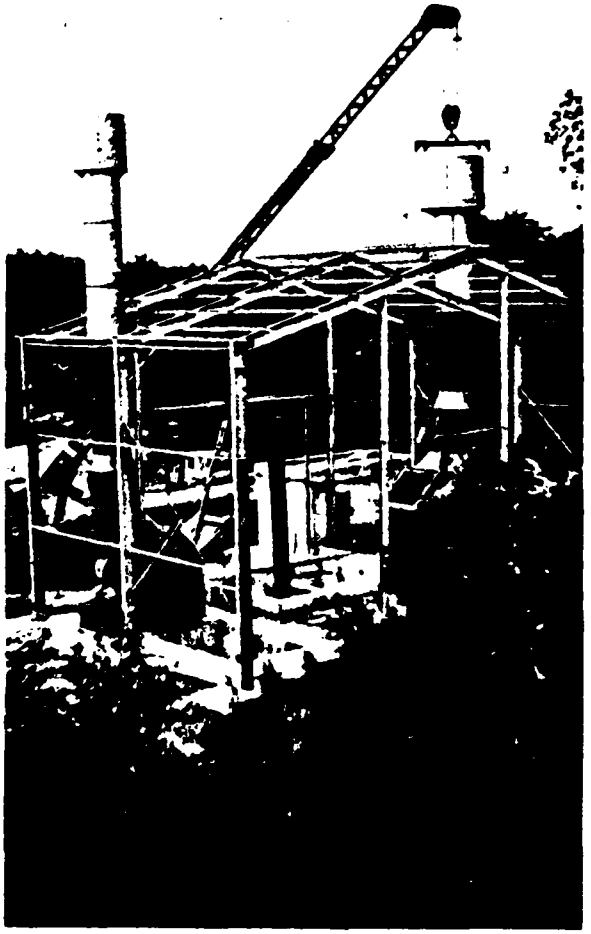
Name:	Sigoure Freres S. A.
Address:	Z. I. Riorges 42309 Roanne, France Telephone: 77-71-67-63 Telex: 380-400
Contact:	Mr. Claude Maille
U.S. Office:	1735 I N.W., Suite 501 Washington, DC 20006 Telephone: (202) 331-1850
Contact:	Mr. Paul Sumerall
U.S. Licensee:	Town Services P.O. Box 9577 Jackson, MS Telephone: (601) 362-4110
Contact:	Mr. Doug Shankas
Technology Description:	Horizontal rotary combustor with 20 degrees of rotation every 10 minutes (adjustable). Modulated air to rotary chamber at ten locations. Secondary chamber. Fire-tube boiler. Crane fed through chute on top of chamber. Water seal. Rack and pinion chain for residue removal. Technology available for 9 years in France.
Brochure:	Attached _____ N/A ___X___
Recommended facility:	Millas, France 50 TPD, 1 unit 150 psi steam 1980
Facility listing:	Attached _____ N/A ___X___
Other:	Negotiation with Pascagoula, Mississippi, for full service of 150-TPD system. Engineer for Pascagoula has visited plants in France and has operating and maintenance data. More data should be available after the contract is finalized in Mississippi.

VENDOR Sigoure Freres S. A.

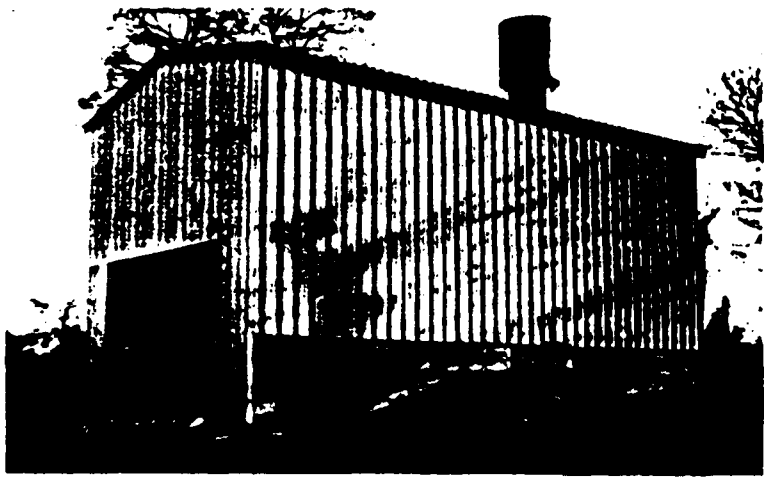
Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Millas, France	1	2	50	1980	Steam

réalisations d'usines

Ejemplos de plantas incineradoras

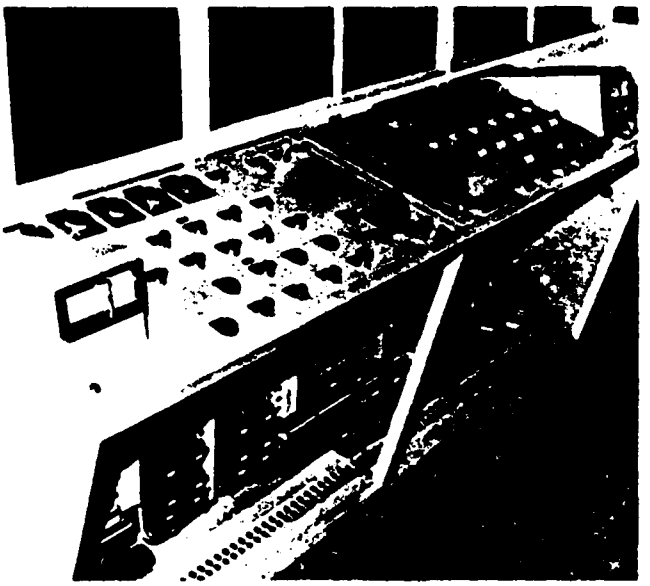


- Capacité 1 000 kg/h, implantée en pleine nature
- *Capacity 1 000 kg/h erected in the country*
- Capacidad 1000 kg/h, situada en plena naturaleza



- Engennering assuré par nos soins - conception économique
- *Engineering realised by ourselves - Economical design*
- Ingeniería propia - diseño económico

- Pupitre de commandes centralisé
- *Control cabinet with all controls*
- Pupitre central de mandos



- Chargement du four avec grappin
- *Loading incinerator with a grab*
- Carga del incinerador con cuchara de mandíbulas

nomenclature

1 - Cheminée
Chimney
Kamin

2 - Eléments de voute
Arch Element
Gewölbeteile

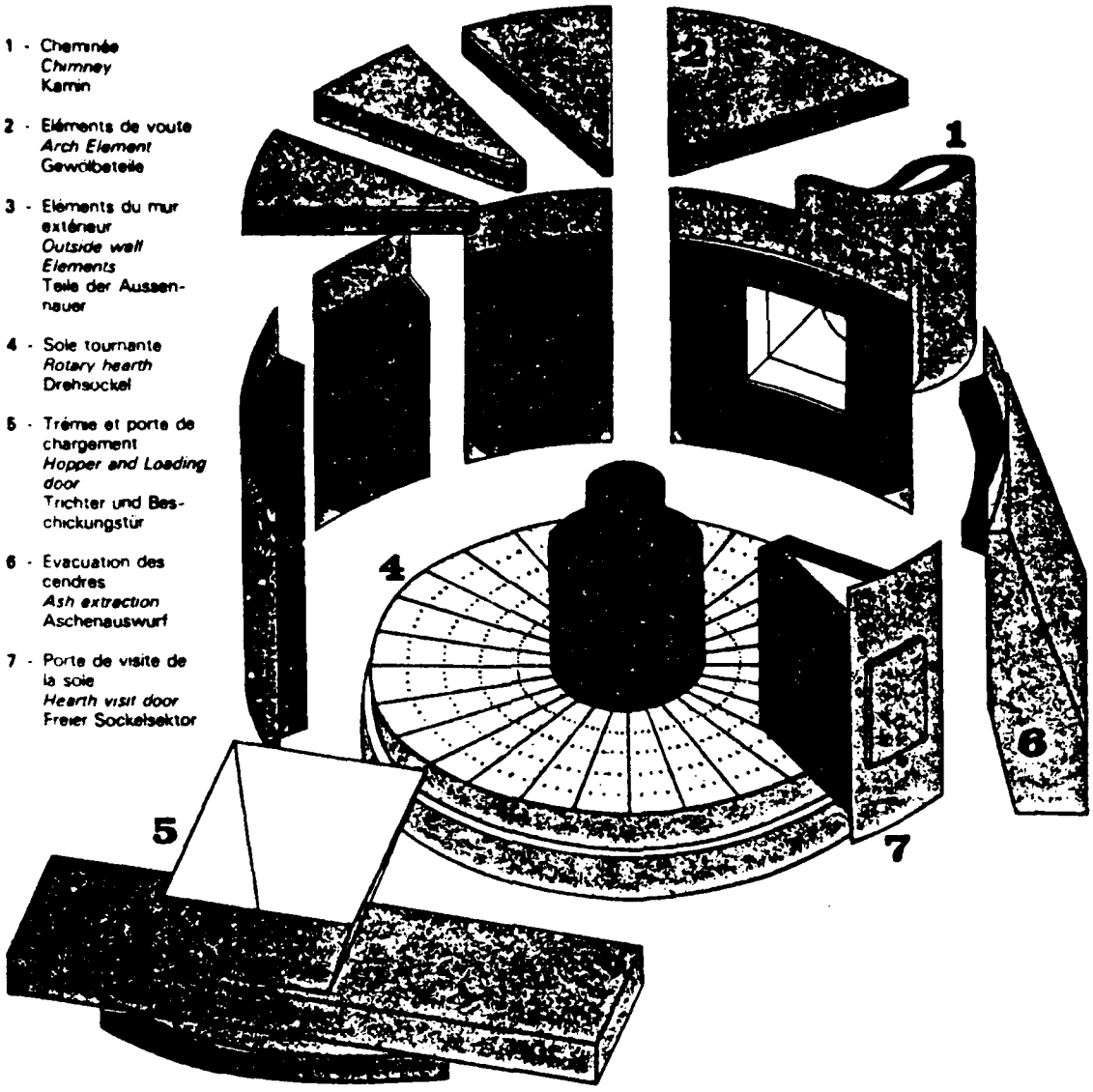
3 - Eléments du mur extérieur
Outside wall Elements
Teile der Aussennauer

4 - Sole tournante
Rotary hearth
Drehsockel

5 - Trémie et porte de chargement
Hopper and Loading door
Trichter und Beschickungstür

6 - Evacuation des cendres
Ash extraction
Aschenauswurf

7 - Porte de visite de la sole
Hearth visit door
Freier Sockelsektor

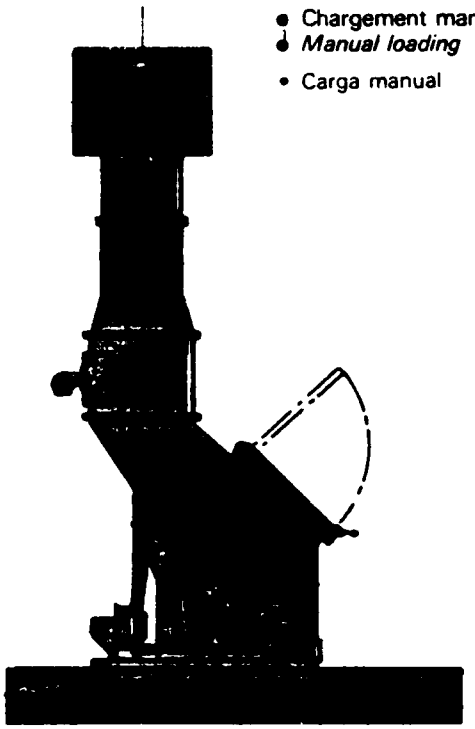


TYPES	25-12	27-15	35-15	45-15	55-16
CAPACITES - T/HEURE	0.9	1.5	2	2.6	3.3

Système d'entraînement de la sole
Hearth command mecanism
Maschinenantrieb der Sohle

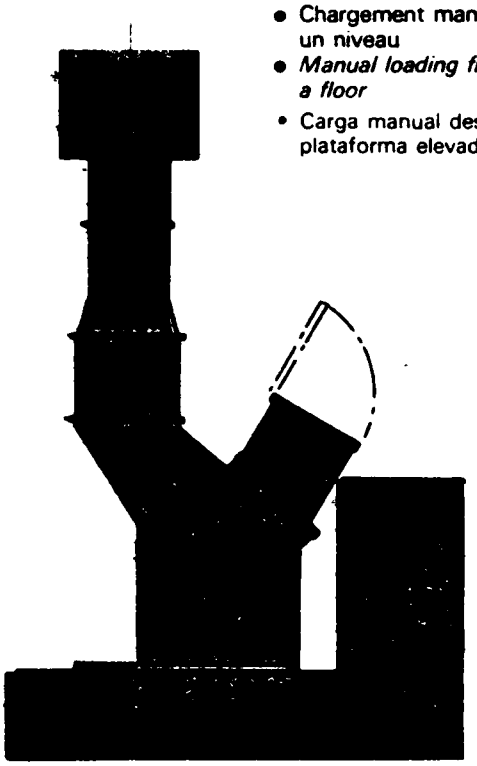
différents types d'installations
various installations
Tipos diversos de instalaciones

1



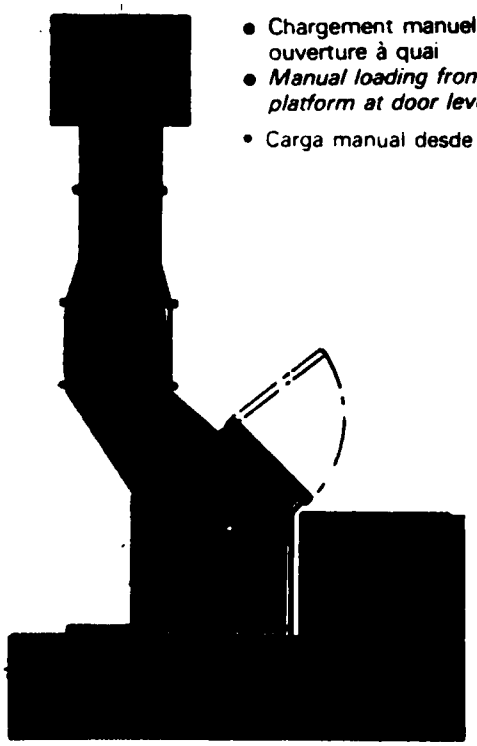
- Chargement manuel
- *Manual loading*
- Carga manual

2



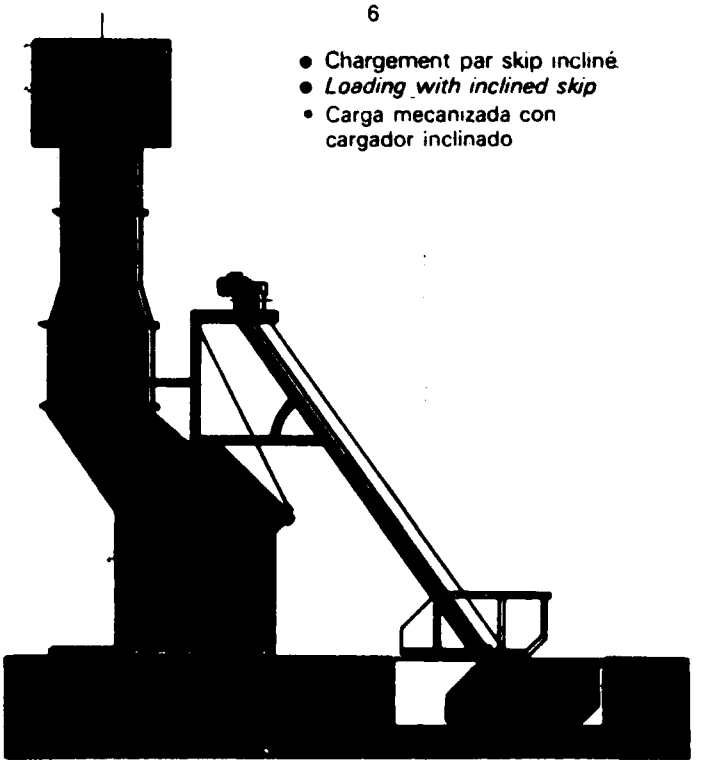
- Chargement manuel depuis un niveau
- *Manual loading from a floor*
- Carga manual desde plataforma elevada

5



- Chargement manuel avec ouverture à quai
- *Manual loading from a platform at door level*
- Carga manual desde muelle

6



- Chargement par skip incliné
- *Loading with inclined skip*
- Carga mecanizada con cargador inclinado

SYSTEM DATA SHEET

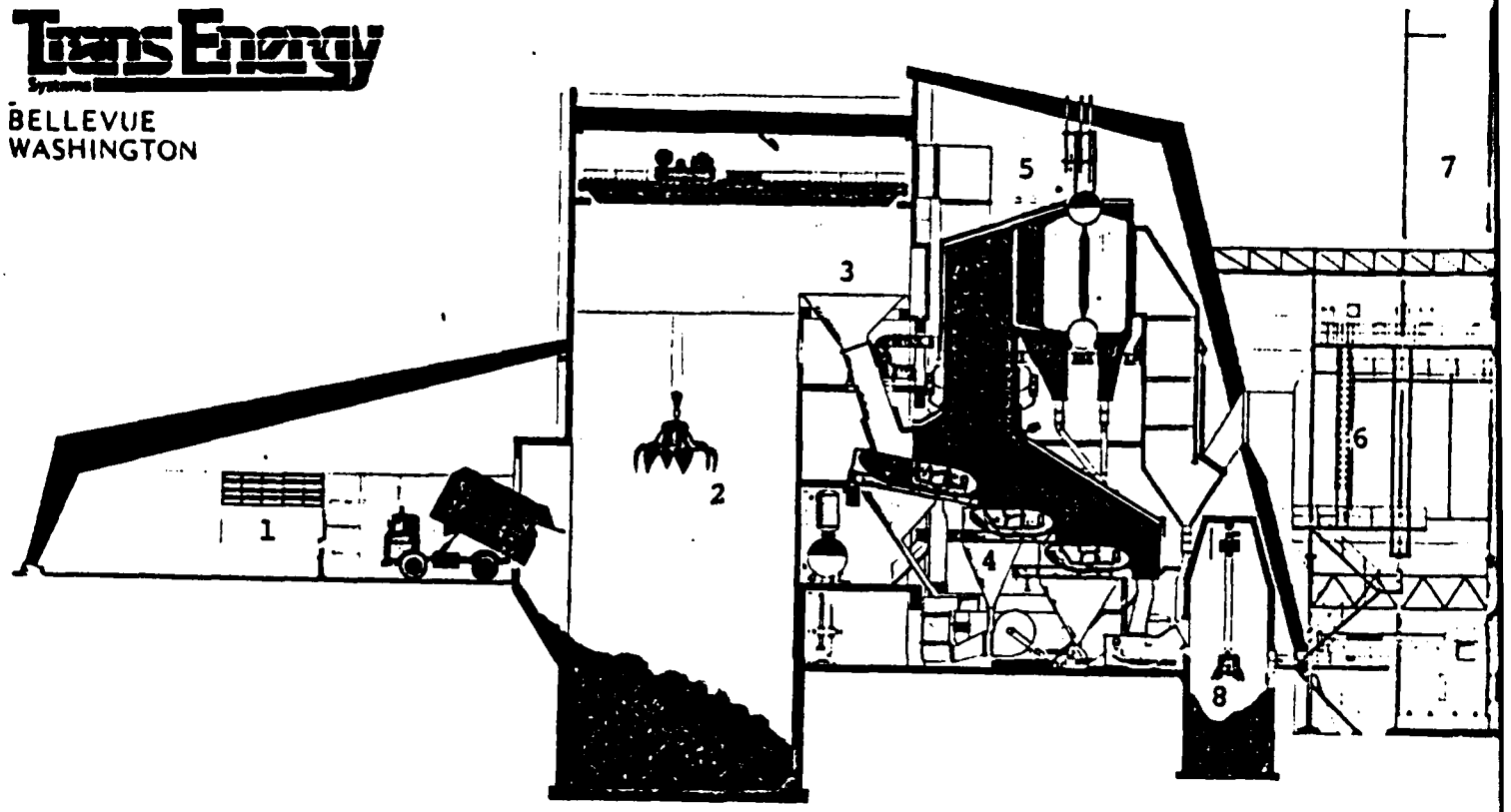
Name:	Stein
Address:	Not available
U.S. Office:	None reported
U.S. Contact:	TransEnergy Systems Suite 101 14711 N.E. 29th Place Bellevue, WA 98007
Technology Description:	Three horizontal traveling grates in a stair step arrangement. Larger units have waterwalled combustion chambers. Grate is similar to the old CE drag chain system. Residue is removed by an extractor which dumps the waste into a pit. No drag chain is used. Feed hopper dumps directly on first grate. No feed ram is used.
Brochure:	Attached select pages N/A _____
Recommended facility:	Rouen, France 2 × 1.2 TPD Steam/electricity 1970
Contact:	TransEnergy Systems Niort, France 3.3 TPH No heat recovery 1982
Facility listing:	Attached Yes N/A _____
Other:	A 500-TPD system is being designed for Salem, Oregon, by TransEnergy.

VENDOR Stein

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Niort, France	2	3.3	158	1972	None
Ales, France	2	2.2	105	1974	None
Sarcelles, France	2	1.0	48	1978	Steam/electricity

How Does a Waste-to-Energy Plant Work?

A cross-sectional sketch of the facility planned for Marion County with numbers keyed to the description in the text following is shown below.



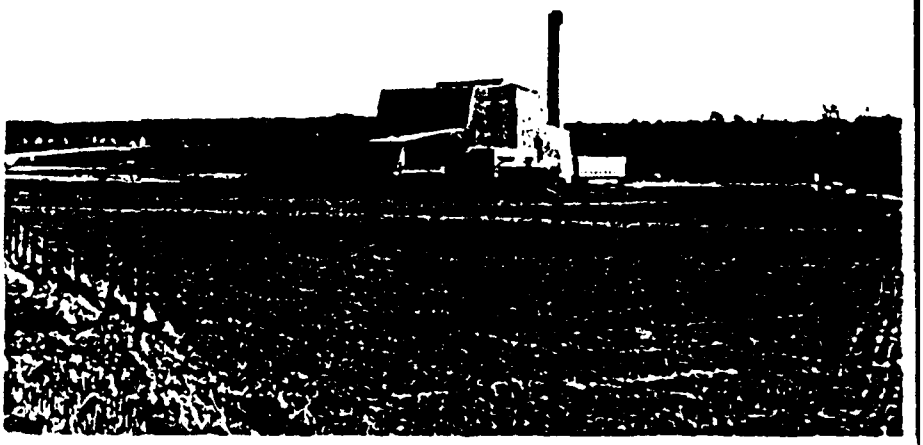
WASTE TO ENERGY PLANT CROSS SECTION

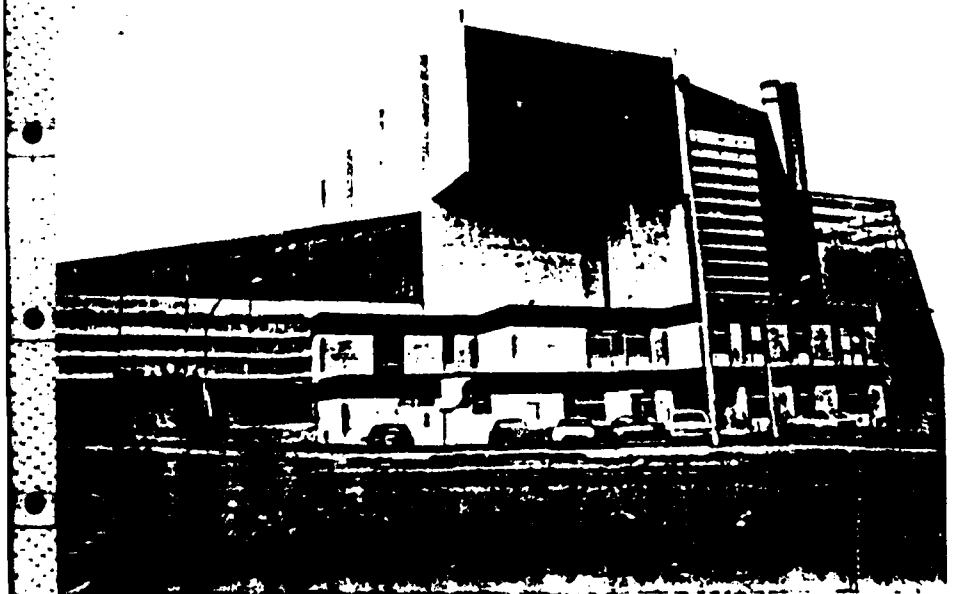
Commercial refuse haulers and transfer trucks enter an enclosed receiving area(1) and deposit the refuse into a deep concrete pit. An overhead grappling hook(2) conveys the refuse to a hopper(3) from which the refuse is fed into furnace/boiler units(4). Air for the combustion process is drawn from the receiving area and holding pit. A negative air pressure is created which draws odors into the furnace where the odors are burned along with the refuse at temperatures up to 1800°F. Hot combustion air converts the water in pipes in the boiler to steam(5). The cooled combustion gases are diverted through air pollution control equipment(6) and then evacuated through a stack(7). The steam produced in the boiler drives a turbine-generator which produces electricity for sale to regional utilities. Ferrous metals are recovered from the ash(8) by means of magnetic separators. Depending on available markets, this metal can then be sold for reuse.

WASTE TO ENERGY PLANTS

MAUBEUGE, FRANCE
(ENTRANCE VIEW)

MAUBEUGE, FRANCE
(VIEW FROM ROAD)





SARCELLES, FRANCE

Trans Energy

SYSTEM DATA SHEET

Name:	Deutsche Babcock Anlagen (DBA)
Address:	Vereinigte Kesselwerke AG (VKW) Postfach 8240 D-4000 Düsseldorf 1 Telephone: (0211) 7 81 41 Telex: 0858 2729
U.S. Office:	None reported
U.S. Licensee:	Browning-Ferris Industries P.O. Box 3151 Houston, TX 77001 Telephone: (713) 870-8100
Contact:	Mr. Edmond Joran
Technology Description:	Roller grate for large systems. Opposed motion grate for small systems, 1.5 to 5 TPH. Two chamber combustion, waste heat boiler, water-tubed, three passes, drag chain for residue removal.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	None
Other:	Several small facilities utilize the VKW grate system. However, the U.S. licensee, BFI, stated that no market effort is being directed towards small systems in the United States since their costs are so much higher than U.S. technology. No assistance was provided by BFI in locating sites. However, brochures and technical data were provided.

VENDOR Deutsche Babcock Anlagen (VKW)

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Willebrock, Belgium	2	2.3	110	1972	Air preheating
Cologne, Germany	1	3	72	1978	Steam
Wels, Austria	1	3.4		1977	None
Vercelli, Italy	2	3		1977	None
Reggio Calabria, Italy	2	3		1972	None
Valdagno, Italy	2	1.6		1974	None
Mira, Italy	1	2.5		1975	None
San Vito, Italy	1	1.5		1976	None
Aachen, France	1	2		1977	Hot water

Vereinigte Kesselwerke AG
Postfach 8240
D-4000 Düsseldorf 1
Werdener Straße 3
Telephone (02 11) 7 81 41
Telex 0858 2729

Deutsche Babcock Group

Environmental Engineering Division

Product lines

Refuse and Waste Product Treatment
Mechanical Equipment for Treatment Plants

Vereinigte Kesselwerke AG
Postfach 8240
D-4000 Düsseldorf 1
Telephone (02 11) 7 81 41
Telex 0858 2729

Water Treatment
Waste Water Treatment

Vereinigte Kesselwerke AG
Postfach 100 347
D-4200 Oberhausen 1
Telephone (02 08) 83 31 (Babcock)
Telex 0856 951

Sludge Treatment

Vereinigte Kesselwerke AG
Berliner Straße 27-33
D-1000 Berlin 27
Telephone (0 30) 4 30 11 (Borsig)
Telex 0181 621

Gas Purification

Babcock-BSH AG
vorm. Büttner-Schilde-Haas AG
Postfach 4 + 6
D-4150 Krefeld 11
Telephone (0 21 51) 44 81
Telex 0853 824

Subsidiary companies

Plafog

Planungs- und Forschungsgesellschaft Dipl.-Ing. W. Kretzschmar GmbH & Co KG
Lichtenfelser Straße 53
D-8650 Kulmbach

WABAG

Wasserreinigungsbau Alfred Kretzschmar GmbH & Co KG
Postfach 2049
D-8650 Kulmbach

Environmental Engineering Systems Programme

Refuse and Waste Disposal

Complete plants for incineration of industrial and community refuse, waste and sewage sludge. Plants for composting, waste recycling plants. Planning and design of complete disposal plants.

Water Treatment
Waste Water Treatment

Plants for treatment of potable water, swimming pool water, service water and boiler feed water. Complete waste water treatment plants and clarification equipment for communities and industry by mechanical and biological methods, including plants for treatment of radioactive waste waters from nuclear power stations.

Sludge Treatment

Plants for treatment of industrial and community waste water sludges by thermal and chemical methods.

Gas Cleaning

Dust collection plants of any type such as electrostatic precipitators, fabric filters, and cyclone dust collectors. Gas cleaning and washing plants, suction plants.

Sports Facilities and Recreation Centres, Schools, Industrial Complexes

Planning, design and construction of complete indoor- and outdoor swimming pools, sports facilities and recreation centres, schools as well as industrial complexes.

Foreword

The dangers to which our environment is exposed by the growing pollution of air, water and ground are entering more and more into the awareness of the public. One of the most urgent problems to be solved in the future is to intercept, stop and control these dangers.

The activities of the GERMAN BABCOCK GROUP in the fields of

- gas cleansing
- water treatment
- waste water purification
- refuse and waste treatment
- waste water sludge treatment

were co-ordinated at the VEREINIGTE KESSELWERKE AG DÜSSELDORF, in an ENVIRONMENTAL CONTROL DIVISION.

In this way it is ensured that the whole experience and knowledge gained from the developments so far made and the operational results achieved in plants already constructed are evaluated and made use of centrally. The comprehensive programme enables an objective selection of the applicable processes and, consequently, optimum solution to the problems.

In the field of waste treatment we discriminate between the following major processes and systems:

- plants for the orderly depositing of domestic, commercial and industrial refuse;
- plants for waste utilization by compostion according to the DANO process, with or without residue combustion;
- plants for the incineration of domestic, commercial and industrial refuse;
- plants for the combustion of sludges obtained by cleansing the waste water of communities and industry.

Numerous plants are already operating in the Federal Republic of Germany, Holland, France, England, Sweden, Czechoslowakia and Japan. Further plants are under construction or have been commissioned for construction in other European countries, including those of the Comecon.

The DANO composting process which has undergone further development by us has been successfully applied in almost all the highly-industrialized countries of the world.

The Vereinigte Kesselwerke AG builds waste treatment plants according to the following furnace systems:

- roller grate of the „Düsseldorf System"
- opposed-motion cascade grate
- rotary kiln

as well as the „DANO" composting system.

In addition to the treatment and disposal of solid and liquid waste of all kinds, the problem of circumventing the sewage sludge from communal and industrial waste water is one that needs to be solved in the future. We supply plants in which this sludge is treated mechanically, chemically or thermally, and which is burnt seperately or jointly with waste.

The decades of experience gained by the Vereinigte Kesselwerke AG in the fields of process, furnace and power station technology and in the construction of complete industrial plants, ensure the optimum in design of all processing elements pertaining to an entire plant and, consequently, a high operational safety and utilization.

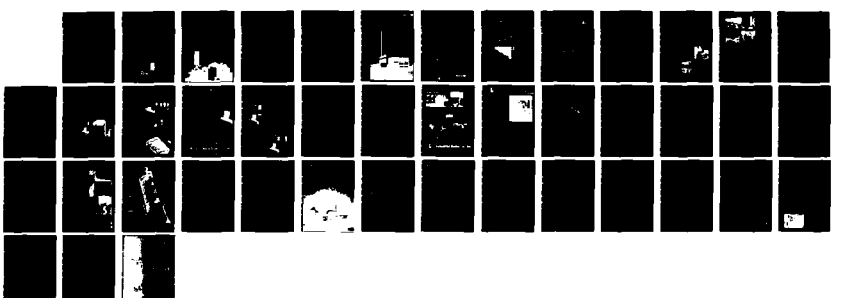
This current publication illustrates the most important processes and systems of waste incineration and composting.

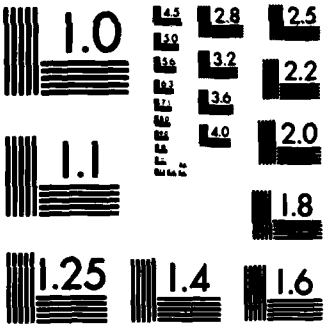
Stockholm refuse incineration plant with roller grate of „Düsseldorf System"; 2 units with a refuse throughput rate of 15 tons/hr each

Contents

AD-A127 461 SURVEY OF FOREIGN SYSTEMS FOR INCINERATION AND ENERGY RECOVERY(U) SYSTECH CORP XENIA OH R FROUNFELKER ET AL. APR 83 NCEL-CR-83.025 N62583-82-MT-150 2/2

UNCLASSIFIED F/G 13/2 NL





Opposed-Motion Cascade Grate Stoker of the Keller-Peukert System

The opposed-motion cascade grate has been especially developed for the combustion of solid domestic, commercial and industrial waste. This grate is suitable for throughput rates of 1.5 to 5 tons/hr.

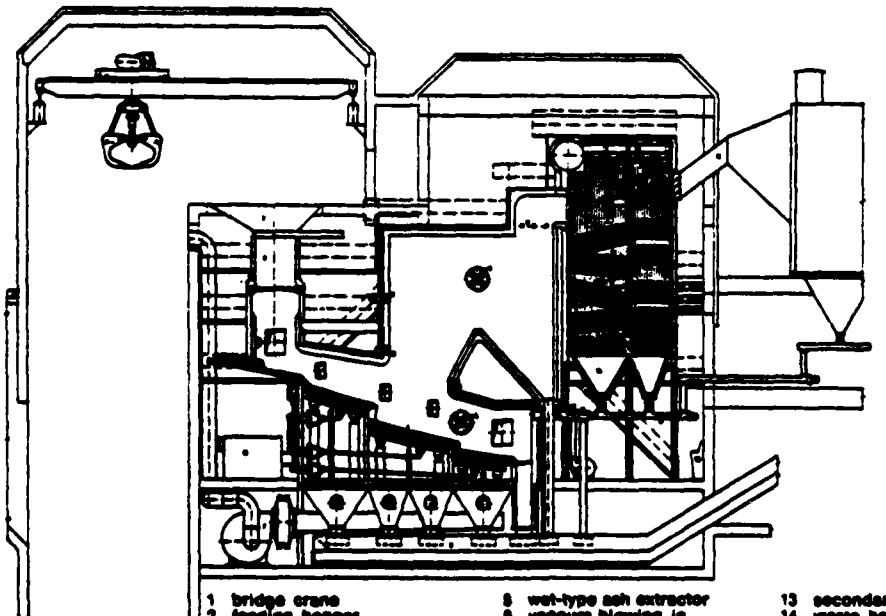
The opposed-motion cascade grate consists of a self-contained processing unit which can be installed stress-free in the combustion chamber. The materialistic quality of its equipment and the robust construction of the grate ensure a high degree of safety and utilization.

The waste is charged over the grate inlet into the feed shaft at the end wall. An infinitely variable feed pusher at the bottom of the shaft ensures a continuous delivery. By the opposed-motion of the grate and intermediate grate bars, the material to be burnt is transported across the grate area, distributed, and thoroughly raked. This raking action ensures a complete waste burn-out in accordance with legal requirements.

The combustion process is regulated by an infinitely variable hydraulic drive of the grate and by the introduction of the combustion air into several, individually separated zones under the grate track.

Waste incineration plant with opposed-motion cascade stoker of the Cologne University Hospital

Cross section of a refuse incineration plant with opposed-motion cascade grate

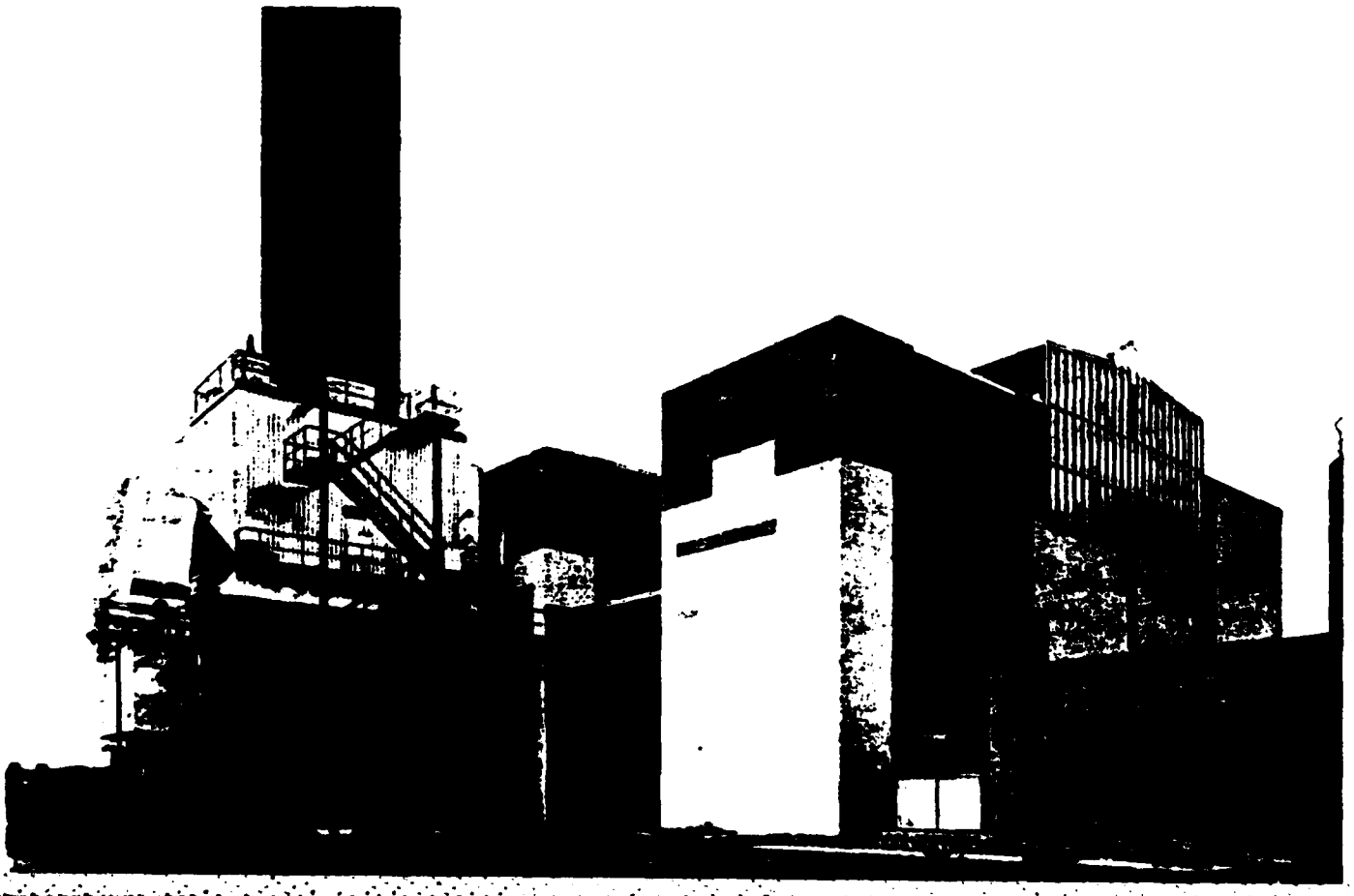


1 bridge crane
2 feeding hopper
3 lock
4 opposed-motion cascade grate
5 lighting-up and aux. burners
6 afterburner
7 undergrate air system
8 wet-type ash extractor
9 vapours blowing in
10 blowing in of dried sludge substances
11 cooling air addition
12 combustion air fan (dried air sludge substance)
13 secondary air
14 waste heat boiler
15 three-gas-pass boiler (space heating)
16 crude gas duct
17 dust removal
18 control desk for roller conveyor

Client and Location of Plant	Number of Units	Throughput of Refuse t hr	Kind of Refuse Calorific Value kJ kg	Utilization of Heat	Production of Steam t/hr	Steam Conditions at Boiler Outlet Pressure/ Temperature	Year of Commissioning
County Corporate for Refuse Disposal Bamberg City and Land	2	2 x 6	domestic refuse and municipal sewage sludges	fully mechanical opposed motion turn-over grate with boiler and sludge dehydration as well as sludge drying with combined drying and pulverising	2 x 18.5	26 bar saturated steam	1977
Technical University City of Aachen	1	2	hospital refuse	fully mechanical opposed motion turn-over grate with heat recovery	–	hot water production 180° C supply temperature	1977
	1	0.3	pathological waste	furnace for pathological waste with ceramic tub			
City of Wels/ Austria	1	3.4	domestic refuse	fully mechanical opposed motion turn-over grate without heat recovery	–	–	1977

Refuse incineration plant at the Technical University in the City of Aachen.

1 incineration unit designed for 2 t/hr refuse throughput capacity.



SYSTEM DATA SHEET

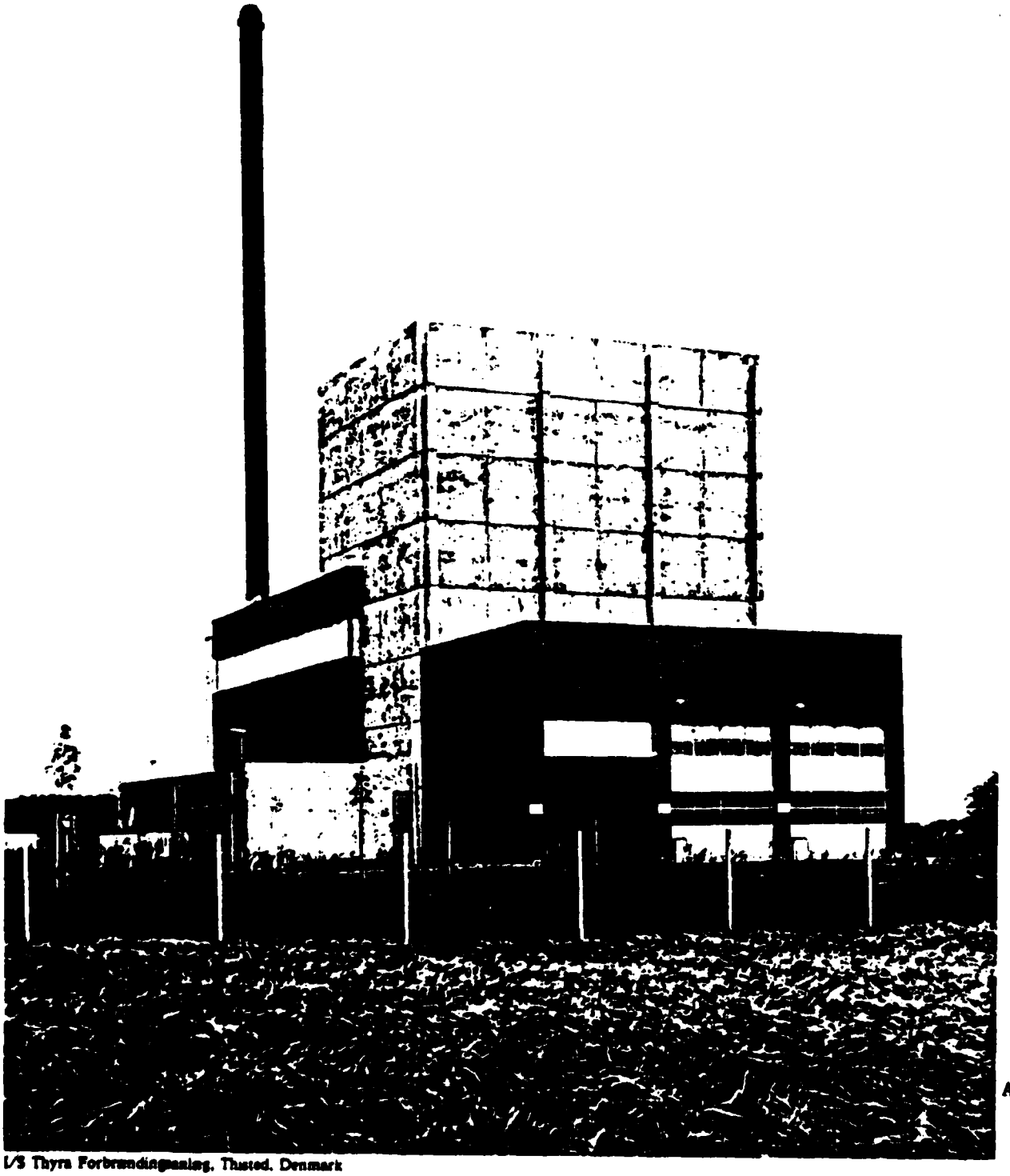
Name:	Volund
Address:	11 Abildager DK-2600 Glostrup Denmark
U.S. Office:	Volund USA 900 Jorie Blvd. Oak Brook, IL 60521 Telephone: (312) 655-1490
Contact:	Mr. Bunnar Kjaer
U.S. Licensee:	Waste Management, Inc. 3003 Butterfield Rd. Oak Brook, IL 60521
Technology Description:	Forward pushing step grate. Hydraulically driven grate mechanism. Special alloy case iron grates loose in a grate block. The blocks move not the individual grates. Several steps for drying, igniting, and burning. Internal baffle directs gases two ways: over incoming waste for drying and into secondary chamber. Turbulence, temperature, and additional combustion air in secondary chamber. The baffle also acts as a device to promote uniform internal temperatures. Ash removal from wet pit by drag chain. Packaged waste heat boiler for energy recovery.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	Thisted, Denmark 3 TPH, hot water Videback, Denmark 2 TPD, hot water
Facility listing:	Attached ___Yes___ N/A _____
Other:	The U.S. versions of the Volund system employ the rotary kiln after the grate system. The kiln is used on plants of 6-TPH capacity and larger.

VENDOR Volund

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Dalum, Denmark	1	2	48	1964	Hot water
Hjoerring, Denmark	1	2.5	60	1965	Hot water
Roskilde I, Denmark	2	3.0	144	1966	Hot water
Haderslev, Denmark	1	3.0	72	1966	Hot water
Hoersholm, Denmark	2	3.0	144	1969	Hot water
Thisted, Denmark	1	3.0	72	1978	Hot water
Videback, Denmark	1	2.0	48	1980	Hot water
Grenaa, Denmark	1	2.5	60	1980	Hot water
Sundbyberg, Sweden	2	2.5	120	1954	Hot water
Linkoping, Sweden	2	2.5	120	1958	Steam
Uppsala, Sweden	2	2.5	120	1962	Hot water
Boras, Sweden	2	2.5	120	1965	Steam

Miljøteknik
Environmental Technology
Umwelttechnik
Protection de l'environnement
Техника по окружающей среде
ごみ焼却プラント

Vølund

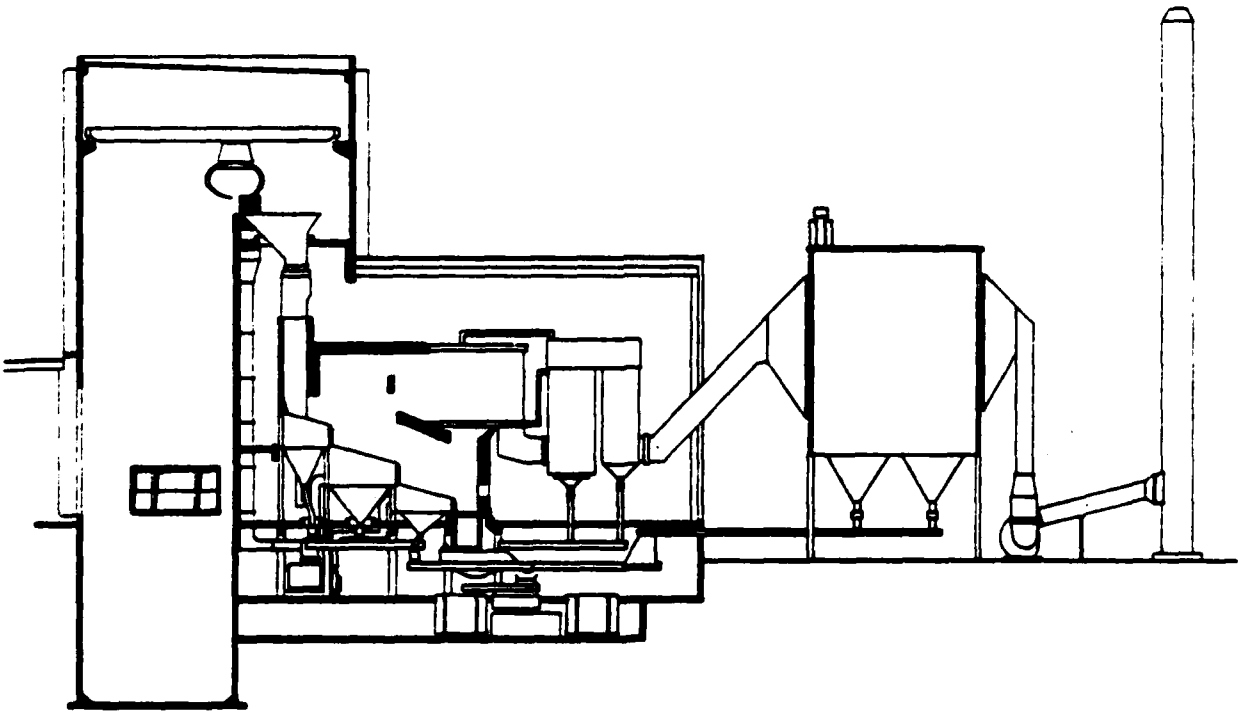


I/S Thyra Forbrændingsanlæg, Thisted, Denmark

Beskrivelse Beschreibung Description
Description Описание 概　　要

I/S Thyra Forbrændingsanlæg, Thisted, Denmark

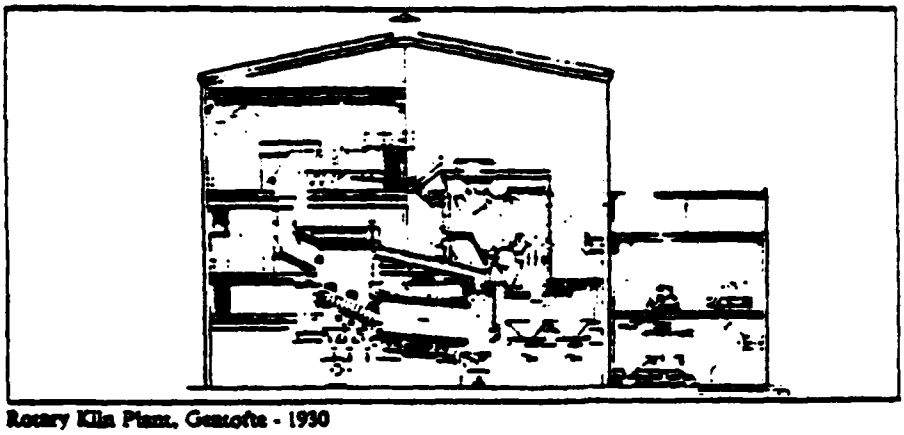
Antal ovne Number of units Anzahl Öfen Nombre de fours Количество печей 炉　数	1	Brændværdi Calorific value Heizwert P. C. I. Теплотворная способность ごみ発熱量	2500 kcal/kg 2500 ккал кг	Røggasrensning Flue gas cleaning Rauchgasreinigung Epuration des fumées Очистка дымовых газов 集塵方式	Elektrostatisk Electrostatic Elektrostatisch Filtre électrostatique Электростатическая 電気集塵機
System System System Système Система 形　式	Rist Grate Rost Gradins Колосник 火格子	Kedelkapacitet Boiler capacity Kesselkapazität Capacité chaudière Производительность котла ボイラ蒸発量	6,1 Gcal/h 6,1 Гкал/ч	Afleveringsår Commissioning year Abnahmejahr Année de mise en service Год пуска в эксплуатацию 竣工年	1978
Kapacitet / ovn Capacity / unit Kapazität / Ofen Capacité unitaire Производительность печь 処理能力(1炉当り)	3 t/h 3 т ч	Kedeltryk Boiler pressure Kesseldruck Pression de timbrage Давление в котле 蒸気圧力	6 ato 6 атм	Energiudnyttelse Utilization of heat Wärmenutzung Récupération d'énergie Использование тепла 余熱利用	Fjernvarme / varmt vand District heating / hot water Fernheizung / Warmwasser Chauffage urbain / Eau surchauffée Централизованное теплоснабжение Горячая вода 給湯 暖房
Total kapacitet Total capacity Gesamtkapazität Capacité totale Общая производительность 総合処理能力	72 t/24 h 72 т/24 ч	Kedeltemperatur Boiler temperature Kesseltemperatur Température chaudière Температура в котле 蒸発温度	120 °C		



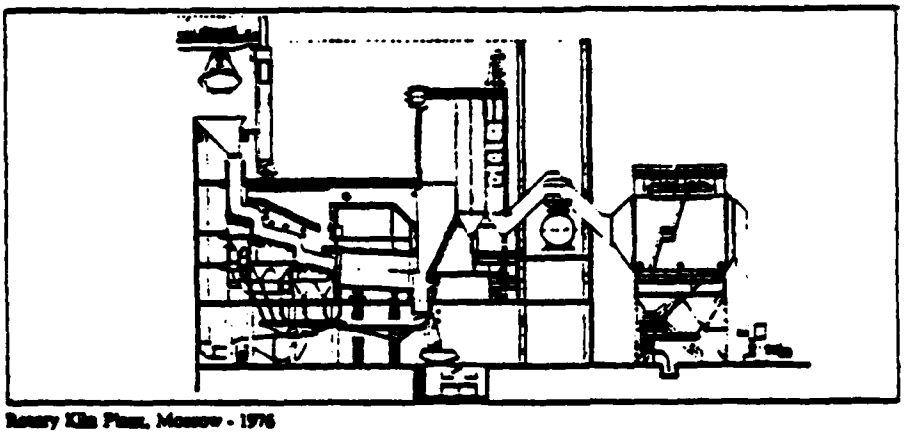
Kedel Boiler Aggregat Chaudière Утилизационный котел ボイラ		Røggasfilter Flue gas filter Rauchgasfilter Filtre Фильтр для дымовых газов 集塵装置	
Ovn Furnace Ofen Four Печь 炉		Aske- og slaggetransport-system Ash and clinker transport system Asche- und Schlackentransport-System Evacuation cendres et mâchefer Система для удаления золы и шлака 灰排出装置	
Luft- og røggaskanaler Air and flue gas ducts Luft- und Rauchkanäle Conduit de ventilation et fumées Каналы воздуха и дымовых газов 空気・排ガスダクト		Bygning / stålkonstruktion / tag Building / steel construction / gitters Gebäude / Stahlkonstruktion / Roste Structure / fers / grilles Постройка / Стальная конструкция / Колосники 建屋 鉄構 火格子	

Vølund

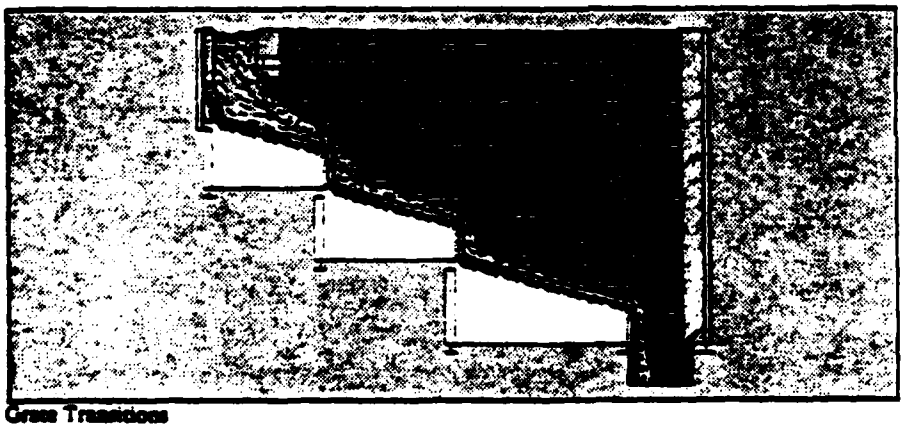
11 Abildager
DK-2600 Glostrup, Denmark
Telephone + 45 2 45 22 00
Telex 33150 Volund DK



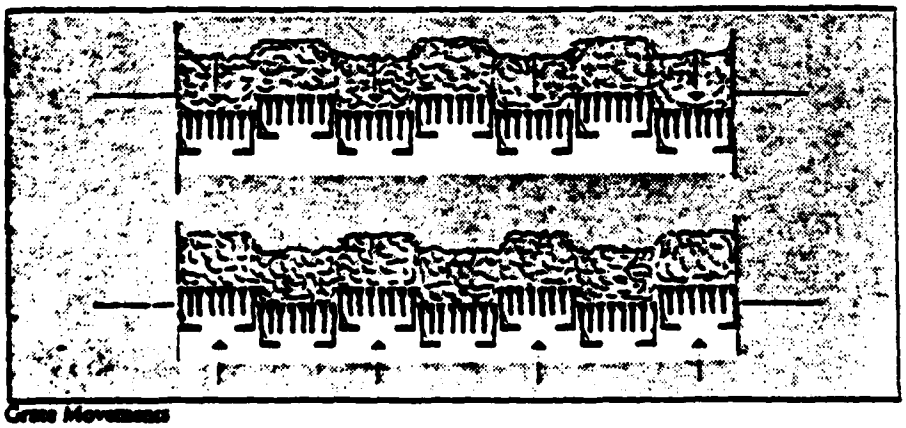
Rotary Kiln Plant, Gentofte - 1930



Rotary Kiln Plant, Moscow - 1976



Grate Transitions



Grate Movements

Development.
Vølund developed the first continuously operating plant for incineration of refuse in the late twenties. The operation of the first two plants started in the early thirties.

During more than 40 years, through the depression of the thirties as well as the prosporous sixties, the plants managed the refuse incineration equally well.

This bears witness of versatility and reliability of Vølund's plants which employ the latest tecnology and incorporate the current new experience gathered from these plants as well as from the more than 150 others which today are in operation all over the world.

The Forward Pushing VØLUND Step Grate.
The heart of the Vølund incinerator plants is the robust, durable, and reliable forward pushing step grate.

The grate area consists of several sections, each separated by grate transitions. Each grate section is built up of longitudinal sections - the grate beams - 180 to 300 mm wide. Every second of these are stationary and every second movable.

The movable grate beams are hydraulically driven, and both the stroke length and number of strokes per minute are adjustable.

The forward stroke of the grate movement is slowly lifting, and in backstroke slowly lowering.

This means that the refuse transported on the grates is controllable in relation to the type of refuse.

The grate movement produces effective cutting up of the refuse along the grate beams.

Due to the upward and downward movement of the movable grate beams, a sideway rotating movement of the refuse layer will take place. This very movement provides good contact berween the refuse and the air for predrying and combustion, and ensures quick covering of any burning through in the refuse layer.

At the grate transitions effective turning over of the refuse takes place. and any crust formations on the refuse layer will be broken, thus exposing unburnt refuse.

The Grate Blocks.
Grate blocks manufactured of specially alloyed cast iron are mounted on the grate beams. Each block is filled up with loose grate bars. This way of building up of the grate layer facilitates quick replacement of any of the grate bars.

The combustion air is supplied from underneath the grates and its amount is adjustable at each grate section.

The vertical placement of the grate bars effects extensive contact with the combustion air, whereby effective cooling of the grate bars and grate blocks takes place.

This is of great importance, especially in the zones of burn up as the longest possible life of the grates thereby will be achieved.

The Combustion Chamber.
The combustion chamber serves to secure the correct temperature conditions in the combustion zones for obtaining the best possible burn up degree of the refuse and the flue gases.

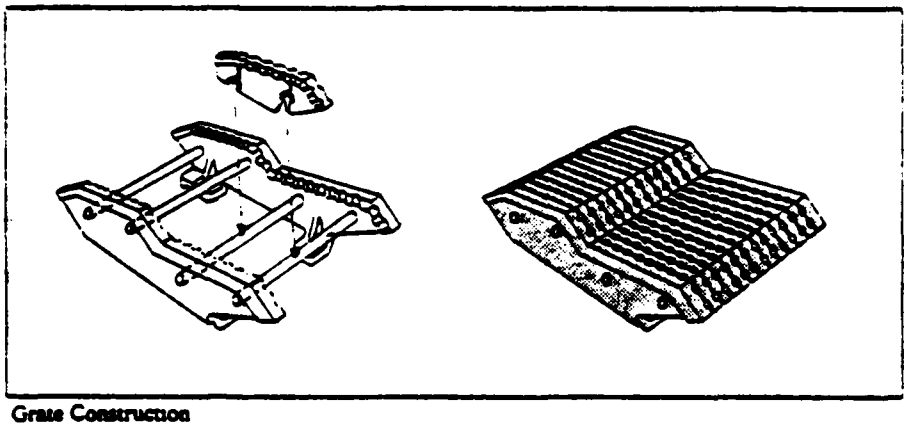
To secure effective drying out of the refuse the counter-flow principle would be preferable.

To secure good burn up of the solid parts of the refuse the uniflow principle would be preferable.

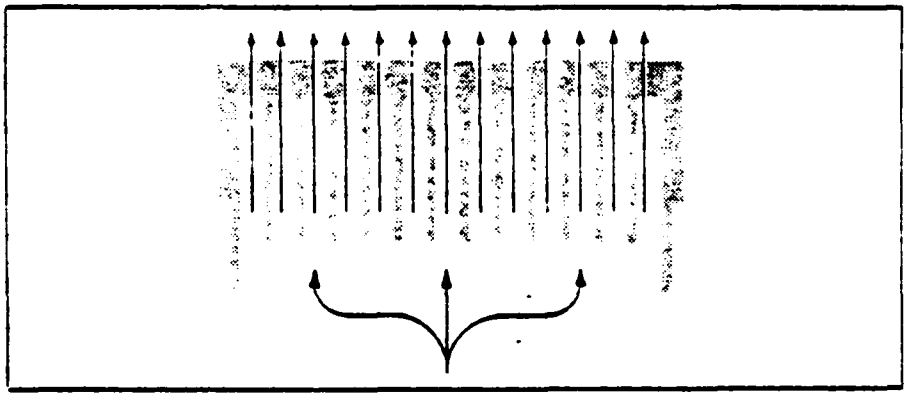
The cross flow principle is a compromise producing average burn up conditions.

The VØLUND Two-Way Flue Gas System.
The ideal solution is VØLUND's two-way flue gas system. The gas flow can be adjusted into full uniflow, or into uni- and counterflow.

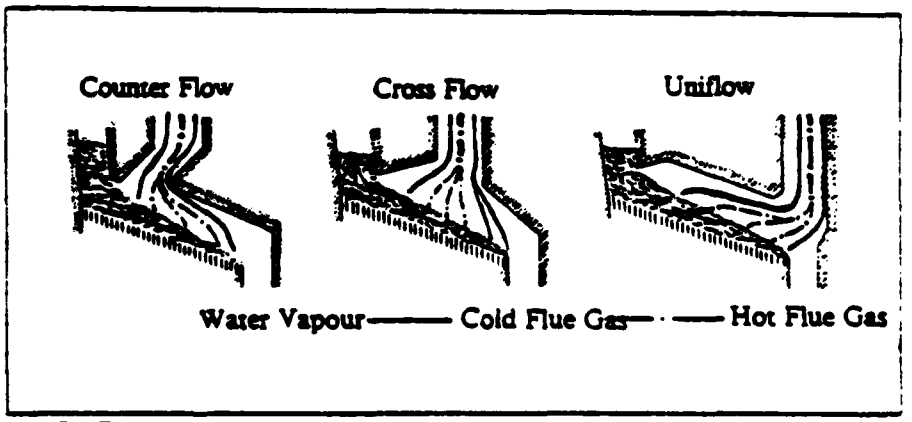
The plants can be built for manual or automatic operation of the dampers.



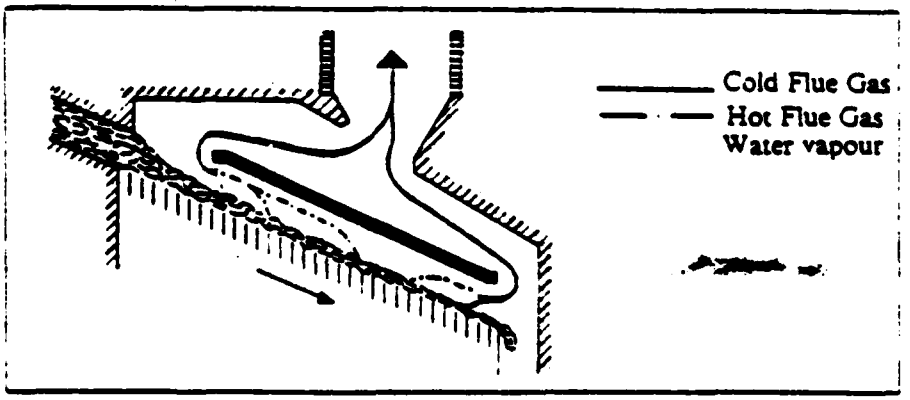
Grate Construction



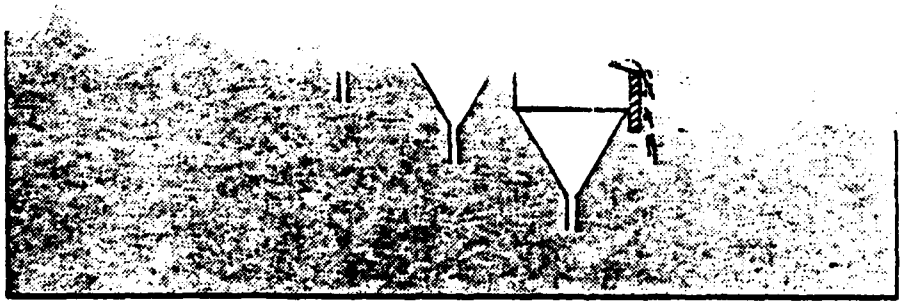
Cooling of Grate Bars



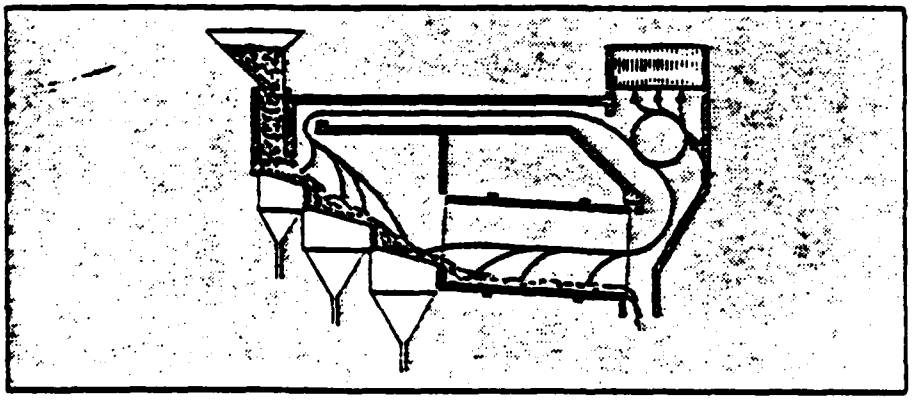
Flue Gas Flows



Volund's 2-way Flow System



System Volund Grate Type Furnace



System Volund Rotary Kiln Furnace

ten... will therefo: ...c
a result, at a low temperature.

On another part of the grate may be light refuse such as paper, plastic, and packing materials, which are easily combustible, and this creates high temperatures.

The brinck arch has the effect that the heat radiation to the areas with refuse of difficult combustion is stronger and support the drying out and combustion.

The heat emitted from the areas with easily combustible refuse is absorbed by the brick arch, with the effect, that the combustion is hampered and the temperature is reduced in these areas.

The brick arch functions as a temperature stabilizer.

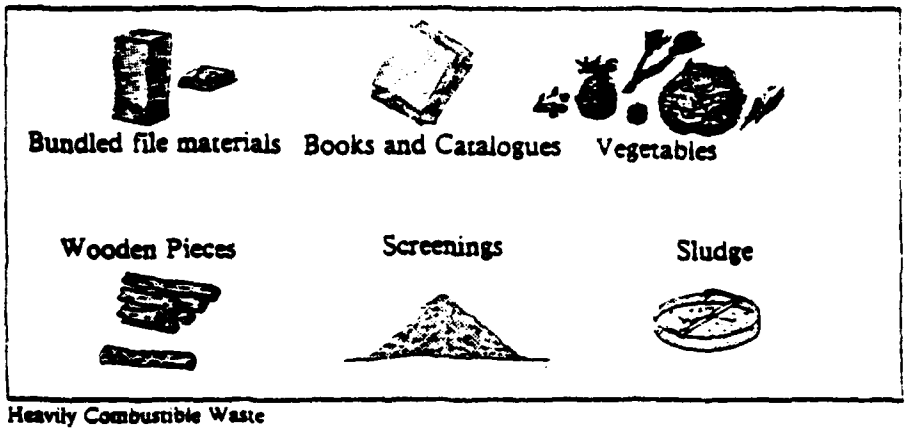
For refuse with a high calorific value the brick arch can be shortened or eventually dispensed with.

Processing Time.
To achieve complete burn up of the refuse three conditions have to be fulfilled: Correct combustion temperature, sufficient combustion air, and the necessary combustion time.

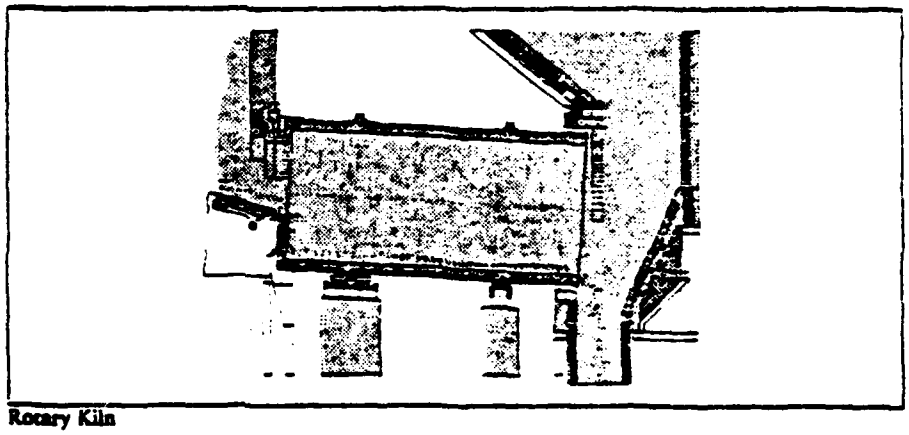
The varying composition on the refuse necessitates combustion periods from one to three and an half hours. An incinerator plant equipped solely with grates will not fully meet the demands to varying combustion periods, as the necessary grate area must be designed for a certain combustion period to suit the major part of the refuse. Periodically this may imply poor burn up of the clinkers. By utilizing Vølund's patented afterburning grate are achieved considerable improvements in the burn up degree.

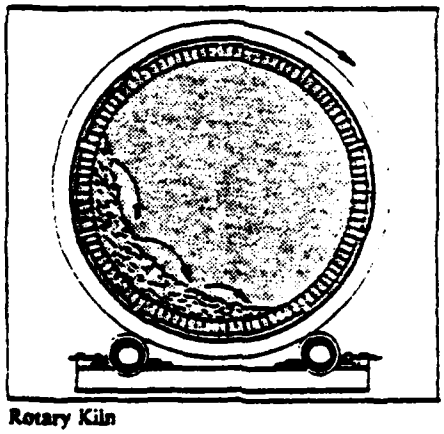
The Rotary Kiln Plant.
The Vølund rotary kiln plant is capable of meeting all demands to varying combustion periods. The pre-drying, ignition, and burning up of the easily combustible refuse take place on the grate section. The clinkers produced, and the refuse not yet burned up, proceed to an additional combustion section made up of a refractory lined kiln rotating at an oblique angle, erected right after the last combustion grate. The rotating movement produces effective turn-over of the refuse, whereby the crust of clinkers is rapped off, and new refuse is exposed. The constant supply of combustion air and the high temperature ensure complete burning up of even the solid and heavy part.

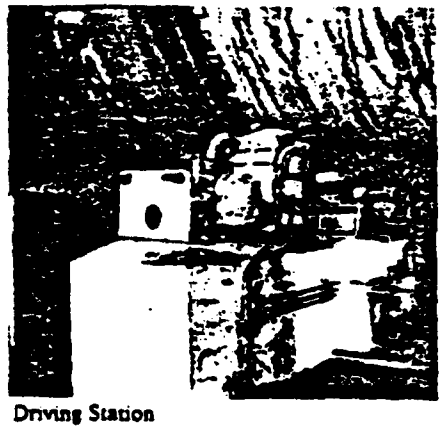
The rotary kiln is hydraulically operated by a patented driving mechanism. The number of revolutions are variable for 0 to 12 r.p.h.



Heavily Combustible Waste

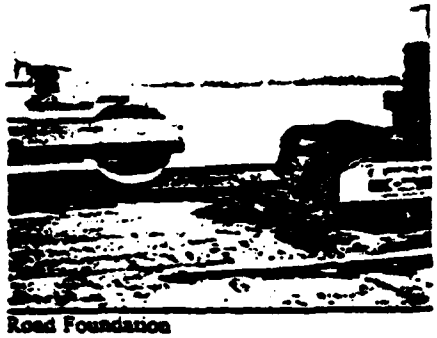

Rotary Kiln


Rotary Kiln


Driving Station

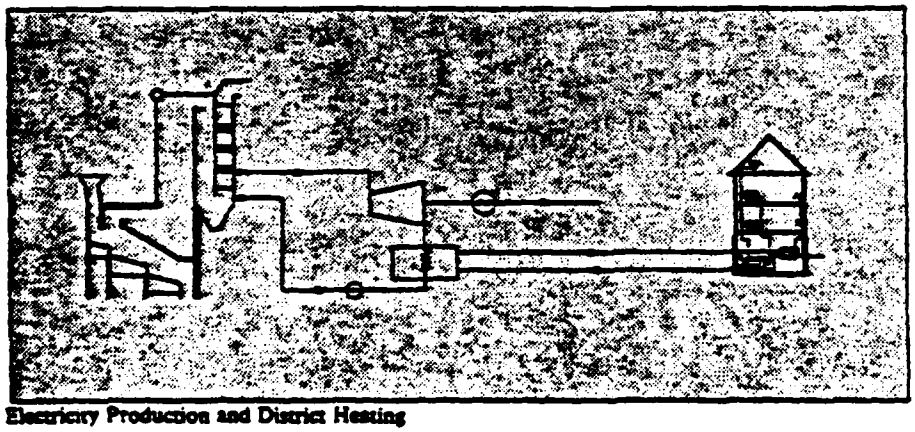

Rotary Kiln

Clinker Separation

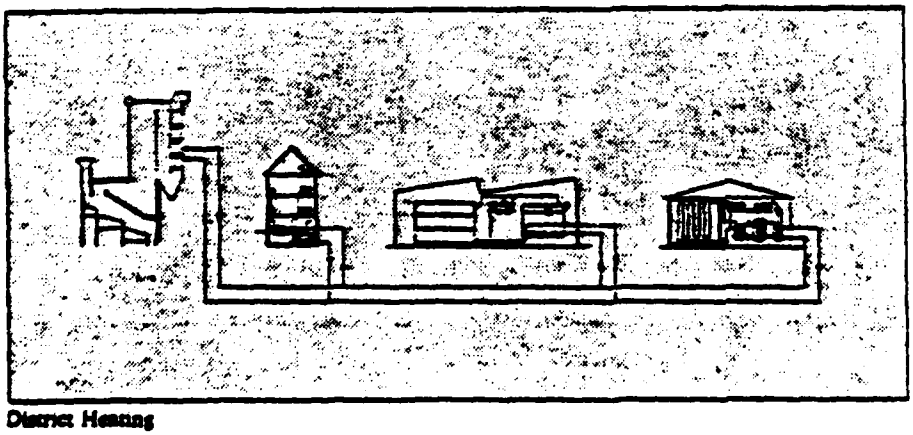


Road Foundation

Slabstone Production



Electricity Production and District Heating



District Heating

Utilization of Clinkers.
Thorough examinations of the clinkers from a Volund rotary kiln incinerator plant have proved that the clinkers are completely sterile and safe for the environment.

The exposure of the clinkers to the mechanical affect of the rotary kiln also produces granulation.

After separation of all the scrap iron, 80 - 90% of the clinkers are re-usable as foundation material and as filling material in the concrete industry, replacing gravel.

A basic condition for re-use is good burn up of the clinkers. Volund's rotary kiln plants effect a degree of burn up of 95-98%.

Energy Recovery.
Incineration develops heat. Of each tonne incinerated waste can be produced energy or heat corresponding to 100 - 220 kg oil. The Volund incinerator plants are especially well suited for heat utilization. Through the times Volund has developed a programme of exhaust-gas boilers, which can be erected in any size of Volund's incinerator plants.

Steam, super-heated water, or warm water may be a means of heating, according to local requirements of heat or energy.

The most ideal heat utilization would be district heating for several users, flats, institutions, industries, etc.

By using the absorption principle the heat can be utilized in cooling systems, air conditioning plants, and for ice production.

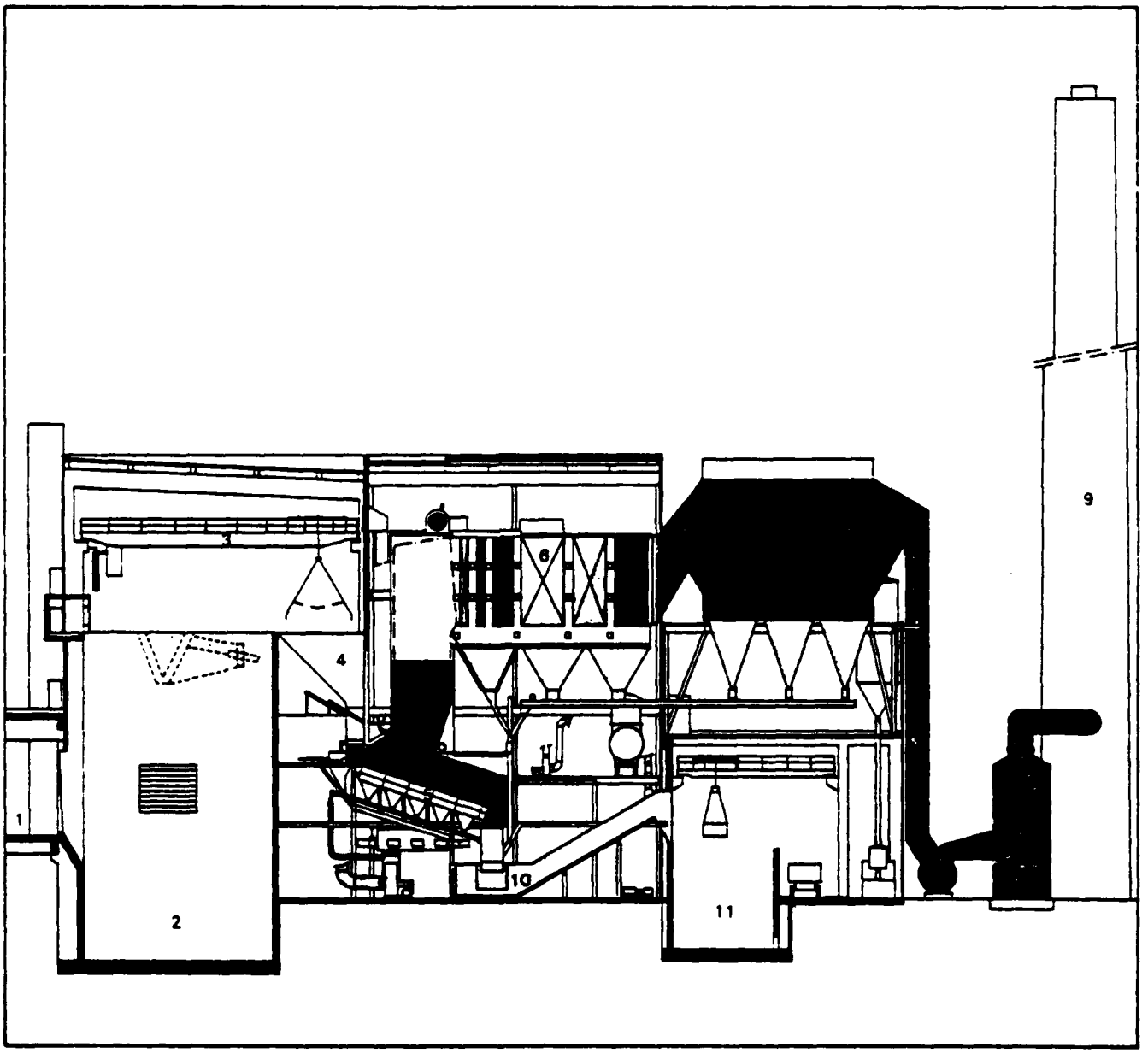
Other energy utilization would be electricity production, or sludge drying.

SYSTEM DATA SHEET

Name:	Von Roll Limited, Environmental Engineering Division
Address:	P.O. Box 760 CH-8037 Zurich, Switzerland Telephone: 01 44 12 41
Contact:	Mr. A. Scharsach
U.S. Office:	Von Roll Inc. Environmental Engineering Division 25 Commerce Drive Cranford, NJ 07016 Telephone: (201) 272-1557
Contact:	Mr. Rolf T. Baumgartner
U.S. Licensee:	Wheelabrator-Frye Inc. Liberty Lane Hampton, NH 03842 Telephone: (603) 926-5911
Contact:	Mr. Chris G. Ganotis Telephone: (617) 777-4412
Technology Description:	The Von Roll incineration system employs a refractory metal step grate system along with the waterwall construction for the heat recovery boiler. The inclined step grates use a reciprocating motion to agitate the fuel bed and to convey the refuse. Primary air is supplied under the grates via slots in the grates while secondary air is above the bed in a manner to ensure complete combustion of CO. The most common form of energy recovery is with a waterwall section in the combustion zone. Part of the boiler tubes in this zone are protected by a refractory covering.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	None reported
Facility listing:	Attached ___Yes___ N/A _____

VENDOR Von Roll

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
BASF-Ludwigshafen II, Germany	2	1.0	48	1964	Steam
Continental Hannover, Germany	1	1.5	36	1964	Steam
Chemische Werk, Huis, Germany	1	2.3	55	1966	Steam
Landshut I, Germany	1	3.0		1971	Steam & electricity
Landshut II, Germany	1	3.0		1974	Steam & electricity
Opel Rüsselshein, Germany	1	1.8	42	1966	Steam
Deauville, France	2	2.5	120	1974	Steam
Dieppe, France	2	3.0	144	1971	Steam
Chinon, France	1	2.8	67	1983	Steam
Schaffhausen, Switzerland	2	3.0	144	1973	Steam
Montcada, Spain	1	3.0	72	1975	Steam



Longitudinal section of a refuse combustion plant with Von Roll two-pass boiler and flue gas scrubber

The collecting vehicles (**1**) unload their contents into a refuse bunker (**2**). A grab crane (**3**) drops the refuse into the feeding hopper (**4**), which leads to the grates (**5**)

The gases produced by the combustion process are cooled in a superimposed boiler (**6**). The steam raised in the boiler is expanded in a condensing turbine, and the power thus generated is either used for in-plant purposes or sold. The exhaust steam from the turbine is condensed in the air-cooled condensers located above the turbogenerator unit.

The flue gases exiting from the boiler are cleaned, first in an electrostatic precipitator (**7**), then, in a wet scrubber (**8**), and subsequently they are exhausted through the stack (**9**) by means of an induced draft fan.

The combustion residues, i.e. slag and ash, drop down into a water-filled clinker through (**10**) and are discharged into the clinker pit by an endless scraper chain (**11**)

The Von Roll Combustion System

Von Roll's combustion system is the result of a continuous development and adaptation of the system to the present high standard of requirements applying to refuse combustion.
Von Roll's combustion system represents the optimum solution to controlling the multitude of problems connected with refuse firing, e.g.:

- combustion automation
- continuous operational availability
- boiler corrosion
- slag deposits in the combustion chamber
- grate riddlings
- water consumption.

Von Roll's combustion system guarantees

- high operational reliability
- exceptional economy

due to the optimum correlative tuning of all system components.

Refuse Feeding Control

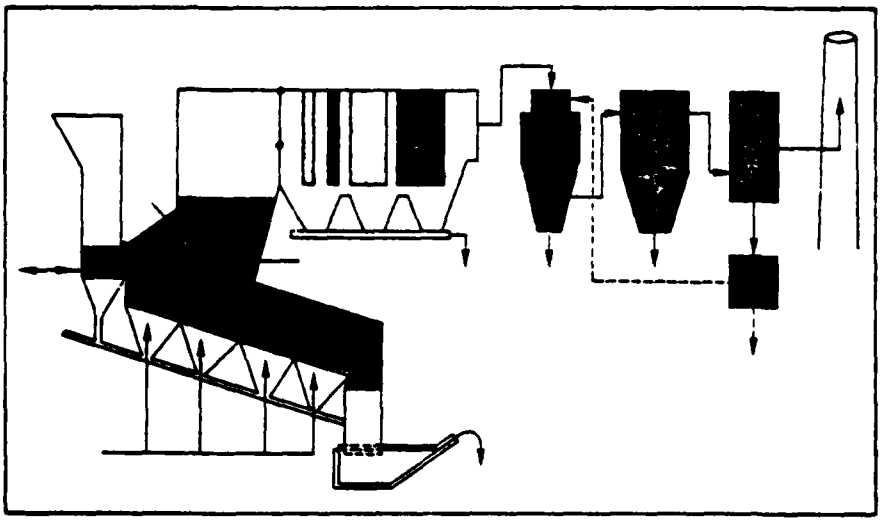
The most important requirement for automatic furnace operation is a steady refuse input load and a zero-lag reaction to every control order signal. Von Roll uses a hydraulically powered ram-type feeding device. Each forward stroke feeds the same volume of refuse into the furnace. The forward stroke speed is infinitely adjustable.

Grate System

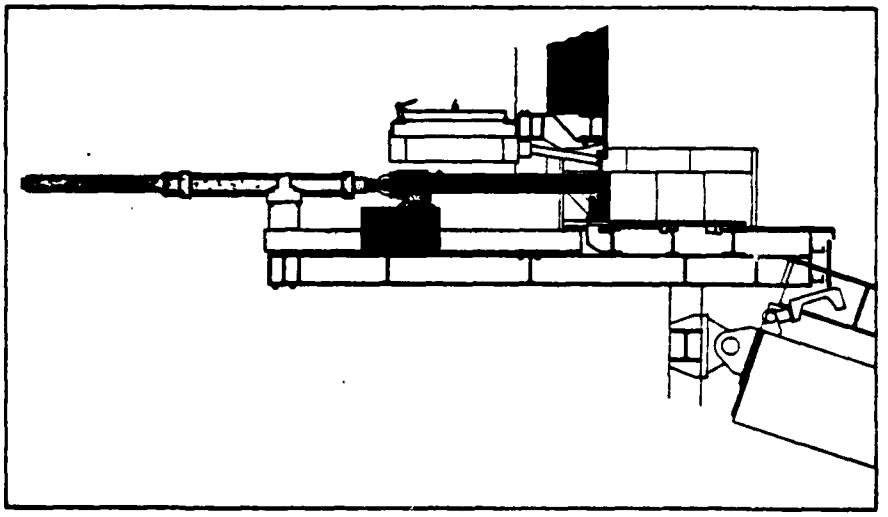
The Von Roll grate is a modular system design and so allows for universal application.

Configuration of Basic Module

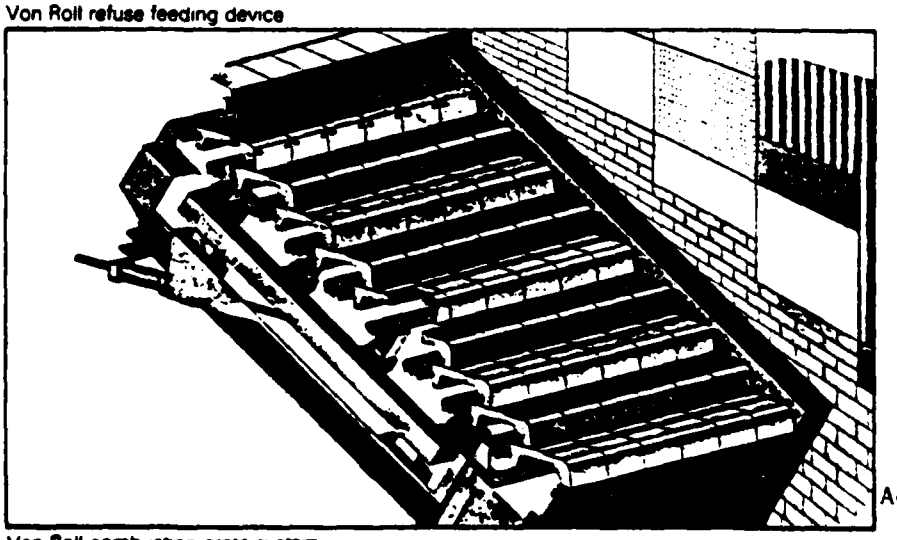
- transversely tied lateral grate blocks resting on a carriage mounted on rollers
- movement of the grate elements by standardized hydraulic cylinders mounted outside of the grate hopper for easy access
- forced cooling of the grate blocks
- high combustion air pressure drop through the grate blocks, resulting in a uniform air distribution
- each grate block is individually replaceable.



Von Roll combustion system



Von Roll refuse feeding device



Von Roll combustion grate system

Design-inherent properties

- minimum riddlings; pneumatic removal is feasible
- thorough raking effect with each grate motion (also at part-load), resulting in a zero-lag performance response to every control order signal
- short grate zones giving any measure of control over the retention time of the refuse on the grate.

Combustion Automation

The operation of a refuse combustion plant as a refuse-burning power station calls for an automation of the firing process that minimizes steam output fluctuations. The main problem to be solved lies in the unorthodox properties of the refuse as a fuel, and particularly in its fluctuating heat value.

Control Requirements

- constant steam production concurrent with all other basic requirements such as:
- burnout quality of the residual slag
- combustion gas burnout
- observance of all temperature limits

Control System

– Load Control

Load control is primarily achieved through the refuse feed volume, i.e. the speed of the feeding device is adjusted to the steam output.

– Process Control

To maintain constant performance stability of all functions, the control of the combustion progress is superimposed on the load control.
This control procedure ensures the best possible stability of the combustion progress and of the amount of heat generated in the combustion process.

Ash Discharge

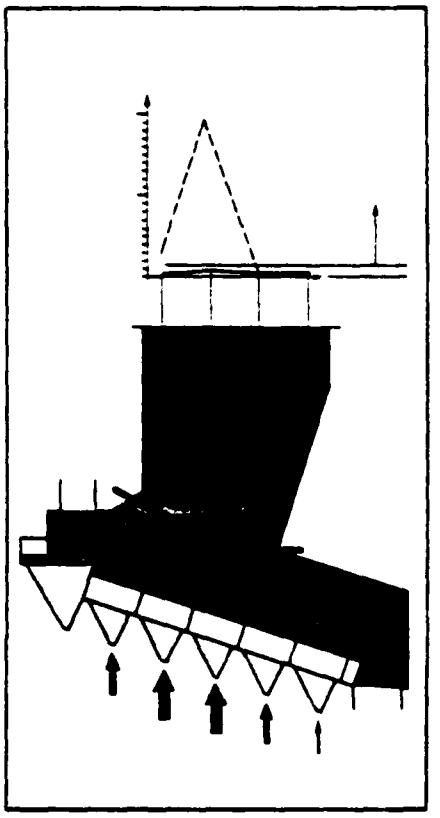
The amount and the properties of the grate riddlings enable the use of a simple pneumatic discharge system for which the required air is taken from the primary under-grate combustion air. The riddlings are directly conveyed to the slag discharge chute.
The ash collected from the boiler and from the electrostatic dust precipitator is removed in dry state by mechanical means.

Slag Discharge

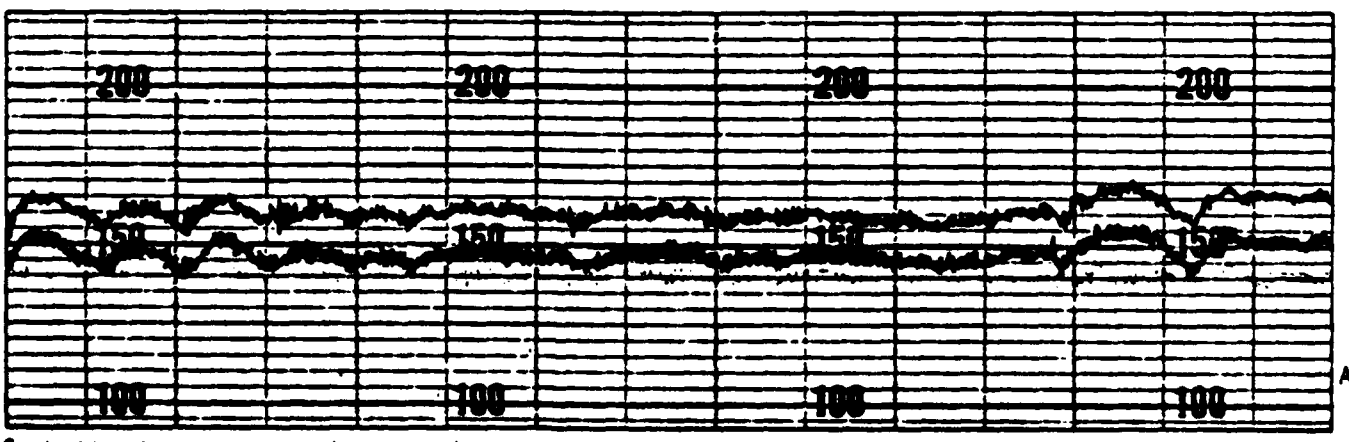
The residual slag and cinders are removed either by means of a scraper chain, or a hydraulic-mechanical expeller. The water content of the wet slag is 15 to 20%.
In every application the slag removal device operates without effluent.

Air System

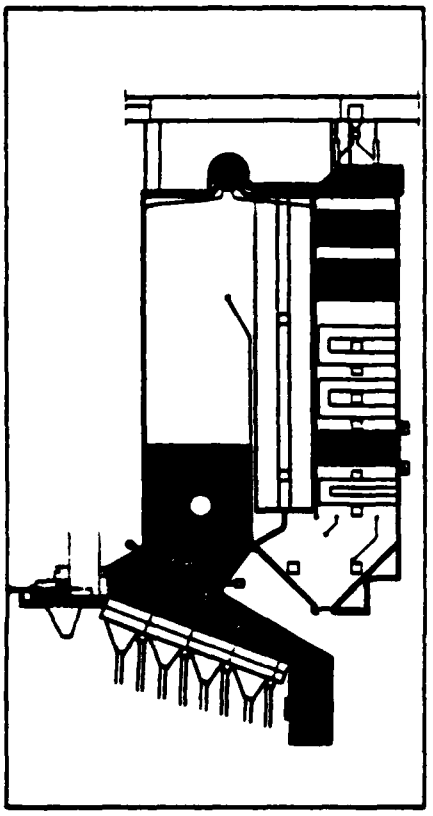
Besides its **primary air system** every modern refuse combustion plant is provided with a **secondary air system.** Its layout is decisive as to whether or not the tube panel-cooled combustion chamber is protected against corrosion. The hydrochloric acid (HCl) formed in the refuse combustion process can corrode the boiler tubing when gas burnout is incomplete and carbon monoxide (CO) remains present.
Von Roll has conducted extensive tests in plants and in flow control laboratories to determine the **optimum** combustion design *and* secondary air feed arrangements in order to achieve complete gas burnout, which removes corrosion risks.



Combustion air system



Combustion automation: steam production recording



Von Roll three-pass boiler

Combustion Chamber Deposits

The only effective measure against the formation of deposits depends on succeeding either in keeping the flyash away from the walls, or solidifying it by cooling, before the particles reach the walls. Combustion chamber wall cooling achieved solely by constructing it as a boiler panel is inadequate without additional provisions, although it will contribute to lowering the temperature in the chamber.
Therefore, Von Roll applies cooled non-perforated and perforated tiles on the surfaces of potential deposit areas.

Boiler

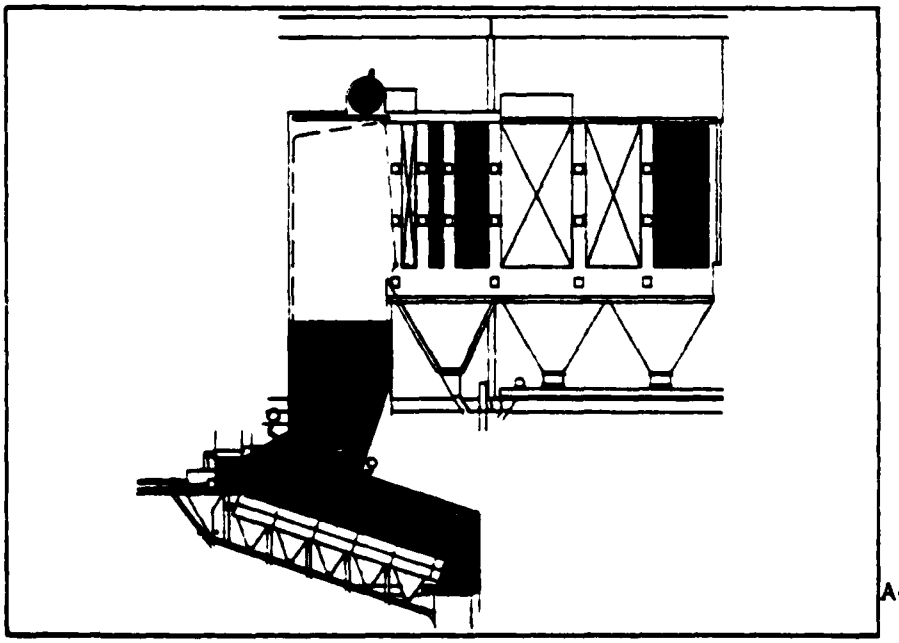
Boiler operation time (= on-duty time span between two consecutive cleaning shut-downs) is a crucial factor which largely determines the boiler design concept. Critical are the correct decisions as to combustion gas temperatures, gas velocities, arrangement of the various heat transfer surfaces, flow patterns on the combustion gas and steam raising sides, boiler cleaning provisions, and the measures against corrosion risks that are always prevalent in refuse combustion processes.
The **Von Roll two-pass boiler** is specially dimensioned and designed to meet these extreme requirements
Corrosion risk is particularly acute with high steam temperatures in the superheater such as are required at the present time in the interest of high energy generating efficiency.

Provisions against corrosion risk are:
- evaporator location upstream of the superheater
- secondary superheater in parallel flow with the gas stream
- effective cleaning (rapping devices)
- selection of appropriate construction materials
- low gas velocity through the tube banks.

Owing to such measures, particularly also the efficient cleaning provisions in refuse-fired boilers such as the rapping device, the Von Roll two-pass boiler ensures long operation periods.
However, Von Roll not only provides two-pass configurations. In cases where existing boiler houses or clients' requirements do not permit a two-pass boiler, a three-pass or even multiple-pass boiler will be provided. In such designs, as many fundamentals of the two-pass type as possible are applied, e.g. rapped suspended evaporators and mechanical shot-cleaning for the third pass.

Dust Removal and/or Flue Gas Scrubbing

The installations for dust removal and/or further flue gas purification are adapted case by case to the local demands and regulations.
Besides plants with mechanical or electrostatic dust removal equipment, Von Roll has constructed many facilities including wet flue gas scrubbing and treatment systems which satisfy the most stringent requirements.



Von Roll two-pass boiler

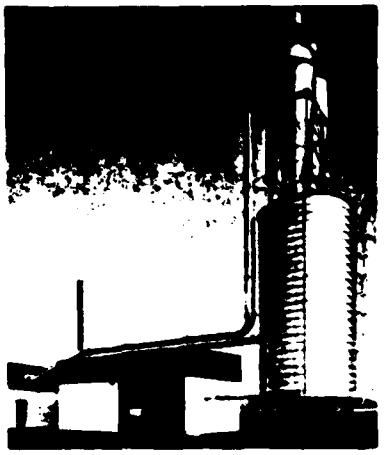
SYSTEM DATA SHEET

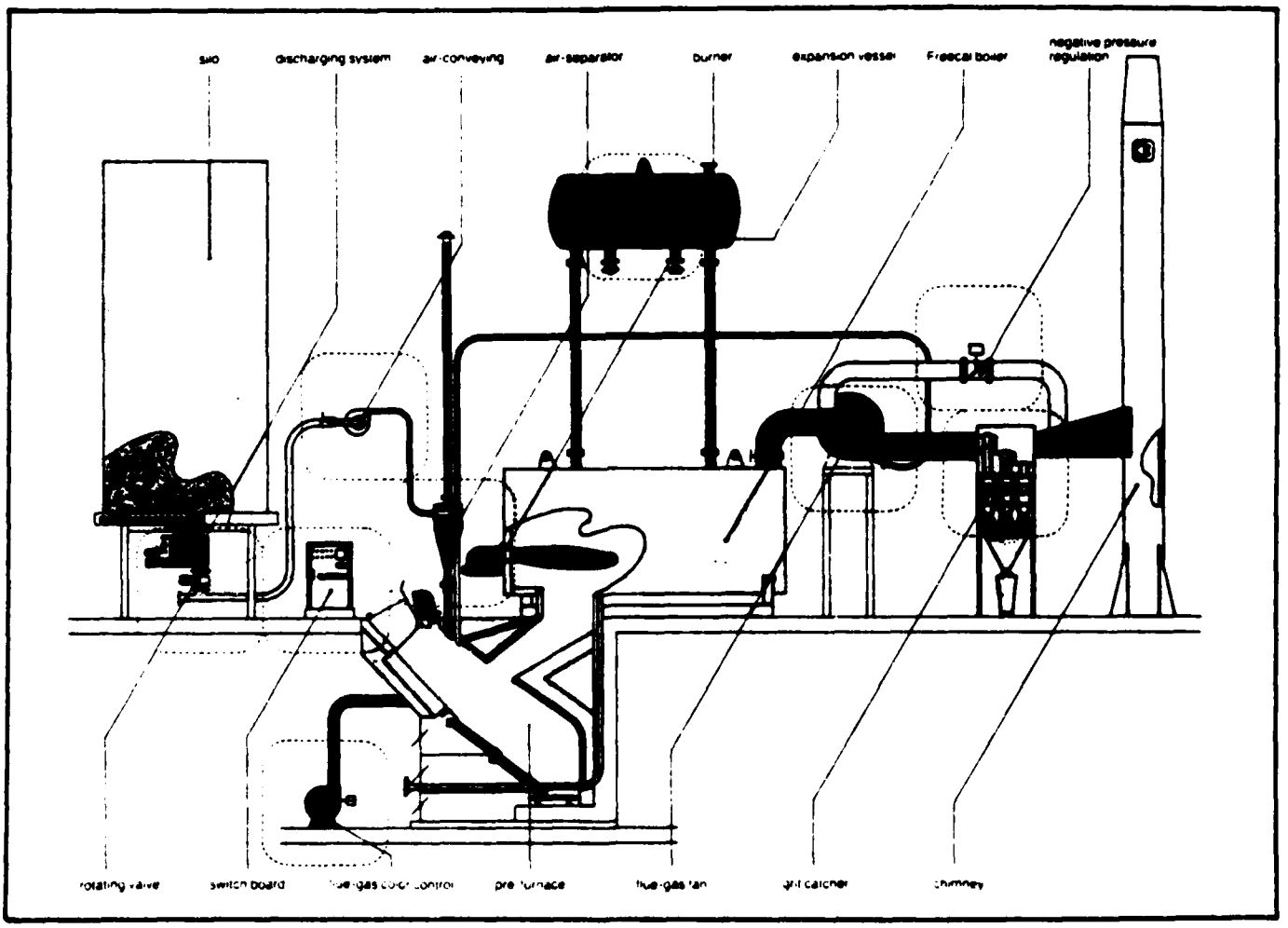
Name:	Elboma PVBA, Engineering Works
Address:	Fratersplein 10-11 B-9000 Gent Belgium
Contact:	Mr. Eric Boflen, Director, Export Division
U.S. Office:	None reported
U.S. Licensee:	Industrial Boiler Company, Inc. 221 Law Street P.O. Drawer 2258 Thomasville, GA 31792
Contact:	Mr. Welch Goggins
Technology Description:	Reciprocating, stepped grate in a two chambered combustor. Small second chamber without secondary air injection. Fire-tubed boiler. Three passes. Manual charging system consisting of counterbalanced doors utilized on many units. Continuous ash removal through wet pit and drag chain.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	None reported
Facility listing:	Attached ___Yes___ N/A _____
Other:	Experience mostly with industrial wood and paper waste. There are a few hospital units and only one municipal unit listed. Units appear to be under 0.75 TPH.

VENDOR Elboma PVBA

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Zon + Zee VZW, Belgium	1	0.6			Hot water

Turnkey Projects





Industrial Boiler Co., Inc.

Designers and Manufacturers of Energy Products for Industry
P.O. Drawer 2258/Thomasville, Georgia 31792
Telephone (912) 226-3024/Toll Free Number 1-800-841-1313/TWX No. 810-785-5848
Cable Address: "BOILERS, THOMASVILLE, GA, U.S.A."

B82-1

Industrial Boiler Co.

FREECAL FC-H HIGH PRESSURE BOILER WITH PRE-FURNACE

ELBOMA

WASTE INCINERATION WITH HEAT RECOVERY

IBC of the United States and Elboma of Belgium have combined their collective experience in the design of waste fired boilers and now offers the American made Freecal™ line.

The FC series is of the three pass horizontal firetube type and is available as high pressure steam (FC-S) or high pressure hot water (FC-H). Almost any solid waste with a sufficiently high calorific value can be used. These boilers are fitted with burners for instantly switching to burn gas or oil. This makes combined combustion possible.

Construction. The FC series is manufactured as per the requirements of Section I of the ASME Code, stamped for and listed by the National Board of Pressure Vessel Inspectors. Quality materials, modern construction technique, and advanced design ensure a quality boiler. Every unit is subjected to a series of quality control tests and inspections.

Insulation. The outer shell is insulated with a thick layer of fiberglass, covered with 22 gauge boiler jacket, and painted with epoxy.

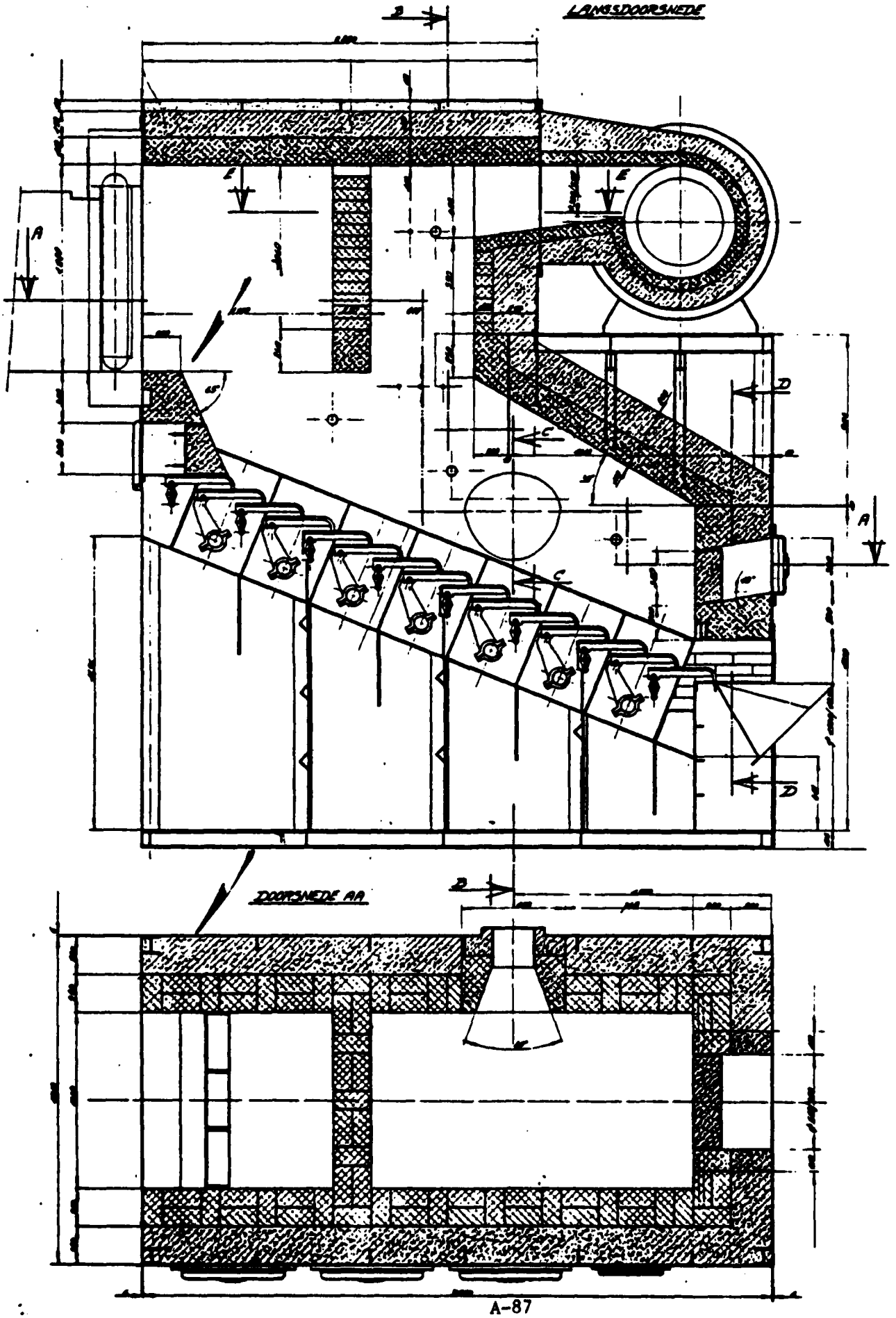
The use of a pre-furnace is recommended when it is necessary to burn large quantities of different kinds of wastes. The illustrated version is of the underground type with the pre-furnace below and in front of the boiler, having the charging door at floor level.

The pre-furnace includes:

- A refractory combustion chamber designed for burning the necessary quantities of dry or wet wastes.
- Refractory brickwork designed for quick and efficient drying of wet materials to facilitate combustion.
- A cooling screen protecting the refractory and connected to the boiler.
- Insulating brickwork around the refractory combustion chamber.
- An inclined grate.
- A flat grate for final combustion.
- A charging door with balancing counter-weights
- A refractory inner charging door.
- A bottom door with adjustable air inlets.

Advantages. The Freecal FC high pressure boiler offers the advantages of:

- long life due to robust construction
- flexibility of fuel supply
- high efficiency due to the multi-pass design
- energy conservation due to the burning of waste


LANGSDOORSNEDE
DOORSNEDE AA

SYSTEM DATA SHEET

Name:	Kvaerner Brug A/S
Address:	Mollergt 12 Oslo 1, Norway
U.S. Office:	None reported
U.S. Licensee:	None reported
Technology Description:	Batch loading with automatic removal of ash. Two chamber combustion. Modulated air. Substoichiometric in the primary chamber. Fire-tube boiler, 16-hr burning, 8-hr burndown, automatic ejection by means of tipping floor. Primary chamber serves as storage pit as the trucks dump directly into chamber. When full the charge door is closed, and the chamber is ignited. A second unit is provided if 24-hr energy recovery is required.
Brochure:	Attached ___Yes___ N/A _____
Recommended Facility listing:	Attached __incomplete__ N/A _____
Other:	Obtained technology recently from Thune-Eureka, another division of their company. Three facilities are mentioned, but there was not enough time to make contact. This system warrants further follow up to obtain more complete information.

VENDOR Kvaerner Brug A/S

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Norway			5	1980	Hot water
Norway			15	1981	N/A
Norway			15	1981	N/A

GENERAL BACKGROUND

Thune-Eureka A/S, an engineering and mechanical production company belonging to the Kvaerner Group of companies, has for several years been working in the field of environmental protection. More that 30 industrial and municipal sewage treatment plants are operating with good results throughout Norway.

The solid waste group is working within the field of composting and materials recycling as well as incineration, specializing on smaller plants with high technology - but low cost.

The Rutan/Thune-Eureka incineration plant is a joint development between Rutan Fabrikker and Thune-Eureka A/S, which meets the following criteria:

- Low investment costs
- Low running costs
- High prosessability
- Energy recovery
- Emission regulations
- Flexibility

TECHNICAL DESCRIPTION

The plant consists of the following main parts:

- The receiving chamber (A):

  The waste is tipped directly from the collection vehicle on to the hydraulically operated Charging plate (B) at the bottom of the receiving chamber after the Rolling port (C) has been moved to its top position. The primary chamber door (D) is now closed. As soon as the waste is deposited on the plate, the rolling port is closed to keep the waste out of sight and closed to the environment. The sealing surfaces around the rolling port keep possible odor from escaping to the surroundings. The capacity of the receiving chamber is abt. 25 m^3. The waste is then fed by hydraulically lifting the charging plate, and automatically opening the primary chamber door into the

- Primary chamber (E), by gravity. The charging plate is then lowered, and the door automatically closed. The incineration is now ready to take place.

The secondary burner (F) is now started to heat up

- the Seconday chamber (G) to 800°C before the waste is lit by activating the Starting burner (H) at the bottom of the primary chamber. Primary and secondary air are now automatically fed into the system from the Blower unit (I) controlled by the automatic control system to ensure the correct amounts. Both burners are now out of operation and the waste burns by itself.
Air is fed to the primary chamber trough 200 Nozzles (J) to get an even distribution over the whole surface of the waste heap.

The amount of air fed into the primary chamber is less than what is required for a complete combustion, and thus, the gases from this chamber, being in itself burnable, burn in the secondary chamber.

The gases, after having passed through the secondary chamber, enter into a simple Syclone (K) where small dust particles are removed, before going through the Boiler tubes (L) on its way out the chimney. In order to ensure a small negative pressure in the system at all times, and to control the incineration capacity, a Flue-gas blower (M) is installed.

The hot water boiler (N) is rated at 580 kW.

When the incineration is completed - and the slagg cooled down - it is tipped,by hydraulically opening the Side plate (O) in the primary chamber, into a Container (P) for removal to landfill site.

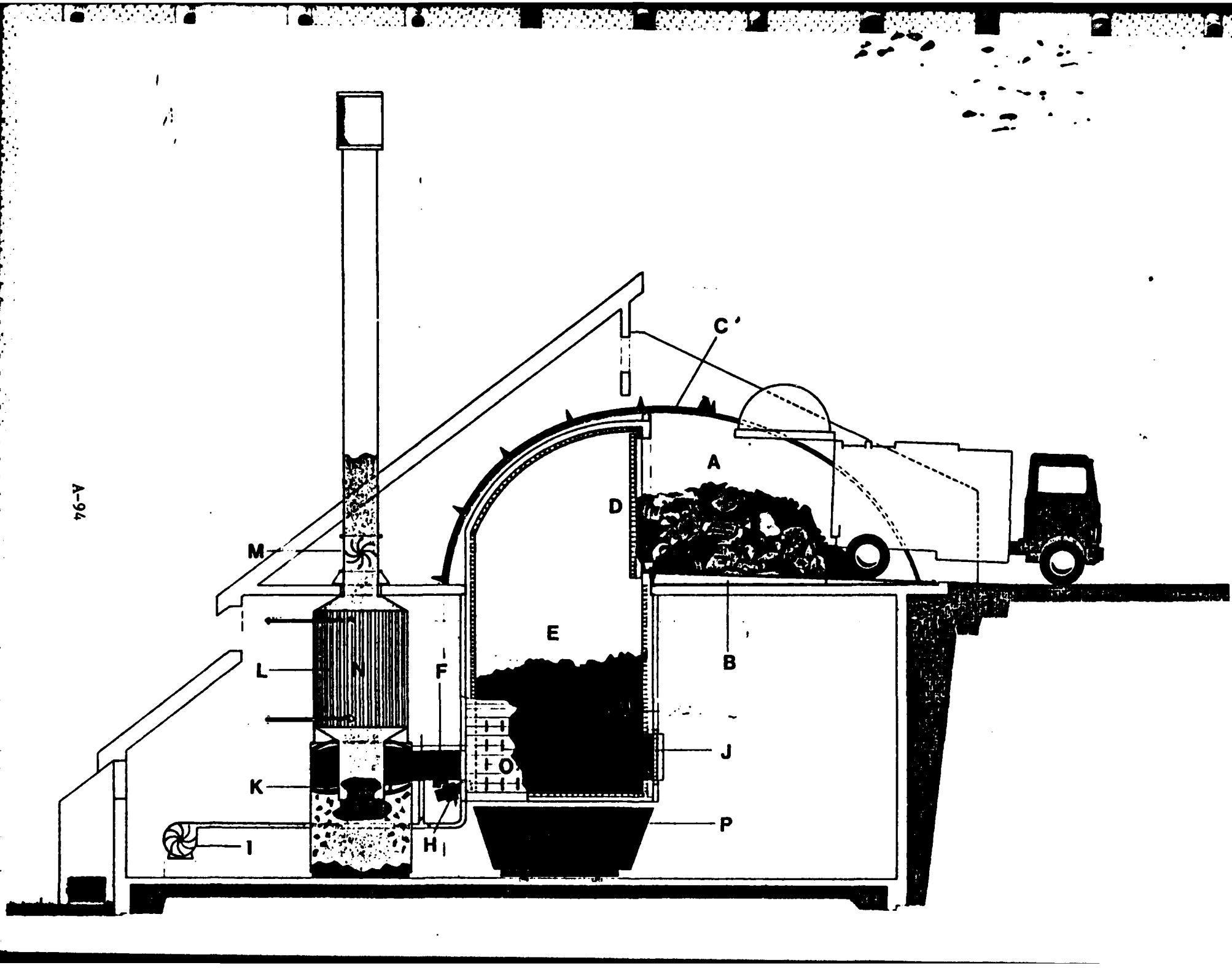
The incinerator is now ready for its next batch.

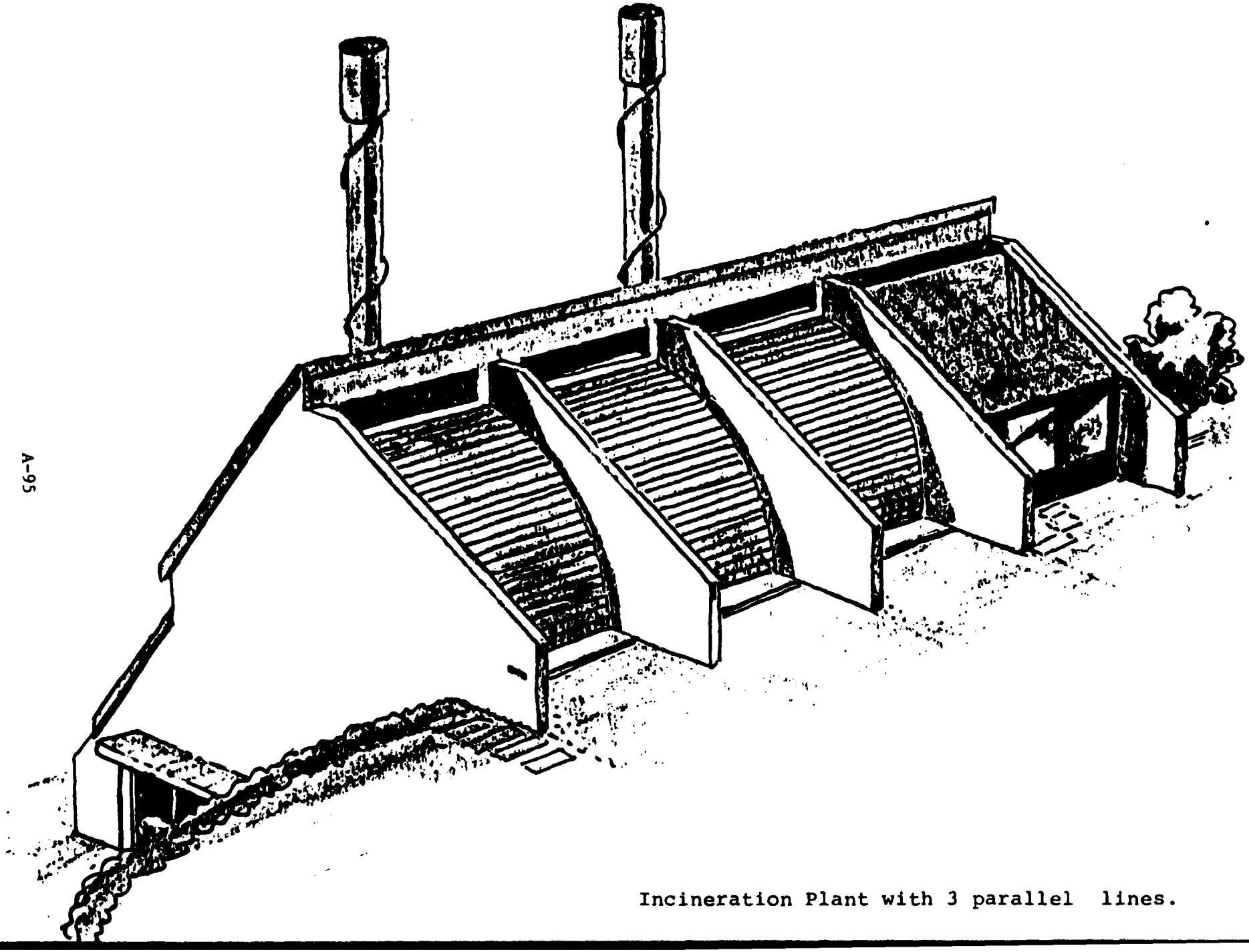
.....

MAIN DATA* (per incinerator):

Maximum capacity	375 kgs/h
Maximum daily capacity (the incinerator can be recharged up to 6 tons during operation)	6 tons
Required cooling time	8 hrs/day
Storage capacity	25 m^3 (enclosed)
Air requirement	abt. 2500 Nm^3/h at abt. 1500 mm pressure
Oil requirement	abt. 70 litres/cycle
Volume reduction	97 %
Operators required	1 on 8 hrs day (the plant, once started, runs automatically)
Installed power	25 kW
Rated power from boiler	580 kW (Available 16 hrs/day at full capacity)
Flue-gas velocity at top chimney	abt. 10 m/S
Dust in flue-gas	max. 150 mg/Nm^3 at 7 % O_2

* All data referred to Norwegian Municipal waste with a heat value of 2.300 kcal/kg (2,67 kWh/kg)


C'
A
D
M
E
B
L
F
J
O
K
P
I
H



Incineration Plant with 3 parallel lines.

SYSTEM DATA SHEET

Name:	Norsk-Hydro
Address:	Oslo Norway
U.S. Office:	None reported
U.S. Licensee:	Stock Equipment Co. Energy Systems 16776 Bernardo Center Drive San Diego, CA 92128
Contact:	Mr. James N. Siltanen
Technology Description:	The Norsk-Hydro system is a two stage modular incinerator having a capacity of 300 to 2000 lb/hr at 4500 Btu/lb. Ash is removed by an auger in the bottom of the primary chamber hearth. Technical data available are incomplete.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	Apartment Heating Plant Oslo Norway 0.9 TPH, hot water, 1981
Contact:	Mr. James Siltanen, Stock Equipment Co.
Facility listing:	Attached __only one__ N/A _____
Other:	Units in operation are less than 0.75 TPH except for the apartment unit above. Units appear to be designed for 16-hr operation with 8-hr burndown while processing industrial or hospital waste.

VENDOR Norsk-Hydro

Facility & location	No. of units	Unit capacity TPH	Plant capacity TPD	Start date	Energy recovery
Oslo, Norway	1	0.9	22	1981	Hot water

STOCK®

Energy Systems

Modular Incineration System

STOCK presents a state-of-the-art system for the incineration of solid, sludge, and liquid wastes. The system satisfies stringent environmental regulations. Operation is highly automated. Incineration occurs by partial pyrolysis in the primary chamber followed by complete thermal destruction in the turbo-oxidation secondary chamber. Economics based on total system investment with low operation and maintenance provides payback from both energy and waste disposal cost savings. The equipment is reliable with special features proven over several years of operation.

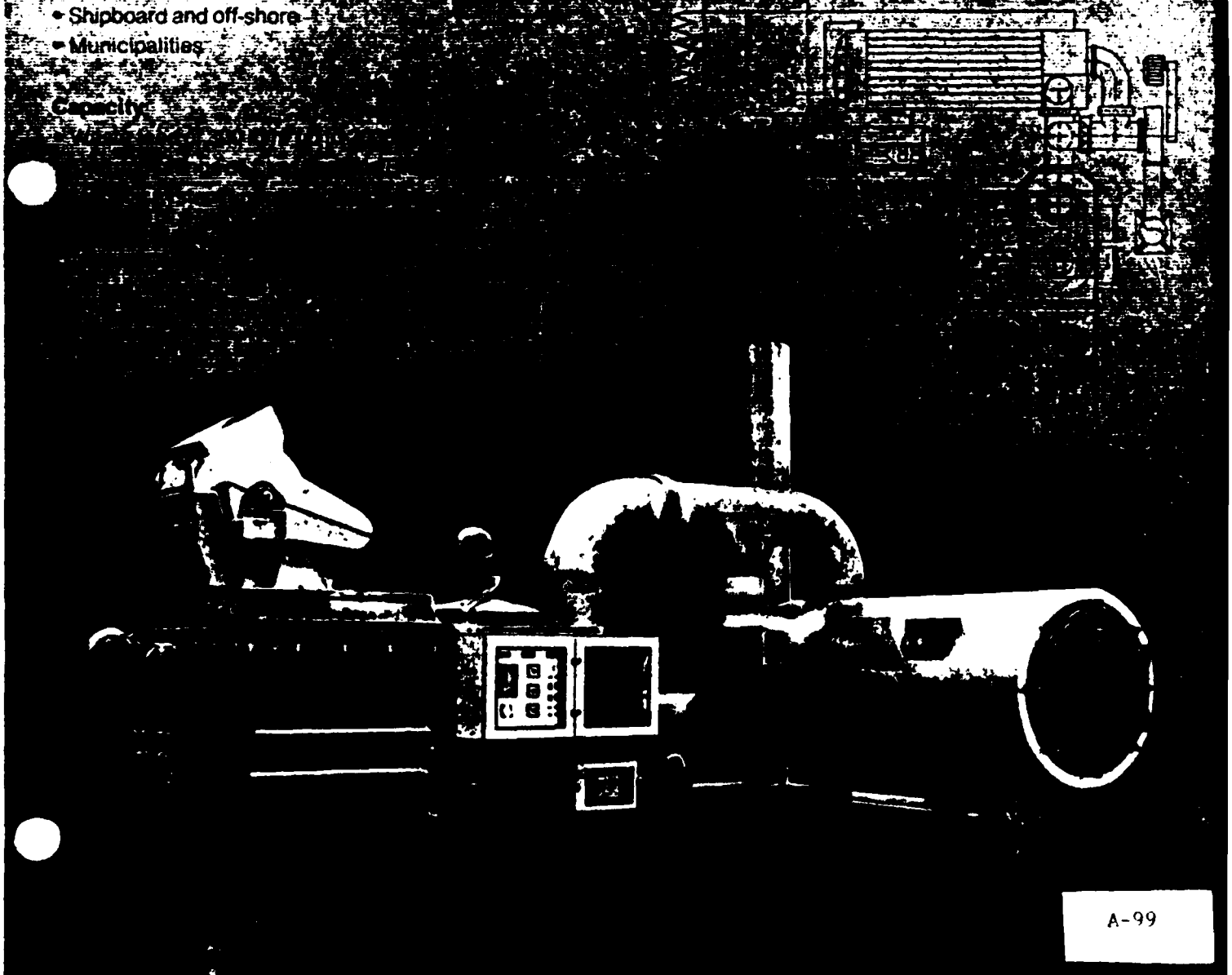
Applications

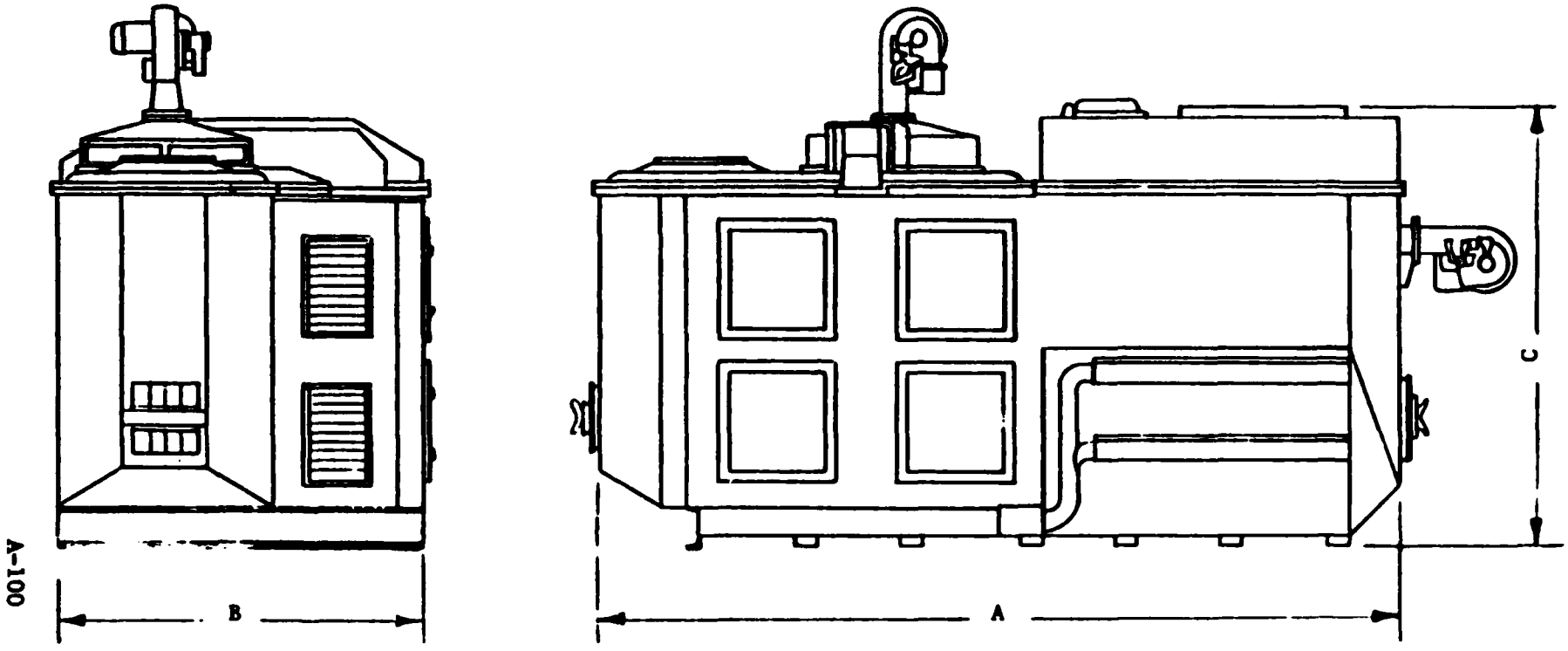
- Hospitals, medical, and research centers
- Industry including hazardous wastes
- Shipboard and off-shore
- Municipalities

Capacity

Special Features

- Compact multi-chamber modular design
- Unique turbo-combustion zone
- Integrated control system
- Controlled feeder system
- Clean flue gas — low particulate
- Built-in fly ash separator
- Complete burnout with sterile ash
- Automatic ash removal
- High temperature waste destruction
- Multi-fuel capability
- Efficient energy recovery





Model	Length - A	Width - B	Height - C	Weight (lb)
ST-1	9' - 7"	5' - 7"	7' - 3"	10,500
ST-2	12' - 3"	6' - 2"	5' - 11"	21,000
ST-4	17' - 9"	8' - 2"	9' - 4"	44,000
ST-8	26' - 8"	10' - 2"	14' - 2"	88,000

Stock Equipment Company • 16776 Bernardo Center Drive • San Diego, California 92128, U.S.A. • (714) 485-9864
A Unit of General Signal

Form 772-2M-7/82

MODULAR INCINERATOR WITH ENERGY RECOVERY

The utilization of heat released by the destruction of waste is practical and economic. With the increasing cost of waste disposal and the present level of fossil fuel prices, investment in an incinerator system can result in benefits and payback for industries and institutions having to dispose of more than 3000 pounds of waste per day. The STOCK modular incinerator uses a turbo-combustion patented design, proven over several years and now operating throughout the world.

Applications

The incinerator is designed for the destruction of both solid and liquid wastes with effective energy recovery. These wastes include industrial, general and pathological hospital waste, ship wastes, special hazardous wastes, municipal solid waste, woodwaste and other biomass materials.

Capacity

The combustion capacity of the incinerator models is 1 to 10 million Btu/hr. For normal waste with a heating value of approximately 4500 Btu/lb, the incinerator capacity is between 300 and 2000 lb/hr of waste feed.

Model	Thermal Rating (Million Btu/hr)	Waste Capacity (lb/hr)
ST-1	1.5	300
ST-2	2.5	500
ST-4	5.0	1000
ST-8	10.0	2000

SYSTEM DATA SHEET

Name:	Alberti-Fonsar
Address:	Not available
U.S. Office:	None reported
U.S. Licensee:	None reported
Technology Description:	Single action grate. One grate slides over a fixed grate. Waste from feed hopper is injected by a feed ram. Gases pass out the back of the combustion chamber rather than over the top.
Brochure:	Attached _____ N/A ___X___
Recommended facility:	None reported _____
Facility listing:	Attached _____ N/A ___X___
Other:	This vendor was listed in the De Renzo work but no mailing address could be obtained. Some facilities close to the desired size range were listed.

SYSTEM DATA SHEET

Name:	Widmer & Ernst
Address:	Zentralstrasse 74 5430 Wetteingen, Switzerland
U.S. Office:	None reported
U.S. Licensee:	None reported
Technology Description:	Not available at this time.
Other:	Information has not been obtained at this time but is expected shortly. Review of the literature does not list any unit with less than 5-TPH capacity.

SYSTEM DATA SHEET

Name:	BKMI Industrieanlagen GMBH
Address:	Sapporobogen 6-8 D-8000 München 40 Germany Telephone: 089/12 40
Contact:	Mr. Orlin
U.S. Office:	Ford, Bacon & Davis Inc. 375 Chipeta Way Salt Lake City, UT 84108 Telephone: (801) 583-3773
Contact:	Mr. J. Edward Immergluck
U.S. Licensee:	None reported
Technology Description:	Large rotary kiln and pyrolysis combustion. Destruction of chemical and industrial waste.
Brochure:	Attached ___Yes___ N/A _____
Recommended facility:	None reported
Facility listing:	Attached ___Yes___ N/A _____
Other:	Formerly Krauss-Maffei and part of Deutsche-Babcock along with VKW. Technology limited to rotary kiln and pyrolysis in MSW. VKW takes all grate projects.

SYSTEM DATA SHEET

Name:	Cornel Schmidt
Address:	Maschinen und Apparateban Postfach 10 1270 D-5090 Leverkusen 1 Federal Republic of Germany
U.S. Office:	None reported
U.S. Licensee:	None reported
Technology Description:	Pyrolysis plant for waste and paper incineration. Two chamber substoichiometric incinerator. Batch feed and ash removal. Packaged fire-tube boiler.
Brochure:	Attached ___Yes___ N/A _____
Other:	No municipal waste experience.

Pyrolysis, substoichiometric combustion

New anti-pollution waste disposal methods!

The destruction of refuse by means of combustion is the most customary method of waste disposal and has reached a high technical level. In the past, the combustion was not satisfactory in some cases due to changing compositions of refuse, different calorific values, high proportions of plastics and increasing amounts of waste. Efforts to find further improvements of the combustion process led to the utilization of an old technique, namely, the thermal fission with a deficiency of free oxygen (also called dry distillation), today covered by the general term pyrolysis.

The technique is very old and was already used in charcoal piles as well as at the beginning of the twentieth century in the distillation of wood for driving motor vehicles or gas engines.

In the field of thermal waste disposal, the designation pyrolysis has also been generally adopted for the "degasification", "dry distillation" and "gasification" processes.

A complete combustion is obtained in the traditional incineration of waste by supplying great air volumes (air factor 2). Pyrolysis, on the other hand, operates with a deficiency of air, which means that only 16–25% of the air volume normally required for a complete combustion of waste is supplied to the combustion chamber through nozzles. This deficiency of free oxygen is called substoichiometric combustion. The combustible gas produced in this way (mainly steam and hydrocarbons) is also called pyrolysis gas. The pyrolysis gas is lighted up by a burner in an afterburning chamber and burned at a temperature of 800–850° C by supplying the required air volume.

CS-JABU Pyrolysis Installations
operate according to the following system:

The incinerator is charged with the waste material manually or automatically via a charging hopper. The afterburning chamber is then preheated to an operating temperature of ≥ 800° C by cutting in the light-oil or natural gas afterburner and the carbonization process initiated by cutting in the lighting-up burner in the main combustion chamber for a short period of time.

The combustible or pyrolysis gas set free is lighted up and burnt in the afterburning cyclone together with the required volume of air.

The capacity stages of the afterburner are switched in accordance with the calorific value of the pyrolysis gas or the burner is switched off.

The particularly significant thermocompensation of the carbonization process and an absolutely uniform incinerator waste gas temperature with minimum consumption of additional fuel are obtained by regulating the carbonization chamber or afterburner chamber air volumes with cutting in of the two additional burners if required.

Numerous TUV (Test Code Association) test certificates confirm the advantages of this process. The cooling of waste gas can take place by the addition of fresh air or in a waste heat boiler.

In the case of a lacking heat requirement or of a malfunction in the water or steam circuits, the incinerator waste gas is cooled with fresh air and conducted directly to the stack, bypassing the boiler.

The installation is fully automatic with the exception of the intermittent combustion chamber charging.

Larger types of incinerators can be run in continuous operation by automating the ash removal.

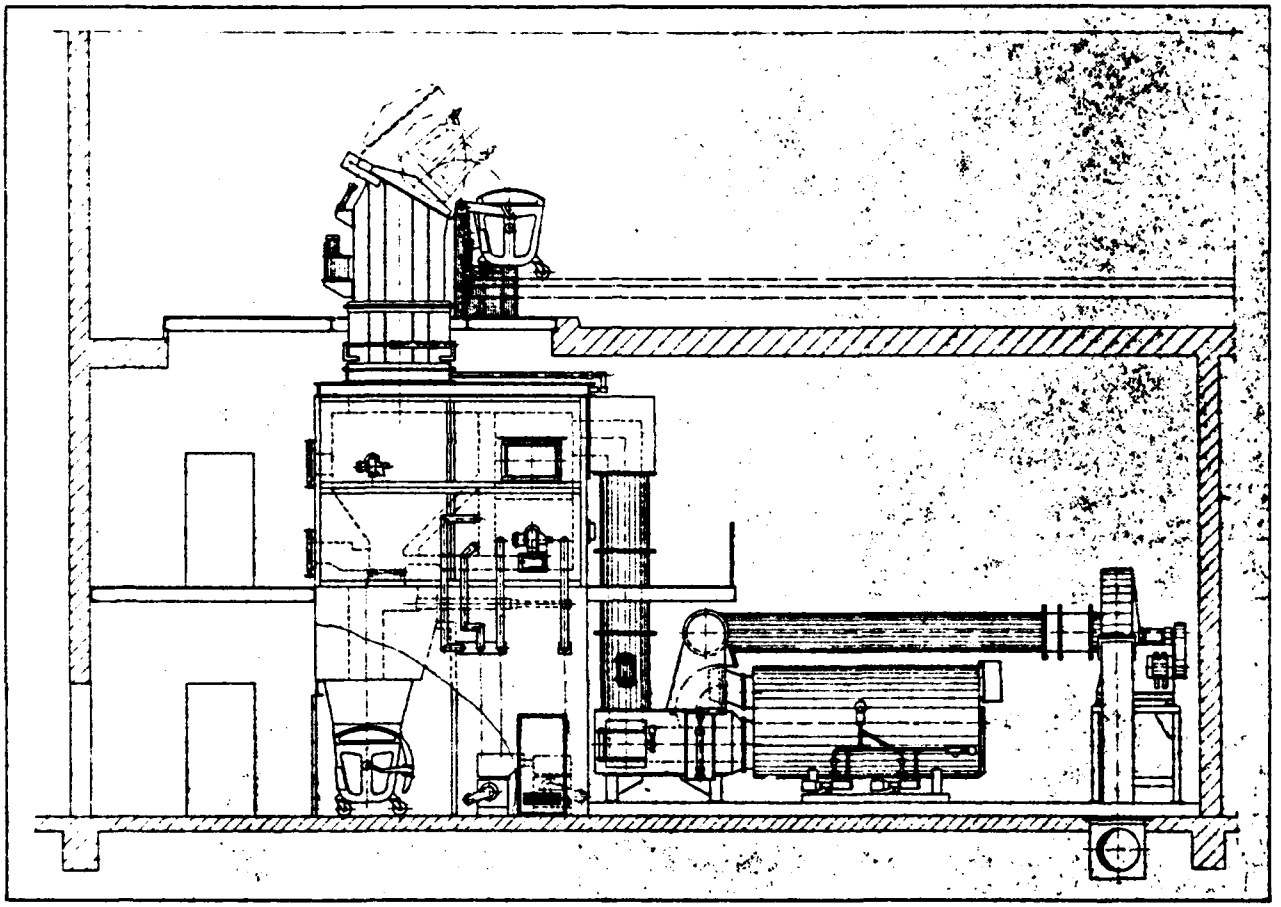
Summary

- The combustion chamber (carbonization chamber) can be charged with waste material for a maximum of 2 operating hours. Staff requirements are thus negligible.
- The waste can contain plastic materials up to a proportion of 40% or even more if they have a suitable composition, without reaching the legal limits fixed for the waste gas emission values. The proportion of waste materials containing chlorine is limited.
- Lowest dust and pollutant emission values or grey scale values of the waste gas plume.
- Optimum burn-up rate of aromatic substances in the waste gas.

CORNEL. SCHMIDT **CS-JABU**

PYROLYSETECHNIK VERTRIEBS-GMBH
von-Kettler-Straße 1 · D-5090 Leverkusen 1
Telefon 02 14 / 6 40 31
Telex Leverkusen 851 08 16

Zweigbüro Troisdorf
Landgrafenstraße 37–39
D-5210 Troisdorf-Oberlar
Telefon: (0 22 41) 4 20 71

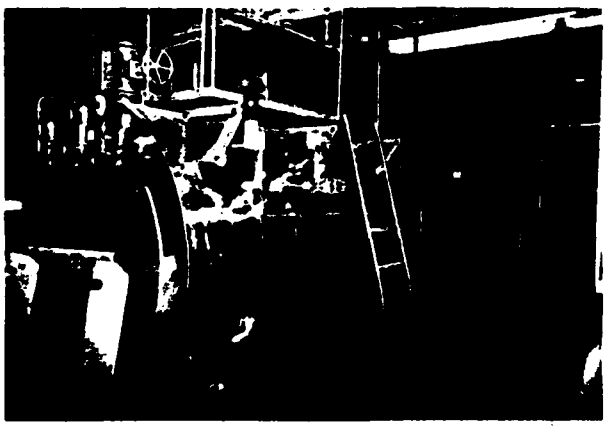


Pyrolysis installation with container charging and waste heat boiler

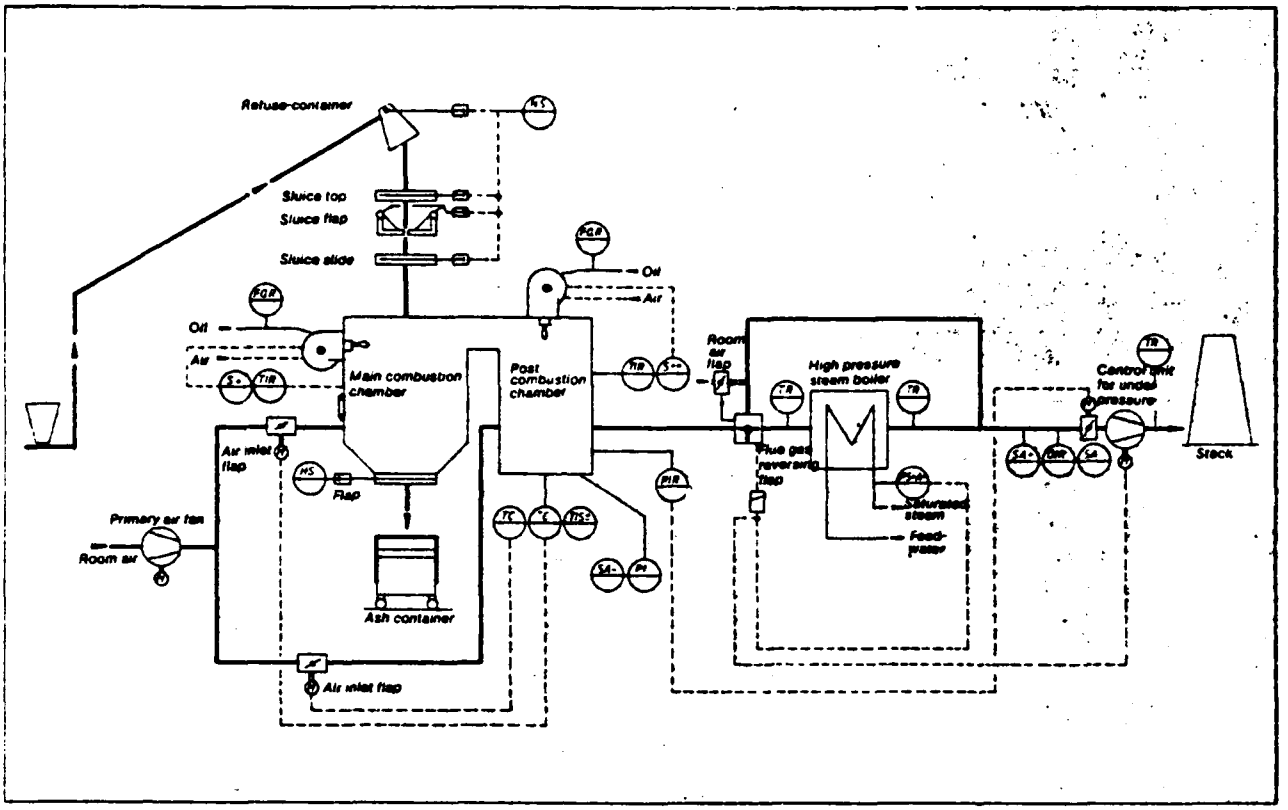
Energy gain by means of heat exchangers or waste gas boilers

- The increasing costs of primary energies and the German Energy Act (Energie-Sicherungsgesetz) make it a compulsory requirement to utilize the flue gas heat which has so far been wasted in the refuse incineration.
- The waste gas from our pyrolysis furnaces has a degree of purity that allows a variety of boilers or heat exchanger combinations to be used without the risk of heating surfaces becoming contaminated.
- The heat recovery plant system can be adapted to your specific requirements.

  Possible heat exchanging media:
  - warm or hot water,
  - low-pressure or high-pressure steam,
  - thermal oil or hot air.



Waste heat boiler behind pyrolysis installation



Functional Characteristics

Charging:
with container tilting mechanism

Feeding:
Feed hopper with pneumatically operated top hopper cover and bottom hopper slide valve.

Ignition:
of the fuel by means of a light-oil or natural gas auxiliary burner and beginning of the carbonization process. After ignition the burner is cut out.

Combustion air feeding:
with the combustion air blower. The air volumes supplied to the carbonization chamber and to the afterburning chamber are proportioned with combustion air dampers 1 and 2.

Combustible or pyrolysis gas:
The pyrolysis gas set free in the carbonization chamber is lighted up with the 2-stage afterburner in a cyclone cell in the afterburner chamber and burned with the introduction of the combustion air.

Depending on the calorific value or the combustibility of the pyrolysis gas, the afterburner stages are switched or the afterburner is cut out.

Note: It can be proven that the requirement of additional fuel is at a minimum value due to the switching of the two burners.

Measuring and control equipment:
The whole carbonization process and the combustion of the pyrolysis gas are regulated by the air damper control and the circuitry of additional burners in such a way that a uniform waste gas temperature of approx. 850° C in the afterburning chamber and a minimum consumption of supplementary fuel is guaranteed.

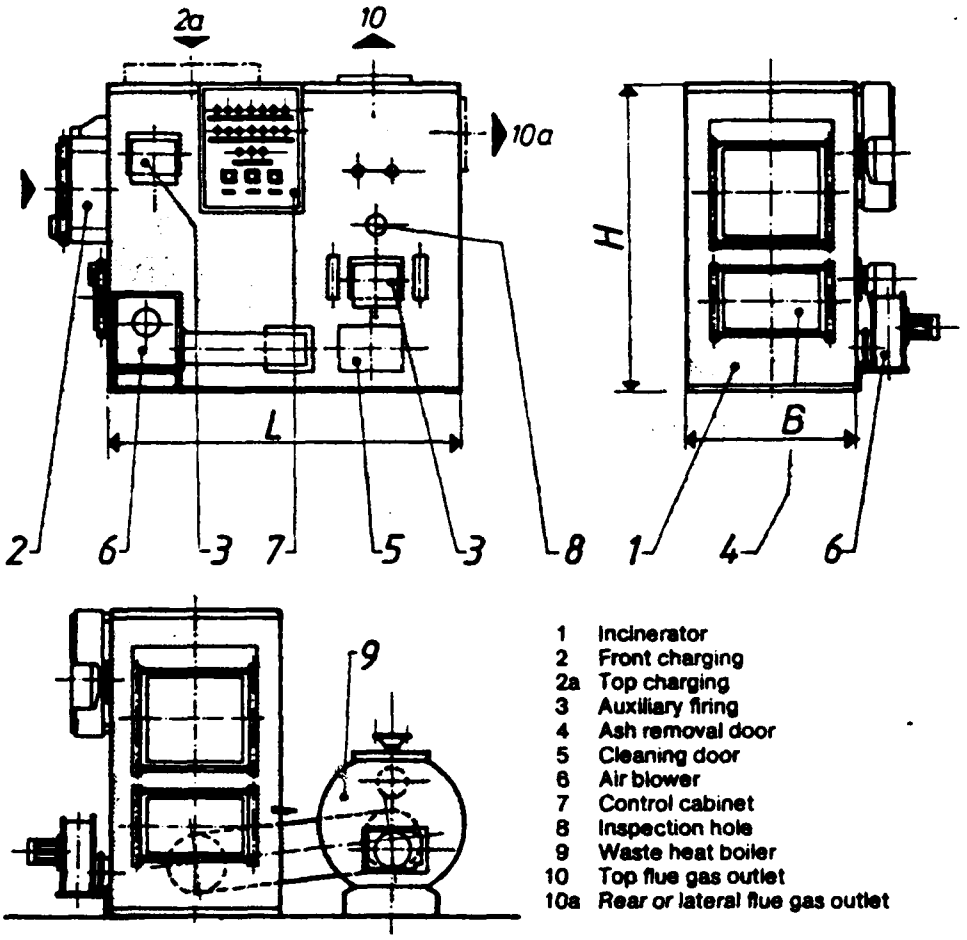
The waste gas temperatures in the carbonization chamber, the afterburning chamber and the waste gas temperature behind the waste heat boiler are indicated and recorded. The suction at the incinerator end is controlled.

Ash removal:
by operating the ash slide valve, into an ash can placed underneath.

Waste gas cooling:
from approx. 850° C to approx. 220 to 280° C in the post-arranged smoke tube waste heat boiler.

Bypass equipment:
In the case of a malfunction in the boiler safety chain (e.g., deficiency of water) or if the steam consumption is too low, the boiler is bypassed on the flue gas side and fresh air is additionally supplied for waste gas cooling. This process is fully automatic.

Waste gas fan:
This fan produces the required suction and conveys the waste gas to the stack.



1 Incinerator
2 Front charging
2a Top charging
3 Auxiliary firing
4 Ash removal door
5 Cleaning door
6 Air blower
7 Control cabinet
8 Inspection hole
9 Waste heat boiler
10 Top flue gas outlet
10a Rear or lateral flue gas outlet

Technical Data		Standard Types			Special Types		
Incinerator type		**CE 50**	**CE 100**	**CE 200**	**CE 300**	**CE 400**	**CE 500**
W – width	mm	1060	1350	1650	1900	2200	2450
L – length	**mm**	**2200**	**2400**	**2975**	**3600**	**3800**	**4175**
H – height	mm	1900	2000	2300	2550	2800	3000
Charging door – front	**mm**	**500/550**	**500/550**	**500/600**			
Charging hopper – top	mm	500/600	700/600	800/800	800/800	800/1000	1000/1000
Topping up quantity	**m³**	**0.58**	**0.92**	**1.75**	**2.25**	**3.20**	**4.6**
Combustion capacity kg/h at Hu = 2,500 kcal/kg waste		50	100	200	300	400	500
Weight	**approx. kg**	**4500**	**9000**	**12000**	**15000**	**18000**	**23000**
Chimney cross section	approx. cm²	625	1225	2500	4000	5000	6500

* Approximate values; the required dimensions are calculated by us in accordance with the specific project.

END

FILMED

5-83

DTIC