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Overview of Biomedical Waste Technology of Contaminants in Letters

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Abstract

Nonincineration methodologies for proper treatment of ***biomedical waste*** *are in increasing demand around the world, as more and more countries adopt regulations restricting air pollution.*

Allen Engineering & Sciences, P.C., recently prepared a report ("Biomedical Waste Treatment and Disposal Options in the Philippines," May 2002) regarding biomedical waste treatment technologies and vendors, at the request of the Philippine Environmental Management Bureau (EMB). Data for the Report were developed under a grant to EMB from the United States Trade and Development Agency.

The Report is intended to provide information needed by EMB and potential buyers of nonincineration biomedical waste treatment equipment for use in the Philippines, and to facilitate communication among vendors of such equipment and potential buyers in that country. It also provides useful information for other parties and governments around the world that are interested in gathering information on current technologies for biomedical waste treatment. Over 50 vendors of biomedical waste treatment technology and equipment were contacted, as part of the Report research effort. This paper summarizes information developed for the Report.

The following are salient points that have grown out of the research conducted for the Report.

1. The limited budgets and size (bed count) of most Philippine medical facilities will probably inhibit the purchase of new, in-house biomedical waste treatment equipment for many of these facilities. Low-technology approaches to sharps (e.g., filling partially full used sharps containers with cement mortar before disposing of them) should be considered, at least for small or remote hospitals.

2. Secure landfills are not available in the Philippines. Solid waste, including treated biomedical waste, is subject to scavenging at open dumpsites. Adequate treatment and destruction of biomedical waste, particularly sharps (e.g., used hypodermic needles), is therefore a significant concern.

3. Notwithstanding the generally limited budgets noted above, a significant market for nonincineration biomedical waste treatment equipment and services exists in the Philippines.

Description of Purpose

General

The Philippine Clean Air Act of 1999 and its November 2000 Implementing Rules and Regulations require that all incineration of biomedical wastes be phased out by July 17, 2003. EMB is charged with enforcing this requirement. EMB has requested investigation of technologies that would comply with the Clean Air Act, while providing the necessary destruction of pathogens in such wastes. This paper summarizes the following key elements of the Report written to address that request:

- A listing of technology types and vendors
- An indication of approximate capital costs for treatment systems
- A tabulation of vendor pathogen destruction performance claims

In the Philippines, "biomedical waste" refers to pathological wastes, pharmaceutical wastes, chemical wastes, and sharps defined as follows (Philippines Republic Act No. 8749):

"Pathological wastes" include all human tissue (whether infected or not) such as limbs, organs, fetuses and body fluid; animal carcasses and tissue, together with all related swabs and dressings;

"Pharmaceutical wastes" include pharmaceutical products; drugs and chemicals that have been returned from wards; have been spilled or soiled; are expired or contaminated; or are to be discarded for any reason;

"Chemical wastes" include discarded solid, liquid or gaseous chemicals from laboratories or other sources such as diagnostic work, environmental work, cleaning, housekeeping and disinfecting procedures; (and)

"Sharps" include needles, syringes, scalpels, blades and any other items that could cut or puncture.

The wastes listed above are generally referred to as "biomedical waste" or "regulated medical waste."

The Report is considered a necessary step in order to perform the following tasks:

- Verify the feasibility of the Clean Air Act-mandated phasing out of biomedical waste incineration.
- Provide technical and cost information regarding available alternative technologies.
- Achieve regulatory acceptance for widespread use of appropriate alternative biomedical waste treatment and disposal technologies in the Philippines, by providing a source of information that regulators can use in order to evaluate treatment system proposals for compliance with the existing Philippine regulations.

The Report was developed with the cooperation of the EMB and the Philippine Department of Health (DOH). The Report is not intended as a guide for the handling and management of biomedical waste, which in itself is a large and significant topic. It should be noted, however, that such waste should be properly segregated and handled as part of an overall waste management strategy. Proper waste segregation and management are keys to minimizing the amount of waste that must ultimately be treated and disposed of, as much waste originating in medical facilities (e.g., cafeteria waste, general waste) may be disposed of without treatment if it is properly segregated from biomedical waste.

Importance of Treatment Technology Guidance

Financial and operational issues (including utility requirements such as steam) are important in the selection of capital equipment such as bioemedical waste treatment systems. In addition, there are several factors that should enter into the selection of biomedical waste treatment technology. These include:

1. Need to comply with Clean Air Act requirements (thus avoiding harmful emissions of air pollutants)
2. Need to prevent possible improper disposal of untreated biomedical waste in landfills (when landfills become available), in open dumps, or by release to informal recyclers/scavengers
3. Need to properly disinfect waste to prevent possible transmission of disease (This is especially important because virtually all wastes are subject to scavenging in the Philippines.)
4. Potential need to properly treat the newly discovered, difficult-to-treat infectious protein particle (prion) that causes Creutzfeldt-Jacob Disease (CJD) or variant Creutzfeldt-Jacob Disease (vCJD).

It should be noted that the biomedical waste treatment performance levels provided in Table 1 (for which vendor pathogen destruction claims are provided in Table 3) do not address destruction of prions. Treatment of prions as such is beyond the scope of the present article. For facilities that anticipate a need to treat prion-containing waste, prion-specific performance information should be sought from the vendor and verified by appropriate testing agencies.

Biomedical Waste Treatment Performance

Performance indicators/levels of biomedical waste treatment (degrees of microbial inactivation or "disinfection levels") are listed in Table 1. Table 1 is

Table 1
Biomedical Waste Treatment Performance Requirements

Level	Minimum Requirement
I	6 log 10 Inactivation of vegetative bacteria and fungi
II	6 log 10 Inactivation of mycobacteria
III	4 log 10 Inactivation of *B. subtilis* (heat) or *B. stearothermophilus* (chemical)
IV	6 log 10 Inactivation of *B. stearothermophilus*

derived from "Guidance for Evaluating Medical Waste Technologies" (Jan. 1993; EPA contract no. 68-WO-0032). Microbial inactivation refers to the effects of physical or chemical processes that render microorganisms incapable of multiplication. Such processes may either kill the organisms or injure them to the extent that effective repair and subsequent growth are not possible. Level IV is the most stringent level of microbial inactivation.

Vendor Information Tables

Table 2 (presented on the following pages) presents contact information for 47 vendors of biomedical waste treatment technologies, located in seven countries. Table 3 provides a comparison of treatment system technologies, including performance and other data, for systems provided by the 21 vendors that responded to requests for information for the Report. Table 2 groups thermal processes into three groups: low heat, medium heat, and high heat. Low heat thermal treatment involves achievement of temperatures approximating the boiling point of water (e.g., use of microwaves or steam autoclaving) or somewhat higher temperatures for pressurized steam systems. Medium heat treatment takes place above 350°F and below 700°F. Finally, high heat thermal treatments operate at more elevated temperatures, generally ranging from around 1,000°F (540°C) to 15,000°F (8,300°C) or higher. High heat processes involve chemical and physical changes resulting in destruction of the waste.

The reader should note that the data (including claims of pathogen destruction) were provided by the companies that produce the treatment technologies. Each vendor was requested to provide written verification of its system's claimed pathogen destruction capability. A letter from a State regulatory authority indicating that the system will "totally destroy all pathogens which have any potential to be harmful to health and the environment" or a sterilization assay report showing laboratory test results for destruction of *B. stearothermophilus*, are examples of such verification. The following vendors provided such written verification:

- Environmental Waste International
- Hydroclave Systems Corp.
- Matrix Technology PTY Ltd.
- San-I-Pak
- Sterile Technology
- Thermal Waste Technologies, Inc.
- Vanguard Research, Inc.

Allen Engineering & Sciences, P.C. makes no claim (either in support or to the contrary) regarding the information provided by vendors as presented in this article.

Information on Tables

Type Key: H = high heat thermal; M = medium heat; L = low heat; I = irradiation; C = chemical/mechanical; O = other; U = undefined

Notes:

1. Please refer to Table 1 regarding Disinfection Levels. Asterisk (*) denotes likely technology-based disinfection level, but confirmation testing has not been performed.
2. Each vendor was requested to provide written verification of its system's claimed pathogen destruction capability. A letter from a State regulatory au-

Table 2

Biomedical Waste Treatment Technology Vendors

Type Key: H = high heat thermal; M = med. heat; L = low heat; I = irradiation; C = chemical/mechanical; O = other; U = undefined											
Description/Type		**Contact**		**Agency**	**Address**					**Telephone**	**E-mail address**
Alkaline Hydrolysis	C	Ms. Kristina	Bransford	Waste Reduction by Waste Reduction, Inc. (WR^2)	5711 West Minnesota Street	Indian-apolis	IN	46241-3825	USA	317-484-4200 or 877-749-2783	kbransford @wr2.net
Autoclave or Retort	L	Ms. Elsa	Brown	BondTech Corp.	2400 North Highway 27	Somerset	KY	42503-5548	USA	606-677-2616	elsabrown@ earthlink.net
Autoclave or Retort	L	Mr. Roger	Markle	Mark-Costello Co.	1145 East Dominguez Street Suite J	Carson	CA	90746-3566	USA	310-637-1851	rogermarkle@ aol.com
Autoclave or Retort	L	Ms. Jennifer	Navarro	Tuttnauer USA Co. Ltd.	25 Power Drive	Hauppauge	NY	11788-4229	USA	631-737-4850	jennifer@ tuttnauer.com
Autoclave or Retort	L	Mr. John	Bucar	Environmental Techtonics Corp.	125 James Way	Southamp-ton	PA	18966-3877	USA	215-355-9100 x1360	info@etcusa. com
Chemical	C	Mr. Michael	Sumner-Potts	Matrix Technology PTY Ltd.	P.O. Box 1213	Cairns	QLD	4870	Aust-ralia	+61 7 4051 2955	msp@cairns. net.au
Chemical/ Mechanical	C	Mr. Andre	DiMino	EnviroPack Development Corp.	224-S Pegasus Avenue	Northvale	NJ	07647-1904	USA	800-978-8006 or 201-767-6040	sales@ admtronics.com
Dry Heat Treatment	H	Mr. John	Bricken	Thermal Waste Technologies, Inc.	19 Stony Hill Road, Suite 4	Bethel	CT	06801-1051	USA	888-336-6549 or 203-778-2210	jbricken@ ix.netcom.com
Dry Inorganic Chemical-Shredding	C	Ms. Susan	Palmer	Positive Impact Waste Solutions, Inc.	5030 East University Boulevard	Odessa	TX	79762	USA	915-550-5883	shpalmer@ airocom.net
Needle/sharps destruction	O	Mr. Mark	Meents	Biomedical Disposal, Inc. (SharpX)	3690 Holcomb Bridge Road	Norcross	GA	30092-2727	USA	770-300-9595	mmeents@ biodisposal.com

Table 2 (Continued)

Biomedical Waste Treatment Technology Vendors

Type Key: H = high heat thermal; M = med. heat; L = low heat; I = irradiation; C = chemical/mechanical; O = other; U = undefined											
Description/Type		**Contact**		**Agency**	**Address**					**Telephone**	**E-mail address**
Needle/sharps destruction	O	Mr. Joe	Adkins	Safeguard Medical Devices DBA The Disintegrator Product	403 Ken Mar Industrial Parkway	Broadview Hts.	OH	44147-2956	USA	877-797-4277 or 440-717-9860	jadkins@safeguardmd.com
Electrocatalytic Wet Oxidation	C	Mr. Terry	Rogers	Delphi Research, Inc.	701 Haines Avenue NW	Albuquer-que	NM	87102-1227	USA	505-292-9315	trogers@delphi-res.com
Electron Beam	I	Mr. Rod	Wilson	Bio-Sterile Technology, Inc.	4104 Merchant Road	Ft. Wayne	IN	46818-1248	USA	888-710-3792	rwilson10@nc.rr.com
Electro-Thermal Deactivation	L	Mr. Tony	Tomasello	Stericycle Inc.	28161 North Keith Drive	Lake Forest	IL	60045-4528	USA	847-607-2053	ttomasello@stericycle.com
Enzyme biodegradation	C	Mr. Mike	Gillette	Biomedical Disposal, Inc.	3690 Holcomb Bridge Road	Norcross	GA	30092	USA	678-938-3958	
Gasification	H	Mr. Roland	Schubert	Thermoselect	Via Naviglio Vecchio 4	Locarno		CH 6600	Switz-erland	4191-756-2525	
Liquids Treatment System	U	Ms. Debbie	Furlow	Microtek Medical, Inc. (Isolyser)	4320 International Boulevard NW	Norcross	GA	30093-3228	USA	800-844-0988	jatwood@orex.com
Microwave Treatment	L			CMB Maschinenbau und Handels GmbH	Plabutscherstrasse 115, A-8051	Graz			Austria	(43-316) 68-55-150	cmb@sintion.at
Needle/sharps destruction	O	Mr. Walter	Weller	MedPro, Inc.	817 Winchester Road, Suite 200	Lexington	KY	40505-3744	USA	859-225-5375 x102	wweller@needlyzer.com
Needle/sharps destruction	O	Mr. John	Bailey	Safesharps	P.O. Box 1702	Bluefield	WV	24701-1702	USA	304-325-2455 x10	jbailey@safesharps.com
Needle destruction	O	Mr. Mark	Rodgers	Earth-Shield Company	304 Yampa Street	Bakersfield	CA	93307-2722	USA	661-322-0300	mrodgers@earth-shield.com
Peracetic Acid-Grinding	C	Mr. Christof	Littwitz	Steris Corp. (Ecocycle)	5960 Heisley Road	Mentor	OH	44060-1834	USA	800-989-7575 x27012 or 440-354-2600	
Plasma Pyrolysis	H	Dr. James T.	Woo	Plasma Pyrolysis Systems	P.O. Box 158	Stuyvesant Falls	NY	12174-0158	USA	518-828-4684	woojt@intersci.com
Plasma Pyrolysis	H	Mr. Art	Yando	Vanguard Research Inc.	8384-C Terminal Road	Lorton	VA	22079-1422	USA	703-339-6222	ayando@vripeps.com

Table 2 (Continued)

Biomedical Waste Treatment Technology Vendors

Type Key: H = high heat thermal; M = med. heat; L = low heat; I = irradiation; C = chemical/mechanical; O = other; U = undefined

Description/Type		Contact		Agency	Address					Telephone	E-mail address
Plasma Pyrolysis	H	Dr. Kenneth	Wittle	Electro-Pyrolysis, Inc.	996 Old Eagle School Road	Wayne	PA	19087-1806	USA	610-687-9070	kwittle@electropyrolysis.com
Plasma Pyrolysis	H	Mr. Omar	Castellon	Peat International	7529 S Memorial Parkway	Huntsville	AL	35802	USA	256-883-8997	omar.castellon@peat.com
Plasma Pyrolysis	H			Daystar Technologies/ Prometron Technics Corp.	Nibancho-on Bldg 47 11-6, Nibancho, Chiyoda-ku	Tokyo		102	Japan	81-3-5275-2411	
Plasma Pyrolysis	H	Mr. Murray	Vance	Bio Arc, Inc.	P.O. Box 98	Pinellas Park	FL	33780-0098	USA	727-548-9572	info@arctechnologiesgroup.com
Plasma Pyrolysis	H	Mr. Joseph	Klimek	Startech Environmental Corporation	79 Old Ridgefield Road	Wilton	CT	06897	USA	203-762-2499	jklimek@startech.net
Plasma Pyrolysis	H	Mr. Serge	Rand-hava	Unitel Technologies	411 Business Center Drive Suite 111	Mt. Prospect	IL	60056	USA	847-297-2265	unitelone@aol.com
Plasma Pyrolysis	H	Mr. Jeffrey E.	Surma	Integrated Environmental Technologies LLC	1935 Butler Loop	Richland	WA	99352	USA	509-946-5700	jesurma@inentec.com
Plasma Pyrolysis	H	Mr. Jason	McClaf-ferty	MSE Technology Applications, Inc.	P.O. Box 4078	Butte	MT	59702-4078	USA	406-494-7100	jmcclafferty@mse-ta.com
Pre-Shredding/ Steam-Mixing	L	Ms. April	Jorgensen	Aegis Bio-Systems LLC	2500 S Broadway Suite 200	Edmond	OK	73013	USA	405-341-4667	ajorgensen@aegisco.com
Reverse Polymerization	M	Mr. Michael	Vocilka	Environmental Waste Int'l.	283 Station Street	Ajax	ON	L1S 1S3	Canada	905-686-8689	mike.vocilka@ewmc.com
Needle/sharps destruction	O	Mr. Gary	Burdette	Imagination Medical, Inc.	12855 Phillips Highway	Jacksonville	FL	32256-3704	USA	904-268-5531	grburdette@aol.com
Shredding/ Steam-Mixing/ Drying, Chemical	L	Mr. Bill	Jones	Sterile Technology Industries, Inc. (STI) subsidiary of WR[2]	5725 West Minnesota Street	Indiana-polis	IN	46241-3825	USA	317-484-4200	chemclav@aol.com

Table 2 (Continued)

Biomedical Waste Treatment Technology Vendors

Type Key: H = high heat thermal; M = med. heat; L = low heat; I = irradiation; C = chemical/mechanical; O = other; U = undefined

Description/Type		Contact		Agency	Address					Telephone	E-mail address
Shredding-Mixing ("Sterimed")	C	Mr. Meier	Wais	MCM Environmental Technologies	Moledet, M.P.	Gilboa		19130	Israel	972-6-653-1104	mcm@kinneret.com.il
Shredding-Steam-Mixing/Drying	L	Mr. Mike	Neubauer	Ecolotec, LLC	8 Savannah Circle	Union Grove	AL	35175-7822	USA	256-498-1114	tmiken@mindspring.com
Sodium Hypochlorite-Hammermill	C	Mr. Jon	Watson	Circle Medical Products, Inc.	3950 Culligan Avenue, #D	Indian-apolis	IN	46218-5509	USA	317-541-8080	circlemed@netdirect.net
Sodium Hypochlorite-Shredding (mobile)	C	Mr. Raymond	Hart	Med-Shred	5855 Westheimer	Houston	TX	77057	USA	713-818-2387	
Specialized cement manufacturing	H	Mr. Mike	Mensinger	GTI	1700 South Mount Prospect Road	Des Plaines	IL	60018-1804	USA	847-768-0602	mike.mensinger@gastechnology.org
Steam-Mixing-Fragmenting/Drying	L	Ms. Rebecca	Fawcett	Hydroclave Systems Corp.	672 Norris Court	Kingston	ON	K7P 2O9	Canada	613-389-8373	inquire@hydroclave.com
Steam-Mixing-Fragmenting/Drying/Shredding	L	Ms. Sharon	Schudmak	Tempico, Inc.	P.O. Box 428	Madison-ville	LA	70447-0428	USA	504-845-0800 or 800-728-9006	sschudmak@tempico.com
Thermal Depolymerization	M	Mr. Brian	Appel	Changing World Technologies	460 Hempstead Avenue	West Hempstead	NY	11552-2716	USA	516-486-0100	cwt@changingworldtech.com
Thermal Depolymerization	M	Mr. Ed	Krisiunas	Sharps Compliance, Inc. (agent for Changing World Technologies)		Burlington	CT		USA	860-675-1217	ekrisiunas@aol.com
Thermal Destruction	H	Mr. Dean	Robbins	Therm-Tec Inc.	20525 Southwest Circle Road	Sherwood	OR	97140-8339	USA	503-625-7575	thermtec@earthlink.net
Vacuum-Steam-Compaction	L	Mr. Arthur	McCoy	San-I-Pak	P.O. Box 1183	Tracy	CA	95378-1183	USA	209-836-2310	arthurmcco@aol.com

Table 3

Comparison of Biomedical Waste Treatment Technologies

Vendor	Description	Type Key	Capital Cost	Feed Prep.	Energy	Capacity/ Process Flow lb/	Env. Control Measures	Waste Unrecog-nizable?	Waste Vol. Reduct. %[5]	Dis-infection Level[1]	Disinfection Level Verification?[2]	Advantages (see below)	Disadvantages (see below)	Training	Limitations[3]
BondTech Corp.	Autoclave or Retort	L	$210,000	Shredder (included)	240 kW boiler	561	Closed system	Y	85%	IV	No	A1, A3	D3	Class-room	Not specified
Changing World Technologies	Thermal Depolymeriz-ation	M	Not provided	Shredder (included)	220 A	varies	Closed system	Y	90%	IV	No	A1	D2, D3	1 wk	None listed
Circle Medical Products, Inc.	Sodium Hypochlorite-Hammermill	C	$295,000	Grinder (included)	400 V	500-2000	HEPA filters	Y	90%	IV	No	A1, A3	D3, D5	2 days	None listed
Electro-Pyrolysis, Inc.	Plasma Pyrolysis	H	$1MM to $10 MM	Not required	.75 kwh/ lb feed	100-3000	APC system	Y	90%	IV*	No	A1	D1, D2	1 wk	None listed
Environ-mental Waste International	Reverse Polymerization	M	$1,100,000	Grinder (included)	Nat. gas, elect.	150 - 800	Scrubber (included)	Y	70-80%	IV	Yes	A1	D1, D2, D3	1 wk	No titanium
GTI	Specialized cement manufacturing	H	$172 MM (varies)	Not required	Nat. gas, elect.	varies	APC system	Y	90%	IV*	*	A1, A3, A4	D1, D2, D3	1 wk	None listed
Hydroclave Systems Corp.	Steam-Mixing-Fragmenting/ Drying	L	$46,000 to $340,000	Internal grinder	Steam/ elect.	Not indicated	Closed system	Y	80%	IV	Yes	A1	D2, D3	4 hr	No cytotoxic, prion
Mark-Costello Co.	Autoclave or Retort	L	$25,000 to $350,000	Bagged; Optional grinder	Steam/ elect.	50 - 1125	Not req'd	N	30%	IV	No	A3	D3	Supplied	No cytotoxic, prion
Matrix Technology PTY Ltd.	Chemical	C	Not provided	Not indicated	3 ph Elect.	varies	Closed system	Y	70-80%	III	Yes	A1	D5	1 day	No cytotoxic, prion
MCM Environmenta l Technologies	Shredding-Mixing– "Stericid"	C	$70,000 ($14,000 for "junior" version)	Not indicated	Not indicated	Not indicated	Not indicated	Y	Not indicated	IV	No	A1	D5, D6	Not indicated	No cytotoxic, prion, biohazardous
MedPro, Inc.	Needle destruction	O	$895	Not required	110 V	N/A	Filter	Y	50%	III	No	A2		1 hr	Only for needles
Med-Shred	Sodium Hypochlorite-Shredding (mobile)	C	$450,000	Grinder (included)	440 V	3000	Filters	Y	89%	IV	No	A1, A3	D3, D5	Supplied	Not >2% cytotoxics

Table 3 (Continued)

Comparison of Biomedical Waste Treatment Technologies

Vendor	Description	Type Key	Capital Cost	Feed Prep.	Energy	Capacity/ Process Flow lb/	Env. Control Measures	Waste Unrecog-nizable?	Waste Vol. Reduct. %[5]	Dis-infection Level[1]	Disinfection Level Verification?[2]	Advantages (see below)	Disadvantages (see below)	Training	Limitations[3]
Microtek Medical, Inc. (Isolyser)	Liquids Treatment System	U	Minimal	Canister	N/A	1	Closed system	N	0%	III	No	A1, A2, A3	D5	1 hr	Liquids only; no prions, not 100% blood
Plasma Pyrolysis Systems	Plasma Pyrolysis	H	$1.3 MM	Boxed	326 kW	360	Boiler	Y	99%	IV*	No	A1	D1, D2, D4	1 wk	No lead, cadmium, mercury
San-I-Pak	Vacuum-Steam-Compaction	L	$40,000 to $500,000	Not required	Steam/ elect.	25 - 3000	Diffuser/ condenser	Y[4]	60-80%	IV	Yes	A1, A3	D3	4 hr	No cytotoxic, prion
Stericycle Inc.	Electro-Thermal Deactivation	L	Not provided	Shredder (included)	Elect.	Not indicated	Not indicated	Y	80%	IV	No	A1, A3	D3		No chem, tissue, pathogenic, cytotoxic
Sterile Technology Industries, Inc. (STI) – subsidiary of WR[2]	Shredding/ Steam-Mixing/ Drying, Chemical	L	Varies	Shredder (included)	Not indicated	300-5000	HEPA filter	Y	90%	IV	Yes	A1, A3	D3	Not indicated	No cytotoxic, prion
Thermal Waste Technologies, Inc.	Dry Heat Treatment	H	$4,000	Not required	Elect.	3	Filter	N	0%	IV	Yes	A1, A2, A3	D4	1 hr	Small quantities (1 gal) only; no body parts
Tuttnauer USA Co. Ltd.	Autoclave or Retort	L	$50,000 to $500,000	Not specified	Steam/ elect.	varies	Closed system	N	50%	IV	No	A3	D3	1 day	No cytotoxic, prion
Vanguard Research Inc.	Plasma Pyrolysis	H	Not provided	Not specified	800-3750 kW	250-4000	Not specified	Y	75%	IV	Yes	A1	D1, D2	1 wk	None listed
Waste Reduction by Waste Reduction, Inc. (WR[2])	Alkaline Hydrolysis	C	$132,500 to $1,237,500	Not required	Elect.	1-3000	Not req'd	Y	97%	IV	No	A1, A3	D3, D5	2 days	No aluminum

thority indicating that the system will "totally destroy all pathogens which have any potential to be harmful to health and the environment," or a sterilization assay report showing laboratory test results for destruction of B. stearothermophilus, are examples of such verification. This column indicates "Yes" if such verification was provided, and "No" if not.

3. All listed systems shall not be used to treat radiological (nuclear) waste. Consult manufacturer for more specific information regarding limitations.

4. Treated waste is unrecognizable if optional shredder is used.

5. 0% waste volume reduction generally is associated with technologies that use a small amount of mass (i.e., a solidifying disinfectant) and volume to the waste.

Advantages

A1 Treated waste is suitable for landfill disposal
A2 Relatively low capital cost
A3 Utilizes well-proven technology
A4 Treated waste is completely useable as cement product

Disadvantages

D1 Relatively high capital cost
D2 Maintenance requirements may be extensive
D3 Possible odors or other emissions unless Air Pollution Control system is well maintained
D4 Singe use containers required (adding to operating costs)
D5 Chemical and waste chemical management and disposal required
D6 Proprietary disinfectant required (adding to operating costs)

"Guidance for Evaluating Medical Waste Technologies." (Jan. 1993; EPA contract no. 68-WO-0032).

Philippines Republic Act No. 8749, otherwise known as the "Philippine Clean Air Act of 1999."

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