

US EPA ARCHIVE DOCUMENT

**GUIDANCE FOR EVALUATING MEDICAL WASTE
TREATMENT TECHNOLOGIES**

FINAL REPORT

Prepared for:

**Office of Solid Waste
U.S. Environmental Protection Agency
Washington, DC 20460**

EPA Contract Number 68-WO-0032

RTI Report Number 94U-5400-005/01-F

GUIDANCE FOR EVALUATING MEDICAL WASTE TREATMENT TECHNOLOGIES

January 1993

Prepared for

Work Assignment Leader: Kristina Meson
Office of Solid Waste
U.S. Environmental Protection Agency
Washington, D.C. 20460

Prepared by

Eugene C. Cole, Dr.P.H.
Terrence K. Pierson, Ph.D.
Dana R. Greenwood
Keith E. Leese
and
Karin K. Foarde

Research Triangle Institute
P.O. Box 12194
Research Triangle Park, NC 27709

Submitted by:

Approved by:


T.K. Pierson, Project Leader


D.F. Naugle, Center Director
Center for Environmental Analysis

DISCLAIMER

The material presented in this document has been funded by the United States Environmental Protection Agency (EPA) under contract number 68-WO-0032. It is a final report that has not been subject to the Agency's peer and administrative review. The views expressed in this document are those of the authors and are based upon previous EPA sponsored evaluation of medical waste treatment technologies, as well as current thinking regarding medical waste treatment, and do not represent official Agency policy.

This report was printed on recycled paper

ACKNOWLEDGEMENTS

This document was prepared as a product of the evaluation of medical waste treatment technologies and methods under EPA Contract No. 68-WO-0032, Work Assignment No. 5, "Medical Waste Treatment Technologies Evaluation and Program Support". The authors wish to express appreciation to Mary Greene and Kristina Meson whose valuable assistance as Work Assignment Managers helped guide this work to a successful completion. In addition, they wish to express their appreciation to Durann Williams who provided valuable assistance in preparing and assembling this document.

ABSTRACT

The Medical Waste Tracking Act of 1988 (MWTAA) requires EPA, among other things to evaluate national medical waste issues. Section 11008 of the MWTAA requires EPA to prepare a series of reports to Congress on various issues related to medical waste. Specifically, Sections 11008 (a)(6) and (7) require EPA to evaluate available and potentially available methods for treating medical waste and their ability to render medical waste noninfectious or less infectious, and unrecognizable and otherwise protect human health and the environment.

This document presents guidance for the evaluation of the effectiveness of medical waste treatment technologies to reduce or inactivate microorganisms that may be present in medical waste. The treatment technologies addressed in this guidance document are:

- Incineration
- Steam Autoclaving
- Chemical Treatment, Mechanical/Chemical Treatment
- Nonionizing Radiation
 - Microwave Irradiation
 - Radiofrequency Irradiation
- Gamma Irradiation (no test method)

Table of Contents

DISCLAIMER i

ACKNOWLEDGEMENTS ii

ABSTRACT iii

1.0 INTRODUCTION 1

 1.1 WASTE CHARACTERISTICS 1

 1.2. TREATMENT DEFINITIONS 4

 1.2.1 Microbial Inactivation 4

 1.2.1.1 Level I Microbial Inactivation 4

 1.2.1.2 Level II Microbial Inactivation 4

 1.2.1.3 Level III and IV Microbial Inactivation 6

 1.3 OPERATION EVALUATION 6

 1.3.1 Test Organism Selection 6

 1.3.2 Test Organism Procurement 7

 1.3.3 Test organism quantitation 7

 1.3.4 Test load preparation 7

 1.3.5 Test load exposure 7

 1.3.6 Organism recovery 8

 1.3.7 Quality Control Procedures 8

 1.3.7.1 Organisms 9

 1.3.7.2 Media 9

 1.3.7.3 Reagents 9

 1.3.7.4 Equipment 9

2.0 INCINERATION 11

 2.1 GENERAL DESCRIPTION OF TREATMENT TECHNOLOGY 11

 2.1.1 Operational Parameters 11

 2.1.1.1 Incinerator Parameters 11

 2.1.1.2 Waste Characteristics 11

 2.1.1.3 Residuals 12

 2.1.2 Incinerator Types 12

 2.1.2.1 Multiple Chamber Pathological Waste Incinerators 12

 2.1.2.2 Controlled Air Incinerators 12

 2.1.2.3 Rotary Kilns 13

 2.2 OPERATION EVALUATION 13

 2.2.1 Equipment/Materials/Reagents 13

 2.2.2 Test Organism Selection 14

 2.2.3 Test Organism Procurement 14

 2.2.4 Test Organism Quantitation 17

 2.2.5 Test Load Preparation 17

2.2.6	<u>Test Load Exposure</u>	18
2.2.7	<u>Stack Sampling</u>	18
2.2.8	<u>Ash Sampling</u>	19
2.2.9	<u>Microbial Analysis</u>	19
2.2.10	<u>Interpretation of Results</u>	19
2.2.11	<u>Quality Control Procedures</u>	20
3.0	STEAM AUTOCLAVE TREATMENT	25
3.1	GENERAL DESCRIPTION OF TREATMENT TECHNOLOGY	25
3.1.1	<u>Operational Parameters</u>	25
3.1.1.1	Time/Temperature/Pressure/Steam Penetration	25
3.1.1.2	Waste Characteristics and Orientation	26
3.1.1.3	Residuals	26
3.1.2	<u>Benchtop Autoclave</u>	26
3.1.2.1	Standard Operating Conditions	26
3.1.3	<u>Laboratory Autoclave</u>	26
3.1.3.1	Application	27
3.1.3.2	Standard Operating Conditions	27
3.1.4	<u>Prevacuum Onsite Autoclave System</u>	27
3.1.5	<u>Large Volume Offsite Gravity Displacement Autoclave System</u>	27
3.2	OPERATION EVALUATION	27
3.2.1	<u>Test Organism Selection</u>	27
3.2.2	<u>Test Organism Procurement</u>	28
3.2.3	<u>Test Organism Quality Control</u>	28
3.2.4	<u>Test Pack Preparation and Loading</u>	28
3.2.4.1	Benchtop and Standard Laboratory Autoclave	28
3.2.4.2	Prevacuum Onsite Autoclave System	29
3.2.4.3	Large Volume Offsite Gravity Displacement Autoclave System	29
3.2.5	<u>Test Pack Exposure and Removal</u>	29
3.2.5.1	Benchtop and Standard Laboratory Autoclave	29
3.2.5.2	Prevacuum Onsite Autoclave System	29
3.2.5.3	Large Volume Offsite Gravity Displacement Autoclave System	29
3.2.6	<u>Organism Recovery</u>	30
3.2.7	<u>Treatment Validation and Testing Frequency</u>	30
3.2.8	<u>Quality Control Procedures</u>	30
4.0	CHEMICAL TREATMENT	31
4.1	GENERAL DESCRIPTION OF TECHNOLOGY	31
4.1.1	<u>Antimicrobial Chemicals</u>	31
4.1.1.1	Scale of Resistance	31
4.1.1.2	Efficacy Under FIFRA	31
4.1.1.2	Application to Medical Waste Treatment	35

4.1.2	<u>Operational Parameters</u>	35
4.1.2.1	Concentration/pH/Interference	35
4.1.2.2	Exposure Time/Temperature	36
4.1.2.3	Neutralization	36
4.1.2.4	Waste Characteristics	36
4.1.2.5	Residuals	36
4.1.3	<u>Static systems</u>	38
4.1.4	<u>Recirculating System</u>	38
4.1.4.1	Size	38
4.1.4.2	Application	38
4.1.4.3	Standard Operating Conditions	38
4.1.5	<u>Flow-Through System</u>	39
4.1.5.1	Size	39
4.1.5.2	Application	39
4.1.5.3	Standard Operating Conditions	39
4.2	OPERATION EVALUATION	39
4.2.1	<u>Test Organism Selection</u>	39
4.2.2	<u>Test Organism Procurement and Preparation</u>	40
4.2.3	<u>Test Organism Quality Control</u>	40
4.2.4	<u>Test Organism Preparation and Exposure</u>	40
4.2.4.1	Static Chemical Treatment	40
4.2.4.2	Recirculating Systems	40
4.2.4.3	Flow-Through Systems	41
4.2.5	<u>Organism Recovery</u>	41
4.2.6	<u>Treatment Validation and Routine Testing Frequency</u>	42
4.2.7	<u>Quality Control Procedures</u>	43
5.0	NONIONIZING RADIATION TREATMENT	44
5.1	GENERAL DESCRIPTION OF TECHNOLOGY	44
5.1.1	<u>Operational Parameters</u>	44
5.1.1.1	Frequency/Duration/Direction of Propagation	44
5.1.1.2	Waste Characteristics/Destruction/Moisture	44
5.1.1.3	Residuals	45
5.1.2	<u>Standard Operating Conditions</u>	45
5.1.2.1	Microwave Systems	45
5.1.2.2	Shortwave Radiofrequency Systems	45
5.2	OPERATION EVALUATION	45
5.2.1	<u>Test Organism Selection</u>	45
5.2.2	<u>Test Organism Procurement</u>	46
5.2.3	<u>Test Organism Quality Control</u>	46
5.2.4	<u>Test Challenge Preparation and Loading</u>	46
5.2.5	<u>Test Load Exposure</u>	46
5.2.5.1	Microwave System	46
5.2.5.2	RF Treatment	47

5.2.6	<u>Organism Recovery</u>	47
5.2.7	<u>Treatment Validation and Routine Testing</u>	47
5.2.8	<u>Quality Control Procedures</u>	47
6.0	WORKER HEALTH AND SAFETY	48
6.1	OCCUPATIONAL CONCERNS OF MEDICAL WASTE TREATMENT	48
6.1.1	<u>Biological Hazards</u>	48
6.1.2	<u>Physical and Chemical Hazards</u>	48
6.1.3	<u>Health Promotion and Protection</u>	48
6.1.4	<u>Onsite Medical Waste Treatment Technologies</u>	48
6.1.4.1	Incineration	48
6.1.4.2	Steam Autoclaving	49
6.1.4.3	Chemical/Mechanical Treatment	49
6.1.4.4	Microwave Irradiation	49
6.1.5	<u>Offsite Medical Waste Treatment Technologies</u>	50
6.1.5.1	Incineration	50
6.1.5.2	Steam Autoclaving	50
6.1.5.3	Non-ionizing Irradiation	50
6.2	WORKER TRAINING	50
6.2.1	<u>Safety</u>	50
6.2.2	<u>Biohazards</u>	51
6.2.3	<u>Incinerator Operator Safety Training</u>	51
6.3	SUPERVISION	52
6.4	HEALTH SURVEILLANCE AND IMMUNIZATION	52
6.5	PERSONAL PROTECTIVE EQUIPMENT	52
7.0	FACILITY MAINTENANCE	53
7.1	GENERAL REQUIREMENTS FOR ALL TECHNOLOGIES	53
7.2	INCINERATION	53
7.2.1	<u>Additional Maintenance Recommendations</u>	53
7.3	STEAM AUTOCLAVE TREATMENT SYSTEMS	56
7.3.1	<u>Benchtop Autoclave</u>	56
7.3.2	<u>Standard Laboratory Autoclave</u>	56
7.3.3	<u>Prevacuum Autoclave</u>	56
7.3.4	<u>Large Gravity Displacement Autoclave</u>	56
7.4	CHEMICAL MEDICAL WASTE TREATMENT SYSTEMS	58
7.4.1	<u>Static Antimicrobial Chemical Treatment</u>	58
7.4.2	<u>Recirculating Mechanical/Chemical Treatment Systems</u>	58
7.4.3	<u>Flow-Through Mechanical/Chemical Waste Treatment System</u>	58
7.5	NONIONIZING RADIATION TREATMENT SYSTEMS	60
7.5.1	<u>Microwave Systems</u>	60
7.5.2	<u>Shortwave Radiofrequency Systems</u>	60
	REFERENCES	63

List of Figures

Figure	Page
2.1 Sampling Train for Determination of Indicator Spore Emissions	15
2.2 Ash Quality Pipe Assemblies	16
2.3 Preparation and Analysis Scheme for Microbial Testing of Impinger Samples	21
2.4 Preparation and Analysis Scheme for Microbial Testing of Ash	22
2.5 Analysis Scheme for Pipe Sample Microbial Viability Tests	23

List of Tables

Table	Page
1.1 Medical Waste Types Appropriate For Treatment By Technology	3
1.2 Evaluation of Effectiveness of Medical Waste Treatment Technologies	5
1.3 Recommended Frequency of Efficacy Testing By Technology	8
2.1 Quality Assurance/Quality Control Procedures for Indicator Spore Testing of Medical Waste Incinerators	24
4.1 Advantages and Disadvantages of Antimicrobial Agents	32
4.2 Selected Antimicrobial Efficacy Claims for Microbial Inactivation	34
4.3 Selected Disinfectant Neutralizers	37
7.1 Typical Maintenance Schedule for a Medical Waste Incinerator	54
7.2 Typical Maintenance Schedule for a Steam Autoclave Medical Waste Treatment System	57
7.3 Typical Maintenance Schedule for a Mechanical/Chemical Medical Waste Treatment System	59
7.4 Typical Maintenance Schedule for a Microwave Medical Waste Treatment System . .	61
7.5 Typical Maintenance Schedule for a Shortwave Radiofrequency Medical Waste Treatment System	62