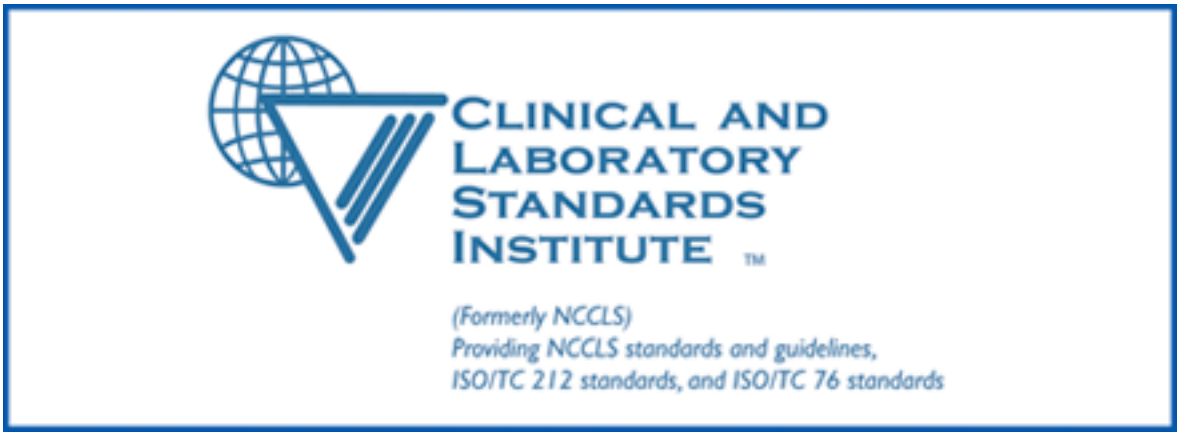
GP5-A2
Vol. 22 No. 3

Replaces GP5-A
Vol. 13 No. 22

Clinical Laboratory Waste Management; Approved Guideline—Second Edition



Based on U.S. regulations, this document provides guidance on the safe handling and disposal of chemical, infectious, radioactive, and multihazardous wastes generated in the clinical laboratory. While a valuable resource for a wider audience, it is intended for use primarily in the United States.

A guideline for national application developed through the NCCLS consensus process.

NCCLS

NCCLS...

Serving the World's Medical Science Community Through Voluntary Consensus

NCCLS is an international, interdisciplinary, nonprofit, standards-developing, and educational organization that promotes the development and use of voluntary consensus standards and guidelines within the healthcare community. It is recognized worldwide for the application of its unique consensus process in the development of standards and guidelines for patient testing and related healthcare issues. NCCLS is based on the principle that consensus is an effective and cost-effective way to improve patient testing and healthcare services.

In addition to developing and promoting the use of voluntary consensus standards and guidelines, NCCLS provides an open and unbiased forum to address critical issues affecting the quality of patient testing and health care.

PUBLICATIONS

An NCCLS document is published as a standard, guideline, or committee report.

Standard A document developed through the consensus process that clearly identifies specific, essential requirements for materials, methods, or practices for use in an unmodified form. A standard may, in addition, contain discretionary elements, which are clearly identified.

Guideline A document developed through the consensus process describing criteria for a general operating practice, procedure, or material for voluntary use. A guideline may be used as written or modified by the user to fit specific needs.

Report A document that has not been subjected to consensus review and is released by the Board of Directors.

CONSENSUS PROCESS

The NCCLS voluntary consensus process is a protocol establishing formal criteria for:

- the authorization of a project
- the development and open review of documents
- the revision of documents in response to comments by users
- the acceptance of a document as a consensus standard or guideline.

Most NCCLS documents are subject to two levels of consensus—"proposed" and "approved." Depending on the need for field evaluation or data collection, documents may also be made available for review at an intermediate (i.e., "tentative") consensus level.

Proposed An NCCLS consensus document undergoes the first stage of review by the healthcare community as a proposed standard or guideline. The document should receive a wide and thorough technical review, including an overall review of its scope, approach, and utility, and a line-by-line review of its technical and editorial content.

Tentative A tentative standard or guideline is made available for review and comment only when a recommended method has a well-defined need for a field evaluation or when a recommended protocol requires that specific data be collected. It should be reviewed to ensure its utility.

Approved An approved standard or guideline has achieved consensus within the healthcare community. It should be reviewed to assess the utility of the final document, to ensure attainment of consensus (i.e., that comments on earlier versions have been satisfactorily addressed), and to identify the need for additional consensus documents.

NCCLS standards and guidelines represent a consensus opinion on good practices and reflect the substantial agreement by materially affected, competent, and interested parties obtained by following NCCLS's established consensus procedures. Provisions in NCCLS standards and guidelines may be more or less stringent than applicable regulations. Consequently, conformance to this voluntary consensus document does not relieve the user of responsibility for compliance with applicable regulations.

COMMENTS

The comments of users are essential to the consensus process. Anyone may submit a comment, and all comments are addressed, according to the consensus process, by the NCCLS committee that wrote the document. All comments, including those that result in a change to the document when published at the next consensus level and those that do not result in a change, are responded to by the committee in an appendix to the document. Readers are strongly encouraged to comment in any form and at any time on any NCCLS document. Address comments to the NCCLS Executive Offices, 940 West Valley Road, Suite 1400, Wayne, PA 19087, USA.

VOLUNTEER PARTICIPATION

Healthcare professionals in all specialties are urged to volunteer for participation in NCCLS projects. Please contact the NCCLS Executive Offices for additional information on committee participation.

Clinical Laboratory Waste Management; Approved Guideline—Second Edition

Abstract

GP5-A2—*Clinical Laboratory Waste Management; Approved Guideline—Second Edition* was written for use by laboratory managers and is intended to provide approaches to controlling laboratory-generated hazardous and nonhazardous waste. A brief summary of the relevant U.S. federal regulations and laws is included. The types of waste addressed include chemical, infectious, radioactive, sharps, multihazardous, and nonhazardous. In this edition, emphasis is placed on methods for avoiding waste generation (source reduction) and reducing the volume and toxicity of unavoidable wastes (waste minimization). Options for handling, packaging, labeling, storing, recycling, transporting, treating, and disposal of each type of waste are also described. While this document will serve as a useful resource for a wider audience, it is based on U.S. regulations, and is intended for use primarily in the United States.

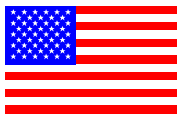
NCCLS. *Clinical Laboratory Waste Management; Approved Guideline—Second Edition*. NCCLS document GP5-A2 (ISBN 1-56238-457-0). NCCLS, 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087-1898, USA 2002.

GP5-A2
ISBN 1-56238-457-0
ISSN 0273-3099

Clinical Laboratory Waste Management; Approved Guideline—Second Edition

Volume 22 Number 3

Peter A. Reinhardt, M.A., Chairholder
Gerald A. Denys, Ph.D., A.B.M.M.
Judith G. Gordon, M.A.
CAPT Edward H. Rau, M.S., R.S., C.H.S.P.



Suggested Citation

(NCCLS. *Clinical Laboratory Waste Management; Approved Guideline—Second Edition.* NCCLS document GP5-A2 [ISBN 1-56238-457-0]. NCCLS, 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087-1898 USA, 2002.)

Proposed Guideline
September 1986

Tentative Guideline
December 1991

Approved Guideline
December 1993

Approved Guideline—Second Edition
March 2002

ISBN 1-56238-457-0
ISSN 0273-3099

Committee Membership

Area Committee on General Laboratory Practices

Stephen J. Sarewitz, M.D. **Chairholder**	**Valley Medical Center** **Renton, Washington**
Sheila M. Woodcock, MLT, ART, MBA **Vice-Chairholder**	**QSE Consulting** **Nova Scotia, Canada**

Members

Miguel Azzar, M.D.	Dept. of Veterans Affairs Medical Center Minneapolis, Minnesota
Donald A. Dynek, M.D.	Pathology Medical Services, P.C. Lincoln, Nebraska
Albert Rabinovitch, M.D., Ph.D.	Specialty Laboratories Santa Monica, California
Max Robinowitz, M.D.	FDA Ctr. for Devices/Rad. Health Rockville, Maryland
Barbara A. Slade, M.D.	Centers for Disease Control and Prevention Atlanta, Georgia

Advisors

Kaiser J. Aziz, Ph.D.	FDA Ctr. for Devices/Rad. Health Rockville, Maryland
James D. Barger, M.D.	College of American Pathologists Las Vegas, Nevada
Steven I. Gutman, M.D., MBA	FDA Ctr. for Devices/Rad. Health Rockville, Maryland
Gerald A. Hoeltge, M.D.	The Cleveland Clinic Foundation Cleveland, Ohio
Joan Johns, M.T.(ASCP)	University of Maryland Medical System Baltimore, Maryland
Robert E. Moore, Ph.D., DABCC	Consulting & Research, Inc. Hartford, Connecticut
Jennifer Schiffgens, M.B.A., M.T.(ASCP), CLS	Clinical Laboratory Improvement Consultants Chicago, Illinois
Daniel W. Tholen, M.S.	Statistical Services Traverse City, Michigan

Advisors (Continued)

Marla Thomas	Litton Pathology Associates Blue Springs, Missouri
Eleanor M. Travers, M.D.	Department of Veterans Affairs Annapolis, Maryland

Working Group on Waste Management

Peter A. Reinhardt, M.A. Chairholder	University of North Carolina Chapel Hill, North Carolina
Gerald A. Denys, Ph.D., A.B.M.M.	Clarian Health Methodist Hospital Indianapolis, Indiana
Judith G. Gordon, M.A.	Gordon Resources Consultants Reston, Virginia
CAPT Edward H. Rau, M.S., R.S., C.H.S.P.	National Institutes of Health Bethesda, Maryland
Beth Ann Wise, M.T.(ASCP), M.S.Ed. *Staff Liaison*	NCCLS Wayne, Pennsylvania
Patrice E. Polgar *Editor*	NCCLS Wayne, Pennsylvania
Donna M. Wilhelm *Assistant Editor*	NCCLS Wayne, Pennsylvania

Acknowledgements

The Area Committee on General Laboratory Practices would like to recognize the valuable contributions of the members and advisors of the Subcommittee on Laboratory Waste that developed the first approved edition of this guideline.

Gerald A. Hoeltge, M.D., Chairholder
Philip G. Pollock, M.D.
Peter A. Reinhardt, MA

Advisors

Martin J. Allen, Ph.D.
Suzanne W. Conner, M.A., CLS/CLDir.
Linda I. Dunlap
Lawrence M. Gibbs, C.I.H.
Mary Green
Rene M. Magnuson, M.T.(ASCP)
Roger R. Roark, Jr.

Active Membership
(as of 1 January 2002)

Sustaining Members

Abbott Laboratories
American Association for Clinical Chemistry
Bayer Corporation
Beckman Coulter, Inc.
BD and Company
bioMérieux, Inc.
CLMA
College of American Pathologists
GlaxoSmithKline
Nippon Becton Dickinson Co., Ltd.
Ortho-Clinical Diagnostics, Inc.
Pfizer Inc
Roche Diagnostics, Inc.

Professional Members

AISAR-Associazione Italiana per lo Studio degli
American Academy of Family Physicians
American Association for Clinical Chemistry
American Association for Respiratory Care
American Chemical Society
American Medical Technologists
American Public Health Association
American Society for Clinical Laboratory Science
American Society of Hematology
American Society for Microbiology
American Type Culture Collection, Inc.
Asociacion de Laboratorios de Alta Complejidad
Asociación Española Primera de Socorros (Uruguay)
Asociacion Mexicana de Bioquimica Clinica A.C.
Assn. of Public Health Laboratories
Assoc. Micro. Clinici Italiani-A.M.C.L.I.
Australasian Association of Clinical Biochemists
British Society for Antimicrobial Chemotherapy
CADIME-Camara De Instituciones De Diagnostico Medico
Canadian Society for Medical Laboratory Science—Société Canadienne de Science de Laboratoire Médical
Clinical Laboratory Management Association
COLA
College of American Pathologists
College of Medical Laboratory Technologists of Ontario
College of Physicians and Surgeons of Saskatchewan
Fundación Bioquímica Argentina
International Association of Medical Laboratory Technologists
International Council for Standardization in Haematology
International Federation of Clinical Chemistry
Italian Society of Clinical Biochemistry
Japan Society of Clinical Chemistry
Japanese Committee for Clinical Laboratory Standards
Joint Commission on Accreditation of Healthcare Organizations
National Academy of Clinical Biochemistry
National Society for Histotechnology, Inc.
Ontario Medical Association Quality Management Program-Laboratory Service
RCPA Quality Assurance Programs PTY Limited
Sociedade Brasileira de Analises Clinicas
Sociedade Brasileira de Patologia Clinica
Sociedad Espanola de Bioquimica Clinica y Patologia Molecular
Turkish Society of Microbiology

Government Members

Association of Public Health Laboratories
Armed Forces Institute of Pathology
BC Centre for Disease Control
Centers for Disease Control and Prevention
Centers for Medicare & Medicaid Services/CLIA Program
Centers for Medicare & Medicaid Services
Chinese Committee for Clinical Laboratory Standards
Commonwealth of Pennsylvania Bureau of Laboratories
Department of Veterans Affairs
Deutsches Institut für Normung (DIN)
FDA Center for Devices and Radiological Health
FDA Center for Veterinary Medicine
FDA Division of Anti-Infective Drug Products
Health Care Financing Administration/CLIA Program
Health Care Financing Administration
Iowa State Hygienic Laboratory
Massachusetts Department of Public Health Laboratories
National Association of Testing Authorities – Australia
National Center of Infectious and Parasitic Diseases (Bulgaria)
National Institute of Standards and Technology
Ohio Department of Health
Ontario Ministry of Health
Saskatchewan Health-Provincial Laboratory
Scientific Institute of Public Health; Belgium Ministry of Social Affairs, Public Health and the Environment
South African Institute for Medical Research
Swedish Institute for Infectious Disease Control
Thailand Department of Medical Sciences

Industry Members

AB Biodisk
Abbott Laboratories
Abbott Laboratories, MediSense Products
Accumetrics, Inc.
Agilent Technologies, Inc.
Ammirati Regulatory Consulting
Anaerobe Systems
Asséssor
AstraZeneca
Aventis
Avocet Medical, Inc.
Axis-Shield POC AS
Bayer Corporation – Elkhart, IN
Bayer Corporation – Tarrytown, NY

Bayer Corporation – West Haven, CT
Bayer Medical Ltd.
BD
BD Biosciences – San Jose, CA
BD Consumer Products
BD Diagnostic Systems
BD Italia S.P.A.
BD VACUTAINER Systems
Beckman Coulter, Inc.
Beckman Coulter, Inc. Primary Care Diagnostics
Beckman Coulter K.K. (Japan)
Bio-Development SRL
Bio-Inova Life Sciences International
Bio-Inova Life Sciences North America
BioMedia Laboratories Sdn Bhd
BioMérieux (NC)
bioMérieux, Inc. (MO)
Biometrology Consultants
Bio-Rad Laboratories, Inc.
Bio-Rad Laboratories, Inc. - France
Biotest AG
Bristol-Myers Squibb Company
Canadian External Quality Assessment Laboratory
Capital Management Consulting, Inc.
Carl Schaper
Checkpoint Development Inc.
Chronolab Ag
Clinical Design Group Inc.
Clinical Laboratory Improvement Consultants
Cognigen
Community Medical Center (NJ)
Control Lab (Brazil)
Copan Diagnostics Inc.
Cosmetic Ingredient Review
Cubist Pharmaceuticals
Dade Behring Inc. - Deerfield, IL
Dade Behring Inc. - Glasgow, DE
Dade Behring Inc. - Marburg, Germany
Dade Behring Inc. - Sacramento, CA
Dade Behring Inc. - San Jose, CA
Diagnostic Products Corporation
Eiken Chemical Company, Ltd.
Enterprise Analysis Corporation
EXPERTech Associates, Inc.
Fort Dodge Animal Health
General Hospital Vienna (Austria)
Gen-Probe
GlaxoSmithKline
Greiner Bio-One Inc.
Helena Laboratories
Home Diagnostics, Inc.
Immunicon Corporation
I-STAT Corporation
International Technidyne Corporation
IntraBiotics Pharmaceuticals, Inc.
Kendall Sherwood-Davis & Geck
LAB-Interlink, Inc.
Labtest Diagnostica S.A.
LifeScan, Inc. (a Johnson & Johnson Company)
Lilly Research Laboratories
Macemon Consultants
Medical Device Consultants, Inc.
Merck & Company, Inc.
Molecular Diagnostics, Inc.
mvi Sciences (MA)
Nabi
Nichols Institute Diagnostics (Div. of Quest Diagnostics, Inc.)
Nissui Pharmaceutical Co., Ltd.
Nippon Becton Dickinson Co., Ltd.
Norfolk Associates, Inc.
Novartis Pharmaceuticals Corporation
Ortho-Clinical Diagnostics, Inc. (Raritan, NJ)
Ortho-Clinical Diagnostics, Inc. (Rochester, NY)
Oxoid Inc.
Paratek Pharmaceuticals
Pfizer Inc
Pharmacia Corporation
Powers Consulting Services
Premier Inc.
Procter & Gamble Pharmaceuticals, Inc.
The Product Development Group
Quintiles, Inc.
Radiometer America, Inc.
Radiometer Medical A/S
David G. Rhoads Associates, Inc.
Roche Diagnostics GmbH
Roche Diagnostics, Inc.
Roche Laboratories (Div. Hoffmann-La Roche Inc.)
The R.W. Johnson Pharmaceutical Research Institute
Sarstedt, Inc.
SARL Laboratoire Carron (France)
Schering Corporation
Schleicher & Schuell, Inc.
Second Opinion
Showa Yakuhin Kako Company, Ltd.
Streck Laboratories, Inc.
SurroMed, Inc.
Sysmex Corporation (Japan)
Sysmex Corporation (Long Grove, IL)
The Clinical Microbiology Institute
The Toledo Hospital (OH)
Trek Diagnostic Systems, Inc.
Versicor, Inc.
Vetoquinol S.A.
Visible Genetics, Inc.
Vysis, Inc.
Wallac Oy
Wyeth-Ayerst
Xyletech Systems, Inc.
YD Consultant
YD Diagnostics (Seoul, Korea)

Trade Associations

AdvaMed
Association of Medical Diagnostic Manufacturers
Japan Association Clinical Reagents Ind. (Tokyo, Japan)
Medical Industry Association of Australia

Associate Active Members

20th Medical Group (SC)
31st Medical Group/SGSL (APO, AE)
67th CSH Wuerzburg, GE (NY)
121st General Hospital (CA)
Academisch Ziekenhuis-VUB (Belgium)
Acadiana Medical Laboratories, LTD (LA)
Adena Regional Medical Center (OH)
The Aga Khan Hospital & Medical College, Karachi (Pakistan)
Akershus Central Hospital and AFA (Norway)
Albemarle Hospital (NC)
Allegheny General Hospital (PA)
Allegheny University of the Health Sciences (PA)
Allina Laboratories (MN)
Alton Ochsner Medical Foundation (LA)
American Medical Laboratories (VA)
Arkansas Department of Health
ARUP at University Hospital (UT)
Armed Forces Research Institute of Medical Science (APO, AP)

Associated Regional & University Pathologists (UT)
Aurora Consolidated Laboratories (WI)
Azienda Ospedale Di Lecco (Italy)
Bay Medical Center (MI)
Baystate Medical Center (MA)
Bbaguas Duzen Laboratories (Turkey)
Bo Ali Hospital (Iran)
Bonnyville Health Center (Alberta, Canada)
British Columbia Cancer Agency (Vancouver, BC, Canada)
Broward General Medical Center (FL)
Calgary Laboratory Services
Carilion Consolidated Laboratory (VA)
Cathay General Hospital (Taiwan)
CB Healthcare Complex (Sydney, NS, Canada)
Central Peninsula General Hospital (AK)
Central Texas Veterans Health Care System
Centre Hospitalier Regional del la Citadelle (Belgium)
Centro Diagnostico Italiano (Milano, Italy)
Champlain Valley Physicians Hospital (NY)
Chang Gung Memorial Hospital (Taiwan)
Children's Hospital (NE)
Children's Hospital & Clinics (MN)
Children's Hospital King's Daughters (VA)
Children's Hospital Medical Center (Akron, OH)
Children's Hospital of Philadelphia (PA)
Clarian Health–Methodist Hospital (IN)
Clendo Lab (Puerto Rico)
Clinical Laboratory Partners, LLC (CT)
CLSI Laboratories (PA)
Commonwealth of Kentucky
Community Hospital of Lancaster (PA)
CompuNet Clinical Laboratories (OH)
Covance Central Laboratory Services (IN)
Danville Regional Medical Center (VA)
Delaware Public Health Laboratory
Department of Health & Community Services (New Brunswick, Canada)
DesPeres Hospital (MO)
DeTar Hospital (TX)
Detroit Health Department (MI)
Doctors Hospital (Bahamas)
Duke University Medical Center (NC)
Durham Regional Hospital (NC)
Dynacare Laboratories - Eastern Region (Ottawa, ON, Canada)
Dynacare Memorial Hermann Laboratory Services (TX)
E.A. Conway Medical Center (LA)
Eastern Maine Medical Center
East Side Clinical Laboratory (RI)
Elyria Memorial Hospital (OH)
Emory University Hospital (GA)
Esoterix Center for Infectious Disease (TX)
Fairfax Hospital (VA)
Fairview-University Medical Center (MN)
Florida Hospital East Orlando
Foothills Hospital (Calgary, AB, Canada)
Fort St. John General Hospital (Fort St. John, BC, Canada)
Fox Chase Cancer Center (PA)
Franklin Square Hospital Center (MD)
Fresenius Medical Care/Spectra East (NJ)
Fresno Community Hospital and Medical Center
Frye Regional Medical Center (NC)
Gambro Healthcare Laboratory Services (FL)
Gateway Medical Center (TN)
GDS Technology, Inc (IN)
Geisinger Medical Center (PA)
Grady Memorial Hospital (GA)
Guthrie Clinic Laboratories (PA)
Hahnemann University Hospital (PA)
Harris Methodist Erath County (TX)
Harris Methodist Fort Worth (TX)
Hartford Hospital (CT)
Headwaters Health Authority (Alberta, Canada)
Health Network Lab (PA)
Health Partners Laboratories (VA)
Heartland Health System (MO)
Highlands Regional Medical Center (FL)
Hoag Memorial Hospital Presbyterian (CA)
Holmes Regional Medical Center (FL)
Holy Spirit Hospital (PA)
Holzer Medical Center (OH)
Hospital for Sick Children (Toronto, ON, Canada)
Hospital Israelita Albert Einstein (Brazil)
Hospital Sousa Martins (Portugal)
Hotel Dieu Hospital (Windsor, ON, Canada)
Houston Medical Center (GA)
Huddinge University Hospital (Sweden)
Hurley Medical Center (MI)
Indiana State Board of Health
Indiana University
Institute of Medical and Veterinary Science (Australia)
Instituto Scientifico HS. Raffaele (Italy)
International Health Management Associates, Inc. (IL)
Jackson Memorial Hospital (FL)
Jersey Shore Medical Center (NJ)
John F. Kennedy Medical Center (NJ)
John Peter Smith Hospital (TX)
Kadlec Medical Center (WA)
Kaiser Permanente Medical Care (CA)
Kaiser Permanente (MD)
Kantonsspital (Switzerland)
Kenora-Rainy River Regional Laboratory Program (Ontario, Canada)
Kern Medical Center (CA)
Kimball Medical Center (NJ)
King Faisal Specialist Hospital (Saudi Arabia)
King Khalid National Guard Hospital (Saudi Arabia)
King's Daughter Medical Center (KY)
Klinični Center (Slovenia)
LabCorp (NC)
Laboratories at Bonfils (CO)
Laboratoire de Santé Publique du Quebec (Canada)
Laboratório Fleury S/C Ltda. (Brazil)
Laboratory Corporation of America (NJ)
Laboratory Corporation of America (MO)

LAC and USC Healthcare Network (CA)
Lakeland Regional Medical Center (FL)
Lancaster General Hospital (PA)
Langley Air Force Base (VA)
LeBonheur Children's Medical Center (TN)
Lewis-Gale Medical Center (VA)
Libero Instituto Univ. Campus BioMedico (Italy)
Long Beach Memorial Medical Center (CA)
Louisiana State University Medical Center
Maccabi Medical Care and Health Fund (Israel)
Magee Womens Hospital (PA)
Manitoba Health (Winnipeg, Canada)
Martin Luther King/Drew Medical Center (CA)
Massachusetts General Hospital (Microbiology Laboratory)
MDS Metro Laboratory Services (Burnaby, BC, Canada)
Medical College of Virginia Hospital
Medicare/Medicaid Certification, State of North Carolina
Memorial Medical Center (IL)
Memorial Medical Center (LA) Jefferson Davis Hwy
Memorial Medical Center (LA) Napoleon Avenue
Mescalero Indian Hospital (NM)
Methodist Hospitals of Memphis (TN)
MetroHealth Medical Center (OH)
Michigan Department of Community Health
Mississippi Baptist Medical Center
Monmouth Medical Center (NJ)
Monte Tabor – Centro Italo - Brazileiro de Promocao (Brazil)
Montreal Children's Hospital (Canada)
Montreal General Hospital (Canada)
MRL Pharmaceutical Services, Inc. (VA)
MRL Reference Laboratory (CA)
National Institutes of Health (MD)
Naval Surface Warfare Center (IN)
Nebraska Health System
New Britain General Hospital (CT)
New England Fertility Institute (CT)
New England Medical Center Hospital (MA)
New York Hospital Medical Center of Queens
New York State Department of Health
North Carolina State Laboratory of Public Health
Northern Indiana Education Foundation
North Kansas City Hospital (MO)
North Mississippi Medical Center
North Shore – Long Island Jewish Health System Laboratories (NY)
Northridge Hospital Medical Center (CA)
Northwestern Memorial Hospital (IL)
O.L. Vrouwziekenhuis (Belgium)
Ordre professionnel des technologists médicaux du Québec
Ospedali Riuniti (Italy)
The Ottawa Hospital (Ottawa, ON, Canada)
Our Lady of Lourdes Hospital (NJ)
Our Lady of the Resurrection Medical Center (IL)
Pathology and Cytology Laboratories, Inc. (KY)
The Permanente Medical Group (CA)
Piedmont Hospital (GA)
Pocono Hospital (PA)
Presbyterian Hospital of Dallas (TX)
Prodia Clinical Laboratory (Indonesia)
Providence Health System (OR)
Providence Seattle Medical Center (WA)
Queen Elizabeth Hospital (Prince Edward Island, Canada)
Queensland Health Pathology Services (Australia)
Quest Diagnostics Incorporated (CA)
Quintiles Laboratories, Ltd. (GA)
Reading Hospital and Medical Center (PA)
Regions Hospital
Reid Hospital & Health Care Services (IN)
Research Medical Center (MO)
Rex Healthcare (NC)
Rhode Island Department of Health Laboratories
Riyadh Armed Forces Hospital (Saudi Arabia)
Royal Columbian Hospital (New Westminster, BC, Canada)
Sacred Heart Hospital (MD)
Saint Mary's Regional Medical Center (NV)
St. Alexius Medical Center (ND)
St. Anthony Hospital (CO)
St. Barnabas Medical Center (NJ)
St-Eustache Hospital (Quebec, Canada)
St. John Hospital and Medical Center (MI)
St. John Regional Hospital (St. John, NB, Canada)
St. Joseph Hospital (NE)
St. Joseph's Hospital – Marshfield Clinic (WI)
St. Joseph's Medical Center (CA)
St. Luke's Regional Medical Center (IA)
St. Mark's Hospital (UT)
St. Mary Medical Center (IN)
St. Mary of the Plains Hospital (TX)
St. Mary's Hospital & Medical Center (CO)
St. Paul's Hospital (Vancouver, BC, Montreal)
St. Vincent Medical Center (CA)
Ste. Justine Hospital (Montreal, PQ, Canada)
Salina Regional Health Center (KS)
San Francisco General Hospital (CA)
Santa Cabrini Hospital (Montreal, PQ Canada)
Santa Clara Valley Medical Center (CA)
Seoul Nat'l University Hospital (Korea)
Shanghai Center for the Clinical Laboratory (China)
South Bend Medical Foundation (IN)
Southern California Permanente Medical Group
South Western Area Pathology Service (Australia)
Specialty Laboratories, Inc. (CA)
Stanford Hospital and Clinics (CA)
State of Washington Department of Health
Stormont-Vail Regional Medical Center (KS)

Sun Health-Boswell Hospital (AZ)
Sunrise Hospital and Medical Center (NV)
T.A. Sourasky Medical Center (Israel)
Tampa General Hospital (FL)
Temple University Hospital (PA)
Tenet Odessa Regional Hospital (TX)
The Toledo Hospital (OH)
Touro Infirmary (LA)
Trident Regional Medical Center (SC)
Tripler Army Medical Center (HI)
Truman Medical Center (MO)
UCSF Medical Center (CA)
UNC Hospitals (NC)
University Hospital (Gent) (Belgium)
University Hospitals of Cleveland (OH)
The University Hospitals (OK)
University of Alabama-Birmingham Hospital
University of Alberta Hospitals (Canada)
University of Colorado Health Science Center
University of Chicago Hospitals (IL)
University of Illinois at Chicago
University of the Ryukyus (Japan)
University of Texas M.D. Anderson Cancer Center
University of Virginia Medical Center
University of Washington
UZ-KUL Medical Center (Belgium)
VA (Denver) Medical Center (CO)
VA (Kansas City) Medical Center (MO)
VA (San Diego) Medical Center (CA)
VA (Tuskegee) Medical Center (AL)
VA Outpatient Clinic (OH)
Vejle Hospital (Denmark)
Washington Adventist Hospital (MD)
Washoe Medical Center Laboratory (NV)
West Jefferson Medical Center (LA)
Wilford Hall Medical Center (TX)
William Beaumont Hospital (MI)
Williamsburg Community Hospital (VA)
Winn Army Community Hospital (GA)
Winnipeg Regional Health Authority (Winnipeg, Canada)
Wishard Memorial Hospital (IN)
Yonsei University College of Medicine (Korea)
York Hospital (PA)

Contents

Contents (Continued)

Foreword

The clinical laboratory is responsible for the proper handling and disposal of its waste. This guideline is intended to provide clinical laboratorians with general approaches to controlling laboratory-generated waste. Specific handling techniques and disposal methods are offered for the most important types of clinical waste.

Some legislative and regulatory background is included in Section 3. This section is intended to help users in the United States understand the specific disposal requirements and recommendations that are detailed later in the guideline. It will also help users in other countries understand the regulatory environment that determines laboratory operations in the United States. A series of important definitions follows in Section 4, and a programmatic approach to waste management—from planning to training—is presented in Sections 5 through 7. Pollution prevention, waste minimization, and recycling have been consolidated into a new Section 6, because we believe it is the essential first step in any waste management program.

Sections 8 through 10 cover the major classes of laboratory waste: chemical, infectious, and radioactive. Section 11, dealing with waste that has more than one hazard, is new to this edition. Section 12 describes special procedures for managing uncontaminated glass and plastic. Within each of these sections, the characteristics of that class of waste are addressed, as well as appropriate handling, storage, accumulation, treatment, and disposal options. Contingency planning is also addressed.

The authors have made every effort to be accurate and thorough in explaining the rules that laboratorians should be aware of, but the legal requirements and the scientific basis for proper waste disposal are voluminous, complex, and ever changing. The waste manager needs to understand the current regulations—federal, state, and local—and keep up to date with changes.

NCCLS consensus documents are developed through an open process that ensures wide review and broad application. This unique approach leads to standards and guidelines for medical testing and healthcare services that address identified needs of both its global and national constituents. Most NCCLS consensus documents are intended for global application. Under certain circumstances, however, an NCCLS standard or guideline may be intended for primary use in a specific country or region.

NCCLS document GP5-A2—*Clinical Laboratory Waste Management; Approved Guideline—Second Edition* is one such consensus document. While GP5-A2 is a useful resource for a wider audience, it is intended primarily to help the U.S. user navigate through stringent U.S. regulations. Since disposal of laboratory waste is heavily regulated and relevant practices are widely "country specific," the Area Committee on General Laboratory Practices determined that it would not be feasible to develop a comparable guideline intended for global application at this time. We hope that development of such a guideline may be possible in the future, as part of a long-term effort to harmonize regulations and practices.

The imprint of the flag and the unique tagline on the cover call attention to its national focus, and differentiate GP5-A2 from our global consensus documents.

Key Words

Hazard abatement, hazardous waste, infectious waste, laboratory management, laboratory safety, laboratory waste, medical waste, mixed waste, multihazardous waste, pollution prevention, radioactive waste, waste management, waste minimization

Clinical Laboratory Waste Management; Approved Guideline—Second Edition

1 Introduction

The total volume of medical waste generated per laboratory averages 51.7 lbs per day but may weigh as much as 1,400 lbs per day in large facilities; this adds up to more than 30,000 tons of waste per year. Most waste that is generated in laboratories can be disposed of as ordinary solid waste. Wastes that require special management are infectious wastes, sharps, hazardous chemicals, radionuclides, and wastes with multiple hazards.

Over 99% of the hazardous chemical waste generated in the United States was produced by "large-quantity generators" (that is, those that produce 1,000 kg or more of hazardous chemical waste per month). Very few clinical laboratories, by themselves, are large quantity generators. Rather, most clinical laboratories and their institutions are either "small quantity generators" (those that produce between 100 and 1,000 kg of hazardous waste per month), or they produce less than 100 kg of hazardous waste per month.

The clinical laboratory is responsible for proper management of the waste that it generates. The following information is intended to provide approaches to controlling laboratory-generated waste and to offer specific handling techniques and disposal methods. Legal requirements for proper waste disposal are complex. As a supplement to this guideline, a list of pertinent references and an additional references section are included. It is the responsibility of the laboratory manager to understand and comply with all relevant regulations.

2 Scope

All clinical laboratories consume materials that are hazardous. Such use generates waste that is hazardous. The majority of the waste resulting from laboratory operations is not hazardous, but that which is hazardous can injure the people who must handle or transport it. Laboratory waste can contaminate sewer systems and other treatment facilities, and it can pollute the environment.

This guideline is intended to provide information about the safe handling and disposal of such wastes. The use of the guideline must be adapted to the local situation. It is not a substitute for awareness of current local, state, and federal rules and regulations. The guideline itself is not to be construed as a regulation. Despite the many similarities of clinical laboratories to one another, differences do exist; no single laboratory waste management program will be appropriate for all facilities. This guideline should, however, provide a basis for the comprehensive waste management program in the user's laboratory.

While GP5-A2 may serve as a useful resource for a wider audience, it is based on U.S. regulations, and therefore is intended for use primarily in the United States.

2.1 Categories of Laboratory Waste

For practical purposes, laboratory waste may be divided into the following categories:

- chemical waste [e.g., Environment Protection Agency (EPA) hazardous waste];
- infectious waste (and other materials regulated as medical waste);

- radioactive waste;
- multihazardous waste (waste with more than one type of hazard);
- sharps (waste that presents a physical hazard); and
- nonhazardous waste.

See Definitions (Section 4) and the specific sections below for a description of each waste type.

2.2 Waste Management Considerations

For each category of laboratory waste, the following issues need to be addressed:

- source reduction, waste minimization, and pollution prevention;
- characteristics and examples;
- handling (including segregation, engineering controls, packaging, labeling, containment, and use of personal protective equipment);
- storage;
- accumulation at the point of generation;
- treatment (both on-site and off-site);
- transportation;
- disposal;
- waste minimization and hazard abatement; and
- regulations and exemptions (as appropriate).

2.3 Responsibilities for Safe Waste Handling

2.3.1 Institutional Responsibilities

Safety, compliance, and community goodwill are best achieved when institutions demonstrate leadership in environmental stewardship. Administrators must provide adequate resources, facilities, and authority to managers and staff who carry out institutional environmental programs, including waste management.

2.3.2 Managerial Responsibilities

Laboratory directors are legally responsible for proper waste management. Clinical laboratory managers must be familiar with the regulations and standards that apply to their particular organizations. Managers must design a system for preventing pollution, as well as for the safe handling of unavoidable waste that provides for proper collection, segregation, storage, recycling, transport, disposal, monitoring, quality control, and recordkeeping. Laboratory management has the responsibility to train employees in the use of engineering controls and personal protective devices, and to ensure that its employees comply with safety directives.

Some laboratories find it more efficient to designate a laboratory waste manager or an emergency coordinator to maintain records, keep emergency call lists current, and oversee the laboratory's waste management program.

2.3.3 Employee Responsibilities

Employees must comply with established policies and procedures. Within the organization, technical employees have the best opportunity to identify those wastes that need special handling. Bench technologists are responsible for segregating and labeling all waste that requires special handling at the point of waste generation. Employees must bring to management's attention unsafe working conditions and identify opportunities for hazardous waste reduction.

2.3.4 Waste Contractor Responsibilities

Waste shippers and contractors have legal and contractual obligations for proper waste management. Because environmental laws are complex and specialized, many laboratories seek compliance assistance advice from their waste contractors.

3 Overview of Requirements for Waste Management

While every effort has been made to accurately and thoroughly explain federal, state, and local laws in this document, waste management requirements are long and detailed, and they change often. Consult appropriate regulatory agencies for the most recent rulemaking and changes.

3.1 Federal Laws and Regulations

3.1.1 Clean Air

The Federal Clean Air Act was originally passed in 1955, and it was extensively revised in 1963, 1977, and 1990. It was enacted because of public concern over the perceived deterioration of air quality. The Act initiated the regulation of air pollution and required the United States EPA to develop national air quality and emission standards. The Act also provided a mechanism for states and municipalities to begin abatement procedures. The 1990 reauthorization authorized the EPA to develop rules to address emissions from laboratories, if necessary.

In 2000, EPA began enforcement of new standards for hospital, medical, and infectious waste incinerators. Many incinerators closed as a result of these stringent standards.

3.1.2 Clean Water

Several federal statutes regulate water quality. The Clean Water Act of 1977 focused on natural waterways, and it established a major effort for improving the quality of the nation's waterways. The Water Quality Act of 1987 was designed to restore and maintain the physical, chemical, and biological integrity of the nation's waters and to control nonpoint source emissions.

3.1.3 Solid Waste Disposal

Solid wastes and spills were initially addressed in the Solid Waste Disposal Act of 1965, which was amended in 1970 as the Resource Recovery Act. (Additional amendments have followed; the Medical Waste Tracking Act of 1988 is an amendment to the Solid Waste Disposal Act.) The Resource Conservation and Recovery Act of 1976 (RCRA) completely revised the Solid Waste Disposal Act and provides most of the EPA's regulatory authority for hazardous waste control. The Comprehensive

Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), better known as the "Superfund," authorized the EPA to clean up releases that present imminent or substantial danger to the environment. This includes hazardous waste spills and inactive or abandoned hazardous waste sites. The most important amendment to CERCLA is the Superfund Amendments and Reauthorization Act of 1986 (SARA), which established the community's right to know about the industrial hazards of its neighborhood. The Hazardous Solid Waste Amendments of 1984 (HSWA) were also an amendment to RCRA.

The solid waste regulations of the EPA were promulgated under the authority of RCRA. They consist of the following components:

- Subtitle C: regulates hazardous chemical wastes. These regulations were updated in 1984 with the HSWA amendment to RCRA.

- Subtitle D: regulates municipal solid waste landfills. New regulations have been proposed for these units.

- Subtitle J: regulates medical waste. The medical waste tracking regulations instituted a two-year tracking program that ended in 1991.

At the present time, there are no federal regulations that pertain to infectious waste disposal.

3.1.4 Transportation of Laboratory Wastes

The Hazardous Materials Transportation Act of 1975 was intended to "protect the nation adequately against risks to life and property which are inherent in the transportation of hazardous materials in commerce." The regulations address the transportation of hazardous, radioactive, and regulated medical wastes.

3.1.5 Other Federal Laws that Regulate Laboratory Waste

There are many other federal laws that relate to laboratory waste. For example, the Atomic Energy Act authorized the Nuclear Regulatory Commission to regulate radioactive waste, and the 1990 Occupational Safety and Health Act authorized the Occupational Safety and Health Administration to regulate waste containing blood-borne pathogens.

Regulations promulgated as a result of these Acts are found in the Code of Federal Regulations (CFR).[a] The most important relevant titles of the CFR are:

(1) United States Environmental Protection Agency (EPA) regulations: Title 40, primarily Parts 260-266;

(2) Nuclear Regulatory Commission (NRC) regulations: Title 10, Parts 1-150, primarily Parts 19 and 20;

(3) Department of Transportation (DOT) regulations: Title 49, primarily Parts 171-179;

(4) Occupational Safety and Health Administration (OSHA) regulations:

- General Waste Disposal, Title 29, Part 1910, Section 1910.141(a)(4) (i-ii);

- Personal Protective Equipment: Title 29, Part 1910, Section 1910.132;

[a] Copies of these publications are available from the U.S. Government Printing Office, via www.gpo.gov.

- Specification for Accident Prevention: Title 29, Part 1910, Section 1910.145;
- Hazard Communication Standard: Title 29, Part 1910, Section 1200;
- Blood-borne Pathogens: Title 29, Part 1910, Section 1910.1030;
- Hazardous Substances in Laboratories: Title 29, Part 1910, Section 1910.1450.

3.2 State Regulations

States may have laws that are more stringent than Federal law, and this is true in many states. Further, many states obtain authorization to administer Federal regulatory programs, which themselves may be the same or more stringent than Federal law. It is therefore important to determine individual state requirements.

3.2.1 Hazardous Wastes

All state EPA regulations are at least as restrictive as federal requirements, but many states have regulations that are more restrictive. Many states are authorized to administer federal EPA regulations.

3.2.2 Radionuclides

With the NRC approval, some states have arranged to have state agencies govern the use and disposal of radionuclides. In these states, enforcement authority rests with the state agencies rather than with the NRC.

3.2.3 Incinerators

New federal EPA regulations have been promulgated for hospital/medical/infectious waste incinerators. The regulations are usually enforced by a state agency and or municipality.

3.3 Local Regulations

3.3.1 Sanitary Sewerage Codes

Sanitary sewerage codes for disposal to a publicly owned treatment works (POTW) are developed at the local level. Any laboratory that discharges liquid wastes into the sanitary sewerage system must comply with these codes.

3.3.2 Fire and Life Safety Codes

In compliance with state regulations, local fire codes regarding flammable and toxic waste accumulation areas are often administered by the local fire departments. Many local fire departments accept the codes established by the National Fire Protection Association (NFPA). NFPA standard number 30 pertains to the use and storage of flammable materials in laboratories.

3.3.3 Transportation of Laboratory Waste

Special restrictions for transportation of laboratory wastes may prevail at the local level.

3.3.4 Incinerator Emissions

Local regulation of incinerator emissions may be more stringent than that required by federal regulations issued under the Clean Air Act.

3.3.5 Sanitary Landfills

Municipalities often regulate landfill operations. The landfill operator may also impose restrictions such as acceptable types of waste and required containers.

3.4 Nonregulatory Requirements

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the College of American Pathologists (CAP) have other safety and environmental standards that apply to clinical laboratories. These standards are requirements for accreditation.

4 Definitions[b]

The following definitions are included to help the reader understand terms as they are used in this document. These are not legal definitions. Because laws change and definitions are complex, readers should refer to current regulations for legal definitions. See the Additional References section for a list of applicable laws, rules, regulations, and guidelines.

Broker, *n* **-** A consultant, contractor, or waste transport firm that evaluates waste material, determines the appropriate disposal method, and makes arrangements for transport and disposal.

Carcinogen, *n* **-** Any substance capable of causing malignant tumors in humans or animals; **NOTE:** See the Agency for Toxic Substance and Disease Registry's (ASTDR) Annual Report on Carcinogens for current information on carcinogens.

Chemical waste, *n* – This category includes chemical waste that is regulated as hazardous waste, as well as unregulated chemical waste that poses a risk to health and to the environment; **NOTE:** Most chemical waste is regulated as hazardous waste (see below).

Corrosive, *n* **-** Any substance that causes visible destruction of human tissue at the site of contact; **NOTE:** The EPA defines corrosivity as a substance that is highly acidic (pH < 2.1) or highly alkaline (pH > 12.4).

Decontamination, *n* – *For infectious waste*, a procedure that eliminates or reduces microbial contamination to a safe level with respect to the transmission of infection; **NOTE:** Sterilization and disinfection procedures are often used for decontamination of infectious waste; other procedures are available for chemical and radioactive material decontamination. See **Infectious waste**.

Disinfection, *n* **-** A procedure that kills pathogenic microorganisms but not necessarily their spores; **NOTE:** Chemical germicides formulated as disinfectants are used on inanimate surfaces (e.g., medical devices); they should not be used on skin or body tissues.

Disposal, *n* **-** Act of indefinitely sequestering either treated or untreated waste, such as by burial in a landfill or waste pile; **NOTE:** Indiscriminate release to the environment is also considered disposal.

[b] Some of these definitions are found in NCCLS document NRSCL8—*Terminology and Definitions for Use in NCCLS Documents.* For complete definitions and detailed source information, please refer to the most current edition of that document.

Generator, *n* – A firm or institution that creates waste.

Hazardous material (hazmat), *n*- As referenced in Department of Transportation regulations, a substance or material, which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated; **NOTE:** Hazardous wastes, regulated medical wastes, and most forms of low-level radioactive waste are hazardous materials.

Hazardous waste, *n* - Regulated hazardous waste is *chemical* waste that singly, or in combination, poses an immediate or potential threat to human health or to the environment and which, singly or in combination, requires special handling, processing, or disposal; **NOTE:** This includes chemical wastes that may be flammable, explosive, reactive, corrosive, toxic, carcinogenic, infectious, bioconcentrative, potentially lethal, irritating, or strongly sensitizing.

Hazmat employee, *n*- As referenced in Department of Transportation regulations, a person who is employed by a hazmat employer and directly affects hazardous materials (hazmat) transportation safety, including an owner-operator of a motor vehicle which transports hazmat; and any other employed person (including a self-employed person) who:

- loads, unloads, or handles hazmat;
- tests, reconditions, repairs, modifies, marks, or otherwise represents packagings as qualified for use in the transportation of hazmat;
- prepares hazmat for transportation;
- is responsible for safety of transporting hazmat; or
- operates a vehicle used to transport hazmat.

Hazmat employer, *n*- As referenced in Department of Transportation regulations, a person who uses one or more of its employees in connection with:

- transporting hazmat in commerce;
- causing hazmat to be transported or shipped in commerce; or
- representing, marking, certifying, selling, offering, reconditioning, testing, repairing, or modifying packagings as qualified for use in the transportation of hazmat.

Hazard reduction, *n* - An active or passive process, procedure, or method that reduces or eliminates the hazard of the waste; **NOTE:** Examples include storing radioactive waste for decay, autoclaving infectious waste, and neutralizing waste mineral acids.

Ignitable, *n* - A substance that, under standard temperature and pressure, is capable of causing fire through friction, absorption of moisture, or other spontaneous chemical change and that, when ignited, will burn vigorously and persistently.

Infectious substance, *n*- A viable microorganism, or its toxin, that causes or may cause disease in humans or animals, and includes those agents listed in 42 CFR 72.3 of the regulations of the Department of Health and Human Services and any other agent that causes or may cause severe, disabling, or fatal disease; **NOTES:** a) As referenced in Department of Transportation regulations; b) The terms "infectious substance" and "etiologic agent" are synonymous.

Infectious waste, *n* - Includes wastes containing, or potentially containing, pathogens of sufficient virulence and quantity so that exposure to the waste by a susceptible host could result in the development by that host of a communicable disease; **NOTES**: a) Also included in infectious waste are regulated waste (as defined by OSHA under the blood-borne pathogen rules), and all but the "unused sharps" category of

regulated medical waste (as defined by the 1988 Medical Waste Tracking Act, which has been adopted by some states); b) This waste type is also referred to as "medical waste," "biohazardous waste," "red bag waste," and "regulated medical waste"; c) This category is defined in Section 9.1

Manifest, *n* **-** A shipping paper required by the regulatory authority when shipping laboratory waste that identifies the type of waste, the generator, and the transporter, as well as the destination.

Multihazardous waste, *n* –Waste that contains any combination of hazardous chemicals, radioactive materials, or biohazardous agents; **Low-Level Mixed Waste**, *n* – A subset of multihazardous wastes that contains both low-level radioactive waste (LLW) and chemicals regulated by the EPA or states as hazardous wastes.

Nonhazardous waste, *n* – **1)** This category includes all other clinical laboratory waste not in any of the above categories; **2)** In this guideline, nonhazardous waste includes all solid waste, sanitary sewerage, and air emissions that are not infectious, radioactive, sharps, chemically hazardous, or multihazardous; **NOTES:** a) Nonhazardous waste is defined in Sections 4 and 12; b) Nonhazardous waste must be handled, managed, and disposed of properly; c) Nonhazardous waste is not risk free; for example, staples can injure, talcum powder can pose an inhalation hazard if spilled, and hard plastics can cause injury if flying sharps are created when the plastic is compacted; d) When improperly disposed of, nonhazardous waste can cause aesthetic degradation of the environment, such as litter on the beach.

Radioactive waste, *n* – **1)** Substances that are radioactive at levels above the exempt limits (more than 0.05 mCi) established by the National Regulatory Commission; **NOTE:** This waste is generated from the use of radioactive materials; **2) Low-level radioactive waste**—defined in the Federal Low-Level Radioactive Waste Policy Act of 1980 as radioactive waste that is not classified as high-level, transuranic, spent fuel, or certain by-product material (the waste types within the domain of nuclear power plants and fuel facilities); **NOTES:** a) Low-level radioactive waste is a broad and somewhat ambiguous category, defined not by what it is, but by what it is not; b) Most generators of infectious and medical waste generate only low-level radioactive waste.

Reactive substance, *n* - Any material that combines violently with water, air, or other chemicals to generate heat, pressure, or toxic fumes.

Regulated medical waste, *n* - As referenced in Department of Transportation regulations, a waste or reusable material, other than a culture or stock of an infectious substance, that contains an infectious substance and is generated in the diagnosis, treatment, or immunization of human beings or animals; research pertaining to the diagnosis, treatment, or immunization of human beings or animals; or the production or testing of biological products; **NOTE:** Exceptions include wastes that have been treated by steam sterilization, chemical disinfection, or other appropriate method, so that they no longer pose the hazard of an infectious substance; corpses, remains, and anatomical parts that are intended for ceremonial interment or cremation; and hazardous wastes.

Satellite accumulation, *n* - The act of collecting hazardous waste at or near its point of generation; **NOTES:** a) The EPA has requirements on how large and small quantity generators may accumulate chemical waste on-site; b) See Satellite Accumulation in Section 8.2.3.

Sharps waste, *n* **-** Certain wastes that can cause puncture wounds or lacerations, including needles, scalpels, and lancets; **NOTE:** This category also includes the "unused sharps" category of regulated medical waste as defined by the medical waste tracking regulations.

Solid waste, *n* – **1)** Defined by EPA as any solid, liquid, or gaseous waste; **2)** In this guideline, the term "solid waste*"* is used to mean any waste that is not regulated nor considered hazardous.

Source reduction, *n* - A method of avoiding the generation of waste through reduction in the amount or hazard of the waste generated; **NOTE:** It is considered the preferred method of waste minimization; examples of source reduction include scaling down a process to generate less waste, changing a process to eliminate waste generation, and substituting materials to reduce or eliminate the hazard of the waste.

Source separation, *n* – Separation of wastes at the point of generation into management or disposal categories.

Small-quantity generator (SQG), *n* **-** A generator of 100 to 1,000 kg of hazardous chemical waste in any given calendar month; **NOTES:** a) For an institution, this may be interpreted as the total hazardous chemical waste in aggregate per calendar month; b) An SQG is required to obtain an EPA identification number (EPA ID number) before he or she treats, stores, disposes of, transports, or offers hazardous waste for transportation; this is referred to as notification and is not considered an application, license, or permit.

Sterilization, *n* - A procedure that kills all microorganisms, including bacterial spores.

Treatment, *n* **-** Process by which wastes are made less hazardous, nonhazardous, nontoxic, or noninfectious, or are converted to another physical form (e.g., stabilized or encapsulated).

Waste, *n* – A discarded material, no longer usable for its original purpose; **NOTE:** It may result from household or institutional activities (e.g., garbage) or from biologic activities (e.g., excreta).

Waste segregation, *n* - The segregation of wastes immediately upon generation into different management categories.

5 Waste Management Program for the Laboratory

A laboratory waste management program should have as its purpose comprehensive control over the production, handling, storage, disposal, and monitoring of all waste originating in the clinical laboratory to ensure that the health of the exposed population and the surrounding biologic environment is properly protected. It should also address broader environmental concerns, such as the decreasing availability of landfill sites and the increasing desirability of recycling. An institutional program for a clinical laboratory may be developed by in-house staff or with the assistance of outside consultants.

Because of their importance, pollution prevention, waste minimization, training, and education are discussed separately below. A complete waste management program will include the following components:

5.1 Planning for Laboratory Waste Management

Development of a waste management program should be preceded by a waste audit of the facility; its procedures and functions; the hazardous materials used or available for use; the wastes that are generated (by type and amount); and the current methods of handling, segregation, storage, on-site treatment and disposal, transfer, and transportation of those wastes. The survey should address all wastes, whether hazardous or not.

The ideal plan is one that meets regulatory requirements and accreditation standards, reduces liability, makes no unreasonable financial demands on the organization, and is acceptable to the employees.

The first step in planning the program is to become fully informed before making any decisions on the elements of the laboratory waste management chain. One must also stay informed of constantly changing regulations, and new waste handling and minimizing technologies. To formulate these plans consider:

- knowing what federal, state, and local regulations, as well as accreditation standards, apply;
- the cost of each management option;
- a cost/benefit analysis of waste disposal methods (as well as trade-offs between EPA and OSHA regulations), including the relative costs of training;
- society and community feelings about hazardous and infectious waste, as well as public relations needs; and
- needs and waste generation habits of the facility.

5.2 Elements of a Waste Management Program

The scope, goals, and objectives of the program must be defined with the participation of the managers who are affected. The goals and objectives should be not only to protect the health and the environment in general terms but also to meet the requirements of all applicable governmental laws and regulations, plus the requirements of accrediting organizations such as the Joint Commission on Accreditation of Healthcare Organizations, the College of American Pathologists, and others.

In designing the program, the following objectives or components should be included. These elements follow a sequential path, from generation, accumulation, storage and shipment, to treatment and disposal.

5.2.1 Waste Determination

EPA requires that all institutions examine the wastes they generate to determine if any are hazardous wastes. Once such a determination is made, all hazardous waste must be disposed of in a manner prescribed by EPA regulations. Therefore, is it a waste? What are its hazards and characteristics?

5.2.2 Source Separation and Segregation of Generated Waste

Do not mix different waste types. Dilution of regulated waste with normal trash does not remove it from regulation, even if the waste mixture no longer has hazardous characteristics. Rather, the entire amount of the new waste mixture will be regulated. Further, mixing incompatible wastes can cause additional hazards. For recycling purposes, it is also advantageous to segregate certain nonhazardous wastes (e.g., newspapers, bottles, and aluminum cans). Thus, it is highly desirable to keep different waste types separate—and well labeled—from the other waste from its point of generation to its final disposition.

Starting at the point of generation, each waste type should be collected separately and be kept segregated throughout storage, transportation, and disposal operations. If precautions are taken to avoid incompatibility and commercial disposal problems, it is appropriate to combine different waste types by collecting them in one container.

5.2.3 Prompt Removal of Accumulated Waste

A key practice for managing waste is its prompt removal from the laboratory. Prompt removal minimizes the risk of spills and overfilling collection containers. This part of good housekeeping demonstrates an active, sound institutional waste management program to outsiders.

Reasonable exceptions to prompt removal of accumulated waste may be made for properly shielded radioactive waste held for decay-in-storage (DIS) at the point of generation, and for low-volume, hard-to-dispose-of hazardous chemical waste held at its satellite accumulation location until cost-effective commercial disposal can be arranged.

5.2.4 Safety Waste Handling

Hazardous materials must be handled properly to avoid accidents and exposures. This is accomplished by following safe procedures, wearing personal protective equipment (PPE), and training all employees who routinely or occasionally handle hazardous materials. Handling techniques and other procedures designed to minimize contamination or exposure are examples of work practice controls. Work practice controls may also reduce worker risk, but they should supplement, and not substitute for, proper engineering controls, such as ventilation.

The choice of PPE depends on the activity, the hazards and characteristics of the material handled (e.g., volatility, permeation, penetration, and degradation), and available engineering controls. PPE is especially important when chemical exposure is possible, such as during transfer operations (e.g., adding waste to an open container, combining and mixing wastes, and neutralizing mineral acids). PPE can include goggles or face shields (regular or safety glasses are not appropriate for transfer operations), aprons or laboratory coats, and proper gloves. A respirator is appropriate when volatile hazardous materials are transferred outside of a fume hood.

5.2.5 Waste Storage

The storage sites must be planned in such a way as to minimize inadvertent access by the untrained or unauthorized. Safe storage requires engineering controls appropriate to the type of waste (see Section 5.3).

While it is economically desirable to reduce the number of waste shipments, storage times must be weighed against the costs and hazards of storage. For example, radioactive materials with a short half-life may be allowed to decay in storage until they are safe for disposal. Alternatively, EPA limits storage for hazardous chemical waste (see Section 8.2.2).

5.2.6 Transportation of Wastes

Arrangements for timely on-site movement and off-site shipment of wastes are critical elements of the waste management program and may comprise a significant fraction of overall program costs and potential liability. Transportation planning should consider safety; facility logistics; the frequency of waste removal services needed to support laboratory operations; manifest tracking and record keeping requirements; regulations; and training needs. Note that EPA limits storage times for small and large generators of hazardous chemical waste.

The Department of Transportation (DOT) regulates labeling, marking, packaging, and shipping of hazardous materials (hazmat). Almost all hazardous, infectious, radioactive, and multihazardous wastes generated by laboratories are classified as hazardous materials. DOT regulations are complex, subject to frequent and revisions, and not within the scope of this guideline. However, these regulations do affect off-site shipments of wastes and have significant impacts on on-site waste management operations ranging from selection of waste collection containers to personnel training. The EPA, NRC, OSHA, and state and local agencies also regulate various aspects of waste transportation.

Properly authorized and licensed haulers must perform the transportation of waste from the institution. Many laboratories rely on waste brokers and contractors to ensure compliance with shipping regulations. This may be convenient; however, the facility shipping the waste bears primary responsibility for

compliance with regulations and liability for violations and incidents. Properly completed manifests and disposal records must be kept on file. Generators are forever liable for the proper management of waste that they generate.

DOT packaging, labeling, and marking requirements apply to all commercial shipments on public roads. Nearly all institutions hire a commercial hazardous waste transporter when they plan to ship waste for off-site disposal.

5.2.6.1 EPA Identification Number

All large generators and small quantity hazardous generators must apply for and receive an EPA ID number. This is achieved by the use of EPA's "Notification of Hazardous Waste Activity" form (8700-12). Waste transporters, as well as treatment, storage, and disposal facilities (TSDs) are also required to have ID numbers.

Many states and transporters also use EPA ID numbers, or similar ID numbers, for tracking shipments of other types of laboratory waste.

5.2.6.2 Manifests (Shipping Papers for Laboratory Waste)

Environmental laws require tracking wastes "from cradle to grave." To achieve this, a manifest or shipping paper is required to document the transportation of laboratory waste. The manifest identifies the waste generator, transporter, and destination of the waste (i.e., the treatment, storage, or disposal facility (TSDF)), and it describes the waste and its quantity. Wastes regulated by DOT may not be transported along public roads without a manifest or shipping paper.

A manifest is a four-part document (some states require more parts). It contains one part each for the generator, the transporter, the TSDF, and a final copy sent from the TSDF back to the generator to document that the waste arrived at its final destination. Manifests also track and assign liability for hazardous waste, so it is prudent to keep these well beyond the three-year period required for record retention.

5.2.6.3 U.S. Department of Transportation (DOT) Requirements

The DOT requires that hazardous material or waste be shipped in approved packaging, with DOT precautionary marking and labeling, and in a placarded (external signed) vehicle. Shipping requirements are complex, but DOT assigns the ultimate responsibility for these requirements to the waste generator. Therefore, to stay in compliance, it is critically important that the shipper have a commanding knowledge of DOT shipping and EPA waste identification requirements.

5.2.6.4 DOT Hazmat Training Requirements

Laboratory owners and employees engaged in activities relating to shipments of regulated forms of waste are subject to training requirements under DOT regulations. These requirements even apply to personnel who may appear to have minimal involvement in shipping operations. For example, an employee whose only shipping related activity is signing waste manifests on behalf of the facility is fully subject to DOT's training requirements. Each hazmat employer must train and test hazmat employees, certify the training, and develop and retain detailed records of current training (inclusive of preceding three years) for each hazmat employee (during the period of employment and 90 days thereafter). Hazmat training must include general awareness and familiarization with hazardous materials and DOT regulations; function-specific training; safety; and driver training (for each hazmat employee who will operate a motor vehicle). Some of this training may now be obtained online from a DOT website.

Initial training is required for new employees, or when an employee changes job functions. Recurrent training is required at least once every three years. Employees may perform hazmat job functions before completing training, provided the employee does so under the direct supervision of a properly trained and knowledgeable hazmat employee; and the hazmat training is completed within 90 days of employment or change in job function. Relevant training received from a previous employer or source may be used to satisfy the requirements, provided a current record of training is obtained from the previous employer or source.

DOT training records must include the hazmat employee's name; completion date of most recent training; training materials (copy, description, or location); name and address of hazmat trainer; and certification that the hazmat employee has been trained and tested.

5.2.7 Waste Treatment and Disposal

Treatment and disposal usually occurs off-site at a commercial disposal facility. In certain instances, it is advantageous to treat laboratory waste on site. Examples are the decontamination or sterilization of infectious waste and neutralization of acids and bases.

5.2.8 Contingency and Emergency Planning

There must be a written contingency plan for emergencies such as leaks, spills, hood failures, and employee exposures to infectious and hazardous substances. Consider any foreseeable emergency or contingency, and include procedures for responding to these events. Conditionally exempt small-quantity generators are exempt from contingency planning requirements for hazardous chemical wastes. Even so, it is prudent for all users of hazardous materials to plan for and actively prevent emergencies. Contingency planning requirements for small-quantity generators (40 CFR 262.34(d)(5)) are appropriate for all users of hazardous materials. The following requirements are mandated by the EPA for generators of hazardous waste:

5.2.8.1 Emergency Responsibilities of All Laboratory Staff

- In the event of a fire, call the fire department and/or attempt to extinguish it using a portable fire extinguisher.

- In the event of a spill, contain the flow of hazardous waste to the extent possible and, as soon as it is practical, clean up the hazardous waste and any contaminated material or soil.

5.2.8.2 Emergency Coordinator

Designate an emergency coordinator responsible for coordinating all emergency response measures. This person must be either on the premises or on call. The emergency coordinator or a designate has the following responsibilities:

- to plan for emergencies by establishing emergency procedures, making arrangements with local emergency responders, and informing laboratory personnel of the above actions; and

- in the event of a fire, explosion, or other release that could threaten human health outside the facility, or when the generator has knowledge that a spill has reached surface water, to notify the National Response Center (using their 24-hour toll free number: 1-800-424-8802). The report must include the name, address, and EPA ID number of the institution; the date, time, and type of incident; the quantity and type of hazardous waste involved in the incident; the extent of injuries, if any; and the estimated quantity and disposition of recovered material, if any. To demonstrate compliance, the emergency coordinator should document this notification.

5.2.8.3 Post Information Next to the Telephone

The following information should be posted next to each telephone within any facility that generates hazardous waste:

- name and phone number of the emergency coordinator; and
- the telephone number of the fire department.

The location of fire extinguisher, spill control equipment, and the fire alarm should also be posted.

Large-quantity generators of hazardous chemical waste need to comply with more stringent contingency planning requirements.

5.2.9 Compliance Planning

The waste management program should be integrated with the institution's hazard communication plan; chemical hygiene plan; infection control plan; disaster plan; existing safety policies and procedures; risk management and loss control plan; and any other related or overlapping programs. It should include a plan for monitoring, reducing, and recycling waste in addition to waste treatment and disposal. Someone who is thoroughly familiar with applicable laws and the institution should design the waste management and its associated plans. Managers, facility engineers, and technical and professional staff should also consult.

5.2.10 Review and Approval

Once the waste management program has been written, representatives from all of the affected departments should review it. A representative from top management should also review it. After changes and adjustments are made, it should be formally approved.

5.3 Safe Facilities for Waste Management

To prevent accidents, releases, injuries, and exposures, various controls and engineering enhancements are appropriate for areas where laboratory waste is accumulated or stored. Some of these controls are required only of large laboratory waste facilities, but they are nevertheless prudent practices for smaller waste generators as well. These controls include ventilation, a containment system, security, fire protection, and sufficient aisle space.

5.3.1 Ventilation

Provide adequate ventilation for volatile chemicals, either by improving the room ventilation or by placing the waste in a ventilated storage area. Alternative fire-safe, nonventilated chemical storage cabinets may be appropriate.

5.3.2 Containment System

Place liquid wastes only in an area surrounded by a dike, berm, or other containment. The EPA suggests that containment systems have sufficient capacity to contain either 10% of the volume of the containers or the volume of the largest of the containers, whichever is greater. For bench tops in laboratories, a high-walled tray is usually sufficient. Containers should be raised so spilled or leaked waste in the containment system does not contaminate the outside of other containers.

5.3.3 Security

Security is needed to prevent access by unauthorized personnel to areas where laboratory waste is generated, accumulated, or stored. A warning sign is also recommended.

5.3.4 Fire Protection

Fire protection should include proper waste collection containers, grounding of metal flammable liquid containers, flammable liquid storage cabinets, ready access to fire extinguishers, and building alarm systems. A fire suppression system is appropriate for the central accumulation areas for flammable wastes. Consult National Fire Protection Association (NFPA) Standards 405 and 30 for other precautions.

5.3.5 Aisle Space

Adequate aisle space is needed to allow an easy and fast exit.

5.4 Plan Implementation

With the full commitment of and support from top management, the plan should be put into effect. This requires obtaining all the equipment and supplies, making arrangements with outside services (such as waste management firms), and appropriate training of staff.

5.5 Program Evaluation and Corrective Action

During the implementation period, the plan should be frequently reviewed. Appendix A is a sample of an annual review of a waste management program. It should be reviewed at least annually thereafter to determine how objectives are being met and how much the plan is costing the laboratory. Pertinent legislation, regulations, and accreditation requirements must be constantly monitored. Appropriate revisions should be made as needed.

5.6 Environmental Liability

Waste generators are liable for compliance with the various federal, state, and local laws described in Section 3. This liability remains forever with the generator. Other parties he or she contracts with for the handling, transport, or disposal of laboratory waste may share the liability, but the liability may never be transferred. For instance, if the waste produced by a laboratory is sent to a hazardous incinerator that has storage tanks that leak and contaminate drinking water, the laboratory will share the liability with the incinerator operator. Under the Joint and Several Liability Doctrine, the laboratory may have to pay a disproportionate share of the fines and damages. This is why it is important to carefully select a waste management service.

Violators of environmental laws may be subject to severe civil or criminal penalties. Personnel who dispose of waste illegally may be held personally liable. Managers who have had knowledge of illegal practices and did not take action have been subject to civil and criminal prosecution. In addition to risking prosecution from governmental agencies, the violator of environmental laws may also face civil litigation from any injured parties, such as owners of an adjacent property whose drinking water may have become contaminated. Legal redress against environmental offenders has been made easier by RCRA.

5.7 The National Waste Management System

The waste management system consists of the waste generators; the transporters; and the treatment, storage, and disposal facilities.

5.7.1 Transporter

A transporter is a firm licensed by the EPA to transport hazardous waste. Each transporter has an EPA ID number and, often, a state permit or ID number. A list of licensed transporters is available from the regional U.S. EPA office and from the state's environmental agency. Although transporters may offer assistance, generators are responsible for compliance with packaging, labeling, transporting, tracking, recordkeeping, and reporting requirements for waste shipments.

5.7.2 Treatment, Storage, and Disposal Facilities (TSDFs)

These are facilities that treat or dispose of waste, or store chemical hazardous waste for more than 90 days. They may perform one or more of these functions. They must keep records of waste shipments received and processed.

5.8 Selecting a Waste Management Service

The institution is likely to need the services of a hazardous and medical waste transporter, plus a service that will treat the waste if the institution does not treat or destroy it on-site. Consulting services are often available from the larger waste management firms, and they may assist with the survey, program design, and implementation. Another option is to use an independent consulting firm that does not have a vested interest in its own waste disposal service; such firms offer similar assistance, plus selection of the most cost-effective waste management firm. The transportation and the treatment/disposal may be performed by the same firm or by different firms. It may be necessary to use different firms for different types of waste.

5.8.1 Choosing a Commercial Transporter

Choose commercial transportation, recycling, treatment, and disposal firms carefully. The selection process usually includes an evaluation of the prospective firm's regulatory compliance record, the potential environmental impact of the firm's practices, and a visit to the waste management facility. The next best thing is to ask a prospective waste management vendor to provide a list of references, then to call the references to find out if they have performed an evaluation and hope that they will share their results. Also ask references about the quality of service, especially in meeting the EPA's storage time limits (i.e., getting waste off site per requests) and helping to comply with the many, frequently changing requirements.

5.8.1.1 Criteria for Selecting a Laboratory Waste Disposal or Transportation Firm

Two important criteria for selecting a laboratory waste disposal or transportation firm are:

- the environmental quality of the ultimate disposal facilities; and
- willingness to assist the laboratory with regulatory compliance, including meeting waste accumulation limits; providing proper containers and labeling; completing manifests, tracking forms, and other transportation paperwork; and preparing the laboratory's annual report and other recordkeeping.

Do not hesitate to ask what can be done to lower costs; however, cost should never be a primary selection criterion.

5.8.1.2 Criteria to Include in the Selection of a Transporter

If a transporter is selected separately from a treatment disposal service, the following are useful criteria to include in the selection process:

- licensing by state and EPA (mandatory);
- number of years in business and years providing this service;
- financial strength;
- number and nature of violations (available from regulatory agencies);
- recordkeeping (i.e., forms, security, information systems);
- names of similar clients for reference (A small institution may benefit from the extensive evaluation of waste management firms that a large institution may have completed before selecting its vendor, so ask for a few large institutional references.);
- differences between this firm and its competitors;
- liability insurance coverage;
- training and education provided initially and ongoing (in person and through printed or audio-visual materials);
- cost of routine services per unit weight and per distance hauled;
- type, size, strength, and ease of use of containers provided;
- frequency of pickup—particularly within the storage limits determined by the United States EPA or state EPA—and availability of emergency pickup;
- reliability of service (e.g., bad weather, strikes) and size of fleet; and
- spill cleanup and emergency response capabilities.

5.8.2 Selecting a Treatment and Disposal Facility

To select a treatment and disposal facility, include all of the items in Section 5.8.1.2, plus the following selection criteria:

- the location of the treatment and disposal facility, as well as the location of the nearest local office;
- types of wastes handled (e.g., chemical, radioactive, medical), and methods of treatment and disposal;
- services provided and cost; and
- availability of emergency services.

If possible, visit their facilities. Even people relatively inexperienced in this field can judge cleanliness, organization, and commitment to excellence.

Before contracting for services, obtaining proposals from at least three different vendors is recommended.

5.9 Where to Get Help

The state's environmental agency is usually an excellent source of compliance assistance.

The following hotline numbers are available to assist laboratories comply with environmental laws:

- RCRA/Superfund Hotline. Call this number for EPA information on hazardous waste regulations:

  1-800-424-9346

- DOT Hotline. Call this number for DOT information on transportation regulations:

  1-202-426-2075

Call the National Response Center (in an emergency only) to report a release, fire, or explosion involving hazardous substances: **1-800-424-8802**

6 Planning for Pollution Prevention, Waste Minimization, and Recycling

If the generation of hazardous, or even nonhazardous, waste can be avoided or reduced in the first place, the costs of storage, transport, treatment, and disposal are not only diminished, but the liability of the generator is also reduced. A chemical inventory will help control stocks and prevent the purchase of duplicates. The manager should promote a system that substitutes smaller quantities and less hazardous materials whenever possible. Minimization of hazardous waste is a regulatory requirement.

6.1 EPA's Guidance for Waste Minimization

EPA's guidance for waste minimization is appropriate for all generators. The EPA recommends that an effective waste minimization program include these elements:

- top management support, such as a statement from the institution's president;
- characterization of waste generation to promote understanding of the amounts and types of waste generated and to identify where waste minimization efforts would be most efficient and effective;
- periodic waste minimization assessments;
- a cost allocation system in which individual departments and units are charged for disposal as a disincentive (Alternatively, every unit that generates hazardous waste should be notified of the disposal costs borne by the institution.);
- encouragement of technology transfer (Talk to other similar institutions. What waste minimization methods work best for them?); and
- program evaluation.

6.2 Examples of Pollution Prevention, Waste Minimization, and Recycling

The benefits of pollution prevention, waste minimization, and recycling include reduction in waste volume with corresponding decrease in disposal costs. There is also the benefit of good community

relations from public knowledge that you are concerned about pollution prevention and have an active recycling program.

Some examples of techniques for waste minimization are buying in smaller quantities to reduce the amount of surplus outdated chemicals that may be generated; switching from disposables to reusables; recycling; redistillation of solvents; use of microsystems; and substitution of nonhazardous for hazardous chemicals. Section 8.5 describes many more ways to minimize chemical wastes.

One way to reduce the quantity of infectious waste generated is to switch from disposable to durable goods. Use of durable items that can be cleaned and sterilized (if necessary) before reuse should be considered as a waste management option. Factors such as quality control, safety, costs, and the impact of cleaning must be considered.

Recycling is an option for many of the wastes generated in the laboratory. In addition to chemical wastes, newspapers, aluminum cans, glass bottles, plastic containers, bond paper, soft plastics, and telephone books can all be recycled. Specific opportunities for recycling depend on the programs available in the area, because a particular type of waste can be recycled only if a broker for that waste operates in the locale.

There are many other opportunities for pollution prevention, waste minimization, and recycling in the clinical laboratory. References for pollution prevention (included in the Additional References section) will help the reader explore them.

Encourage people to minimize waste and to recycle. Place containers for recycled items in convenient locations, close to the point of use. Include pollution prevention and recycling as parts of training programs, newsletters, and posters, as well as other promotional materials.

7 Education and Training

Education and training are critical elements of a successful waste management system. They give needed information and skills to both management and employees at all levels in the organization and for all stages of waste management.

Adequate training is not only necessary for a successful program, it is also required under various regulations of multiple federal regulatory agencies: the Occupational Safety and Health Administration, the Nuclear Regulatory Commission, the Environmental Protection Agency, Department of Transportation, etc. Also important is voluntary compliance with relevant standards set by the Joint Commission on Accreditation of Healthcare Organizations, the American Osteopathic Association, the College of American Pathologists, and other accrediting agencies.

The training programs needed depend on the laboratory's waste management plan, and should consider the following elements:

- who needs training;
- what needs to be taught;
- when and how frequently training is needed;
- how best to present the training; and
- how training will be documented.

7.1 Training Program Elements

Because there are common elements in many environment, health, and safety training requirements, such training can be consolidated. Most applicable regulations are listed below in Table 1.

Table 1. Laboratory Training Requirements Pertaining to Waste Management

Training Requirements	Who Must Be Trained
EPA Hazardous Waste Requirements (40 CFR 262.34 & 265.16) Large-quantity Generators: • Facility personnel must complete a program of classroom instruction or on-the-job training that teaches them to perform their duties in a way that ensures compliance with 40 CFR Part 264. • The training program must be directed by a person familiar with hazardous waste management procedures, and must include instruction in emergency response management. Small-quantity Generators: • Training should cover waste management and emergency response procedures relative to the employee's responsibilities. Frequency: Employees must be trained annually.	Employees whose responsibilities include waste management activities such as waste identification, transfer, collection, facility emergency coordination, certifying hazardous waste shipments, and waste-related inspections.
NRC training requirements for users of radioactive materials (10 CFR 19.12): • kept informed of the storage, transfer, or use of radiation and/or radioactive material; • instructed in the health protection problems associated with exposure to radiation and/or radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed; • instructed in, and required to observe (to the extent within the workers' control) the applicable provisions of Commission regulations and licenses for the protection of personnel from exposure to radiation and/or radioactive material; • instructed of their responsibility to report promptly to the licensee any condition which may lead to or cause a violation of Commission regulations and licenses or unnecessary exposure to radiation and/or radioactive material; • instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation and/or radioactive material; and • advised as to the radiation exposure reports which workers may request pursuant to §19.13.	All individuals who in the course of employment are likely to receive in a year an occupational dose in excess of 1 mSv (100 mrem).

Table 1. (Continued)

Training Requirements	Who Must Be Trained
OSHA training requirements (29 CFR 1910.1200) Hazard Communication Standard): Train employees on hazards of chemicals, labeling and other warning mechanisms, Material Safety Data Sheets (MSDSs), site-specific hazards, and protection measures for workers. Frequency: Initial and when new hazards are introduced.	Employees exposed to hazardous materials in the work place.
OSHA training requirements (29 CFR 1910.120(q) HAZWOPER for Emergency Response (First Responder Awareness Level)): First responders at the awareness level shall have sufficient training or have had sufficient experience to objectively demonstrate competency in the following areas: • an understanding of what hazardous substances are, and the risks associated with them in an incident; • an understanding of the potential outcomes associated with an emergency created when hazardous substances are present; • the ability to identify the hazardous substance, if possible; and • an understanding of the role of the first responder awareness individual in the employer's emergency response plan.	Employees who participate in emergency response, except for laboratory personnel who clean up their own spills. Employers who will evacuate their employees from the danger area when an emergency occurs, and who do not permit any of their employees to assist in handling the emergency, are exempt from the 29 CFR 1910.120(q) training requirements, if they provide an emergency action plan in accordance with 29 CFR 1910.38(a). See 29 CFR 1910(q)(1) for this exemption.
OSHA training requirements (29 CFR 1910.130(g)(2) Bloodborne Pathogen Standard): Training must cover all applicable requirements listed in 29 CFR 1910.130(g)(2). Frequency: At the time of initial assignment and at least annually thereafter. Additional training must be provided when an employee's tasks are changed or the employer's procedures change.	Employees with occupational exposure to blood-borne pathogens.
DOT Training Requirements (49 CFR 173.197 and 173.134(a)(4)) Transportation of Hazardous Materials (Hazmat): Each hazmat employer must train and test hazmat employees, certify the training, and develop and retain detailed records of current training for each hazmat employee. Hazmat training must include general awareness and familiarization with hazardous materials and DOT regulations; function-specific training; and safety training. Frequency: Initial training is required for new employees, or when an employee changes job functions. Recurrent training is required at least once every three years. Recordkeeping: DOT training records must include the hazmat employee's name; completion date of most recent training; training materials (copy, description, or location); name and address of hazmat trainer; and certification that the hazmat employee has been trained and tested.	Employees engaged in activities relating to shipments of regulated forms of waste, including employees whose only shipping-related activity is signing waste manifests on behalf of the facility.

7.2 Mandatory Employee Awareness Training and Education

All employees who handle laboratory waste must receive training that covers the risks associated with all types of waste, whether regulated or not. Federal regulations and voluntary accreditation standards require that all employees who manage or handle hazardous or infectious materials or waste be trained. Training must be done when the waste management programs are implemented; when they are changed (as when a new chemical or a medical waste handling product is introduced); at the time of hire for new employees; and at least annually thereafter.

All employees must be informed about the applicable regulations, copies of which should be available to them.

All employees should be informed about the contents and location of the laboratory waste management plan(s). The plan(s) must be explained and be available to everyone. The location of lists of hazardous chemicals, their Material Safety Data Sheets (MSDS), and instructions for accessing them must be included. The plan should also define the responsibilities of management, supervisors, and employees. The material taught should be appropriate in content and vocabulary to the educational level, literacy, and language background of the people to whom it is presented.

Training should include injury prevention; waste avoidance and segregation; treatment/emergency procedures; reporting; and follow-up policies.

Employees must be informed of the potential physical and health hazards of their work areas and precautions for their protection. The training material should include general safety principles; modes of exposure for chemicals; radioactive materials and infectious agents; methods of labeling; and proper work practices to minimize exposures. For chemicals, instructions on how to detect the release of and overexposure to a hazardous substance should also be presented.

Use of personal protective equipment is one aspect of proper work practices that must be taught.

7.3 Annual Refresher Training Requirements

Every three years, DOT requires refresher training for employees who are actively involved in preparing a shipment of chemical, infectious, or radioactive waste. OSHA requires annual refresher training for employees who use respiratory protection, and for members of the spill response team (see below). EPA requires annual refresher training for employees who handle hazardous chemical wastes of small- and large-quantity generators. See Section 8.

7.4 Emergency Response Training

Each employee must be taught his/her role in an emergency. Responders must contain the spill, prevent exposures to other personnel, and decontaminate the area.

The laboratory's first responders must be trained to contact the appropriate outside agencies, and to differentiate spills that can be safely managed in-house from those for which outside help must be acquired. Larger spills will likely require response from the local hazmat team (or other specially trained personnel).

Eight-hour HAZWOPER awareness training is prudent for all employees, even though the definition of "emergency response" in OSHA 1910.120(a)(3) considers responses by "employees in the immediate release area" to be outside of HAZWOPER's scope. HAZWOPER requires additional training, and an annual refresher, for members of an in-house spill response team.

7.5 Requirements for Prior Approval

The waste management plan should also define circumstances under which training and prior approval is required before carrying out a particular operation, activity, or procedure. For example, procedures for distillation recovery of solvents or treatment of hazardous chemicals before disposal could specify that before any employee is allowed to perform the procedure for the first time, the employee must be trained, supervised, and given permission.

7.6 Training for Supervisors

The key to successful hazardous and medical waste management is to decrease the amount of waste in general. To make this happen, supervisors should be aware of waste management costs, as well as ways to reduce risks and costs. They need to know all the in-house options for handling wastes, how to do cost analysis on the options available, and how to make time for the training needed. They must ensure that solving one waste management problem does not make another one worse. Their support is critical for the successful operation of an institution's waste management plan.

7.7 Training Program Evaluation

The training program and its documentation should be reviewed at least annually. All employees involved in generating or handling hazardous, radioactive, multihazardous, or medical waste must be included. The teaching materials should be regularly updated for new procedures, technologies, and requirements. Special language or communication needs should be accommodated.

Employees should demonstrate competency in following the contingency plans, first aid, and emergency procedures—including spill response and use of the safety shower and the emergency eyewash. Annual refresher training is required for employees with emergency response or other special duties, as well as for those who use personal protective equipment or wear respiratory protection.

8 Chemical Waste

This section deals with wastes that are hazardous because of their chemical constituents or characteristics. When the EPA uses the term "hazardous waste," it refers to chemical waste, although some states use the term to include other wastes not regulated by the EPA.

8.1 Types of Laboratory Chemical Waste

As a first step in any program to properly manage laboratory wastes, an institution should carefully survey its waste generation activities and identify those wastes that must be managed, handled, and disposed of separately. There are three general types of laboratory chemical waste:

- chemical waste regulated as hazardous by EPA (i.e., hazardous waste);
- controlled substances and other drugs; and
- other chemical waste.

8.1.1 Hazardous Chemical Waste

Four chemical characteristics are used by the EPA to identify hazardous chemical waste: ignitability, corrosivity, reactivity, and toxicity. Of course, chemical waste can have multiple characteristics, as well as the characteristics of radioactivity and infectiousness—although these characteristics alone do not meet EPA's definition of a hazardous waste. The characteristics of hazardous chemical waste below are described in terms of EPA regulations found in 40 CFR 261.

8.1.1.1 Ignitability

Liquid, ignitable hazardous waste has a flashpoint less than 60 °C, or it has some other characteristic that has the potential to cause fire. Solid, ignitable hazardous waste is capable of causing fire through friction, absorption of moisture, and spontaneous chemical changes; or when ignited, it burns vigorously and

persistently. Flammable gases and oxidizers also have the characteristic of ignitability, as shown in Table 2.

Table 2. Examples of Ignitable Chemical Waste

Flammable Liquids	Flammable Gases	Oxidizers
Organic solvents such as acetone, alcohols, toluene, xylene	Hydrogen, butane	Nitrate salts, peroxides

40 CFR 261.21 describes the characteristics of ignitability in detail. Ignitable waste is identified on manifests and other reports with the identification number D001.

EPA regulates some waste organic solvents, because they are listed separately in 40 CFR 261 in that part's F, U, or P lists. Waste identification numbers 5001 through 5005 designate certain spent (waste) solvents.

8.1.1.2 Corrosivity

Liquid, corrosive hazardous waste has a pH ≤2 or ≥12.5; or it has the capacity to corrode steel, as described in 40 CFR 261.22. Examples include mineral acids, such as sulfuric, hydrochloric, and phosphoric acid, or bases such as ammonium hydroxide. D002 is the identification number for corrosive waste.

8.1.1.3 Reactivity

Reactive hazardous waste includes chemicals that are unstable; readily undergo a violent change; react violently with water; are capable of detonation; or are explosive. A cyanide- or sulfide-bearing waste is also considered reactive, as are other wastes that have the potential to generate toxic gases, vapors, or fumes (see Table 3).

Table 3. Examples of Reactive or Potentially Reactive Waste

Reactive	Potentially Explosive	Toxic Gas Source
Sodium, potassium, and other alkali metals	Dry picric acid; ether that contains peroxides	Cyanide or sulfide solution

40 CFR 261.23 describes this characteristic in detail. Reactive waste has the identification number D003.

8.1.1.4 Toxicity

The EPA regulates toxic chemical waste in two ways:

8.1.1.4.1 Leachate Toxicity

First, EPA has defined the characteristic of leachate toxicity, which is technically called "toxic constituent leachate procedure (TCLP)." If disposed of in a landfill, waste with this characteristic would create leachate (liquids that drain through or from the waste) containing toxic metals, pesticides, or certain other chemicals, thus posing a threat to ground water. The remaining D identification numbers are used for waste exhibiting this characteristic.

8.1.1.4.2 Lists of Hazardous Waste

The second way the EPA identifies toxic hazardous waste is by listing specific chemicals. These lists are given in 40 CFR 261. The P- and U-lists (referring to their identification number prefixes) name commercial chemical products and waste from the cleanup of spills from these materials. P- and U-list wastes do not include waste comprised of materials contaminated with P- and U-list chemicals, such as chemically contaminated gloves. The EPA does not regulate this type of waste, unless it possesses the characteristic of leachate toxicity.

A P-list waste is called an "acute hazardous waste." P-list wastes are important to small and conditionally exempt generators, because generation of more than 1 kg/month of a P-list waste will require the institution to comply with the most stringent generator requirements (see below). The list of acute hazardous waste includes allyl alcohol (P005); arsenic pentoxide (P011); carbon disulfide (P022); cyanides including soluble cyanide salts (P030); and osmium tetroxide (P087).

EPA regulations principally address industrial waste streams and do not cover some chemical wastes that are generated in laboratories. Nevertheless, many of these wastes are hazardous and may deserve special precautions. Further, many states define toxicity more broadly than the EPA and regulate additional laboratory chemical waste. State and local regulations that define regulated waste must be considered.

8.1.2 Controlled Substances and Other Drugs and Pharmaceuticals

The Drug Enforcement Agency (DEA) regulates the disposal of controlled substances. Disposal options and policies vary by region. Contact your local DEA office for procedures to dispose of controlled substances.

The Food and Drug Administration (FDA), U.S. Pharmacopoeia (USP), International Agency for Research on Cancer (IARC), and other bodies have published few specific guidelines for the disposal of other drugs and pharmaceuticals. In most cases, surpluses are either returned to the manufacturer for disposal, or disposed of in a sanitary sewer system that leads to the local publicly owned treatment works (POTW). Chemical treatment methods are available in the literature for many toxic drugs and pharmaceuticals.

8.1.3 Other Laboratory Chemical Waste

Be aware that other federal and state laws regulate the management and disposal of other types of chemical wastes. Polychlorinated biphenyls (PCBs) are regulated under the Toxic Substance and Control Act (TSCA), but PCB waste is rarely found in laboratories, except as analytical standards. The Clean Water Act regulates chemicals disposed as wastewater or to sanitary or storm sewer systems. Chemical waste may be a candidate for disposal in the sanitary sewer only if it is allowed by local POTW and the user is reasonably sure that the chemical will readily break down in the treatment process. Consult the POTW authority to be sure.

Chemical waste not regulated by federal, state, or local laws may still harm health and the environment if not properly disposed of. Exotic, experimental, or new substances may exhibit environmental toxicity, even though they are not included in current disposal regulations. When in doubt, cautiously manage unregulated chemical waste as if it were hazardous.

8.2 Accumulation and Storage

Plans for proper storage of chemical waste must consider regulatory requirements and conditions for safe accumulation.

8.2.1 Generator Classifications

The EPA regulates generators of hazardous waste differently according to the amount of waste generated per calendar month. According to RCRA, the term "generator" is reserved for those institutions that generate more than 1,000 kg/month (2,200 lb/month) of hazardous waste or more than 1 kg/month (2.2 lb/month) of an acute hazardous waste. Because the term "generator" is often used generically to include all hazardous waste generators, some states use the term "large-quantity generator" to identify the most stringently regulated generation category. Except when referring to specific requirements, this guideline uses the term "generator" generically.

Few hospitals, clinics, or other medical facilities fall into the "large-quantity generator" category. Instead, their regulatory category is either "small-quantity generator" or "conditionally exempt small-quantity generator," depending on the amount of waste they generate (see Table 4). This guideline does not explain the more stringent requirements for large-quantity generators.

8.2.1.1 Acute Hazardous Waste

Be aware, however, that the generation of more than 1 kg/month of an acute hazardous waste can require compliance with the large-quantity generator requirements for that waste. These additional requirements may be imposed even in the case of one-time generation of 1 kg of an acute hazardous waste. It is therefore important to control the generation of this waste by disposing of acute hazardous waste regularly. (Refer to Table 4.)

Table 4. Hazardous Waste Generator Classifications

Criteria Based on Waste Generation Rate	
Generator (large-quantity generator)	> 1,000 kg/month (or > 1 kg/month acute hazardous waste)
Small-quantity generator*	< 1,000 kg/month and > 100 kg/month (and < 1 kg/month acute hazardous waste)
Conditionally exempt small-quantity generator	< 100 kg/month (and < 1 kg/month acute hazardous waste)

*Technically, the EPA does not use the term "small-quantity generator" for this category. Instead, this category is simply referred to as "generators of between 100 and 1,000 kg/month."

8.2.2 Accumulation and Storage Requirements

EPA uses the term "storage facility" to mean a facility that has received a permit from EPA for long-term storage of hazardous chemical waste. Very few laboratory institutions have the need or resources for this burdensome permit.

EPA uses the term "accumulation" to mean the on-site accumulation of hazardous waste prior to shipment to an off-site, permitted treatment, storage, or disposal facility (TSDF).

Large- and small-quantity generators may accumulate hazardous waste only in locations that meet EPA requirements for accumulation facilities, or at or near the point of waste generation—which is called "satellite accumulation."

8.2.2.1 Large-Quantity Generators

Large-quantity generators may accumulate hazardous waste away from its point of generation for up to 90 days. These "90-day accumulation facilities" must meet certain EPA requirements for contingency planning, container management, etc.

8.2.2.2 Small-Quantity Generators

Small quantity generators may accumulate no more than 6,000 kg of hazardous waste in any 180-day period. If they must transport waste further than 200 miles, the time limit is extended to 270 days. (Six thousand kg is equal to about thirty 55-gallon drums.)

8.2.2.3 Conditionally Exempt Small-Quantity Generators

There is no time limit for storage of hazardous waste by a conditionally exempt small-quantity generator. However, the generators in this category may store no more than 1,000 kg at any time. Accumulation in larger quantities requires compliance with small-quantity generator limits. (One thousand kg is equal to about five 55-gallon drums.)

8.2.3 Satellite Accumulation for Large- and Small-Quantity Generators

Large- and small-quantity generators may accumulate up to 55 gallons of hazardous waste at its point of generation. This is called "satellite accumulation." Laboratories can use this allowance for hard-to-dispose-of wastes, and to accumulate sufficient quantities of low-volume wastes for a cost-effective shipment.

The waste must be in an appropriate, closed, and labeled container at or near the point of waste generation. Secondary containment is also prudent.

8.2.4 Waste Container Requirements for All Generators

Requirements for chemical waste containers at the point of generation as well as during handling, accumulation, and on-site storage include:

- collecting waste in a container that is compatible with the waste type (i.e., chemically resistant plastics for solvents, glass for mineral acids);
- using a "Hazardous Waste" label or marking, including the chemical name (e.g., "waste xylene"); and
- making sure the container is tightly capped at all times except when adding or disposing of waste. Disposal of RCRA wastes by evaporation is illegal.

8.3 Special Requirements for Transporting Hazardous Chemical Waste

In addition to the above, at the time of shipment waste must be packaged, labeled, and marked according to U.S. Department of Transportation standards. Transported hazardous waste must have an additional, special label (see 40 CFR 262.32).

Although conditionally exempt small-quantity generators are not required to use a manifest and get an ID number, some transporters or TSDs insist on one as a condition of accepting waste. This is a good idea for conditionally exempt small-quantity generators, because it will help track wastes and limit liability.

Hazardous waste manifests must be accompanied by a Land Disposal Restriction (LDR or Landban) certification. Both documents are difficult to complete properly. Completion requires an intimate knowledge of the waste, its method of generation, EPA waste classification requirements, LDR requirements, and DOT identification and shipping paper requirements.

The two most common hazardous waste shipping containers from laboratories are the labpack and bulk solvent drum. A labpack is a plastic or metal drum into which smaller waste containers are placed. Absorbent material is added as filler. The labpack is usually marked with a generic shipping name (e.g., "waste poison, N.O.S.") and appropriately labeled (e.g., "poison"). Plastic drums are used for labpacks that are to be incinerated.

Larger quantities of waste solvents can sometimes be combined into bulk 55-gallon steel drums at a great cost savings to the institution (compared to the cost of shipping many small containers of solvents in a labpack). Precautions must be taken to ensure that the combined waste is compatible and accepted by the waste disposal firm. In addition, precautions must be taken to prevent harmful exposure to whoever combines the liquids; respiratory protection may be required. Check with the transporter for proper drums and labels required by DOT.

8.4 Treatment and Disposal Options

Perhaps the most important decision pertaining to hazardous waste management is the selection of treatment and/or disposal methods. These decisions should be based on a consistent strategy that takes into account regulatory requirements, future liability, occupational and environmental risk, institutional self-reliance, cost, and other values important to the institution. Some of these methods may also be considered waste minimization.

8.4.1 Redistribution of Surplus Chemicals

Some laboratory chemicals become unwanted when procedures change or when excess is purchased. If these surplus chemicals are in their original container and still usable, consider offering them for redistribution within the laboratory or institution. By doing so, these chemicals never become regulated as "waste" and usually result in less chemical waste.

8.4.2 Unknown Waste

A waste cannot be transported, treated, or disposed of unless its identity is known. One common problem is chemical containers with illegible, deteriorated, or missing labels. These are commonly referred to as "unknowns." *Prudent Practices in the Laboratory* (see Additional References) gives guidelines that a chemist can follow to identify unknowns.

8.4.3 In-Laboratory Neutralization

Waste mineral acids can be disposed of inexpensively by neutralization. A chemist, or other technically qualified laboratorian, will find most neutralization procedures to be simple, as long as certain personal safety precautions are taken. Procedures and precautions for neutralization are described in texts prepared by the National Research Council and Armour, et al. that are listed in the Additional References section. Elementary neutralization is an exempt treatment activity according to the EPA [see 40 CFR 264.1(g)(6)], although some states may be more restrictive.

8.4.4 On-Site Recycling

Solvent recycling by distillation is a useful way to recover spent solvents if the solvent can be recycled to a purity that is equal to or better than that of the purchased original, and if the volume of solvent

generated makes it economically feasible. Proper segregation of the spent solvents will make the process more efficient.

The EPA considers recycling as a means of waste reduction to be the second preferred waste management alternative on their waste management hierarchy. EPA regulations (40 CFR part 261.1) state that material is "recycled" if it is used, reused, or reclaimed.

8.4.5 In-Laboratory Hazard Reduction

Treatment or disposal of hazardous waste requires either an EPA permit or state license, both of which are beyond the resources of most laboratories. Exceptions are made for neutralization (as described above), totally enclosed treatment facilities (see 40 CFR 260.10), and treatment in accumulation containers. Some regulatory agencies, as well as *Prudent Practices for Disposal from Laboratories,* consider in-laboratory hazard reduction procedures to be a totally enclosed hazardous reduction treatment process and therefore exempt from regulation. Check with state regulators.

Many in-laboratory hazard reduction methods have been described in the National Research Council and Armour, et al. texts. For example, oxidizing cleaners can be reduced for safe drain disposal. These methods are inexpensive disposal options for small amounts of certain chemical wastes. These are especially valuable for the smaller-waste generator who faces high waste pickup costs.

Note that evaporation is not a legal disposal method for hazardous wastes.

8.4.6 Commercial Disposal Options

There are many off-site, commercial facilities that accept waste for treatment, incineration, recycling, and landfilling. Recent EPA regulations have restricted and banned certain wastes from landfilling, and as a result commercial disposal of these laboratory wastes today is by incineration and fuel blending. Use of recycling and other treatment technologies will likely expand in the future, and they should be investigated.

8.4.7 Commercial Recyclers

Commercial recycling firms are available for recycling mercury and other wastes.

8.4.8 Disposal via the Sanitary Sewer

Disposal of hazardous waste into the sanitary sewer is not allowed, except in limited situations. Following are the criteria for disposal of hazardous waste in the sanitary sewer:

- The hazardous waste must be mixed with domestic wastewater and pass through a sewer system to a publicly owned treatment works (POTW) for treatment.

- The waste type, amount, and concentration must meet the regulations and limits of the POTW that will receive the waste.

If approved by the local POTW, it may be allowable to dispose of dilute solutions of toxic metals and other hazardous chemicals in the sanitary sewer. This exemption from RCRA requirements is given in 40 CFR 261.4(a)(1)(ii). A separate laboratory exemption for wastewater that is not a mixture of domestic sewage is given in 40 CFR 261.3(a)(2)(iv)(E).

Some buildings, laboratories, and fume hoods have sinks that lead to mixing tanks that are designed to facilitate neutralization and dilution of waste acids prior to the wastewater's entry to the sanitary

sewerage system. If mixing tanks are present, personnel should be trained in their proper use, and their efficacy should be checked periodically.

8.4.9 Disposal in the Normal Trash

Disposal of any amount of hazardous waste in the normal trash or as a solid waste is strictly forbidden. Off-site disposal of hazardous waste is only allowed at facilities that have an EPA or state hazardous waste permit. Some states do allow conditionally exempt small-quantity generators to dispose of hazardous waste at other specifically approved facilities, but few facilities allow it.

8.5 Waste Minimization

Waste minimization is an essential part of any waste management planning. Waste minimization activities are described in Table 5. Waste minimization methods also include some of the methods described in previous sections.

Table 5. Examples of Waste Minimization Activities

Method	Example
Source separation	• The use of multiple waste collection containers to keep waste types separate, so that each waste type can be optimally managed. • In offices, separate receptacles for recyclable paper.
Waste segregation	• Keeping waste types segregated during collection, storage, transport, treatment, and disposal. • Keeping needle boxes out of red bags.
Source reduction	• Require purchases to be in small, manageable quantities. This reduces the potential for future disposal costs of used and, more importantly, unused hazardous materials. • Use nonhazardous or less hazardous materials whenever possible. For example, there are substitutes available for xylene in the histology laboratory; formalin in histology and from surgical specimens; and mercuric chloride salts used in some fixation procedures. Use a scintillation cocktail that is not aromatic hydrocarbon-based. Each laboratory must determine if these products work satisfactorily.
Redistribution	• Identify surplus or unwanted laboratory chemicals, and relocate them to laboratories that can use them.
Recycling	• Solvents like xylene, xylene substitutes, and alcohols can be recycled and reused in the process from which they were generated. Formalin, a fixative, can also be recycled. • Many facilities have set up recycling programs for aluminum cans, paper, and other solid waste items.
Process changes	• Substitute nonchromium cleaners for chromic acid. • Use miniaturized testing procedures to reduce the quantity of hazardous materials needed. • Substitute ozone-friendlier cryogenic sprays. • Use xylene substitutes in tissue processing, staining, and cover slipping.
Recovery	• Silver recovery units. • Heat recovery using waste solvents for fuel. This requires proper attachments to the facility fuel burner and may require permits in some areas. Be sure to check additional federal and state requirements.
Hazard reduction	• A treatment or procedure that reduces the hazard of the waste, making it easier or less expensive to dispose of. • When allowed, neutralize waste acids so that they can be disposed of in the sanitary sewer.

Conditionally exempt small-quantity generators are exempt from waste minimization requirements. However, generators are required to have a waste minimization program; therefore, small quantity generators must make a good faith effort.

8.6 Contingency Planning and Employee Training

Train employees to properly handle waste and follow emergency procedures, as appropriate to their responsibilities. EPA requires annual training for employees who handle hazardous chemical wastes of large- and small-quantity generators.

For first responders and spill-response teams, OSHA training standards apply. Spills are common chemical emergencies in laboratories. Spill clean-up procedures are specific to the chemical; the Armour text (see Additional References) is one source of this information.

9 Infectious Waste

Proper management of infectious waste is important because of potential health problems and environmental concerns. The health problem is the actual risk to healthcare workers, waste handlers, patients, and the public posed by mismanaged infectious waste. The environmental concerns relate primarily to public perception of the health risk; the recognizability of medical objects; the need to minimize waste volume; and prevention of secondary pollution, such as dioxin emissions from incineration of medical wastes. Although there have been isolated, highly publicized instances of public exposure to medical waste, no cases of actual disease transmission from these public exposures have been reported.

As a health problem, infectious waste is primarily an occupational hazard for healthcare workers, waste handlers, and waste haulers. The risk of disease transmission is greatest at the point of origin, but it persists throughout the chain of waste handling.

9.1 Definitions of Laboratory Infectious Waste

Infectious waste is broadly defined as waste capable of producing infectious disease. This functional definition is based on four factors necessary for disease transmission: the presence of pathogens capable of producing disease, pathogens of sufficient virulence to produce disease, a portal of entry, and a susceptible host.

No universally accepted, specific definition of infectious waste has been developed. The 1986 Environmental Protection Agency Guide for Infectious Waste Management includes the following six categories of infectious waste:

Table 6. Categories of Infectious Waste

Category	Examples
(1) Cultures and stocks of infectious agents and associated biologicals	• Specimens from medical and pathology laboratories • Cultures and stocks of infectious agents from clinical, research, and industrial laboratories; disposable culture dishes; and devices used to transfer, inoculate, and mix cultures • Discarded live and attenuated vaccines
(2) Pathological waste	• Wet tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy
(3) Human blood and blood products	• Waste blood, serum, plasma, and other blood components
(4) Contaminated sharps	• Contaminated hypodermic needles, syringes, scalpel blades, Pasteur pipettes, broken glass, used cover slips, and used glass slides
(5) Contaminated animal waste	• Contaminated animal carcasses, body parts, and bedding of animals known to have been exposed to infectious agents
(6) Isolation wastes	• Blood, excretion, exudates, and secretions from patients with highly communicable diseases

The infection control committee or safety committee of each healthcare facility should survey all relevant laboratories to determine the types, volumes, site of origin (generation site), and management of the infectious wastes that they generate. On the basis of this information, the committee should develop an infectious waste management policy that is in compliance with state and local regulations. This policy should specifically define categories of infectious waste that are generated in these laboratories.

9.2 Infectious Waste Management Program

The following steps are needed to establish and to implement an infectious waste management program:

- Appoint someone to administer/coordinate the infectious waste management program.
- Determine which wastes should be considered infectious waste.
- Identify infectious waste sources, and determine waste composition and quantity.
- Develop waste-reduction strategies.
- Establish procedures for segregating, packaging, moving, and storing the waste, as well as options for on-site and off-site treatment and disposal.
- Develop institutional review and quality assurance procedures.
- Develop waste management training, contingency, and safety programs with documentation for each.
- Develop documentation and manifesting procedures, and maintain records for off-site shipments of untreated waste.

9.3 Handling Infectious Waste

Personal protective equipment, specifically gloves and protective clothing, must be worn when infectious waste is handled. Water-resistant utility gloves, rather than thin latex or vinyl gloves, are recommended for handling bagged infectious waste. Puncture-resistant gloves should be used when handling containers of infectious waste that contain sharps (i.e., needles, blades, and laboratory glass). Waste handlers should wash their hands after removing their gloves. Additional precautions are needed when waste is disposed of through the sanitary sewer; these are discussed in Section 9.7.2.

Infectious waste should not be compacted except in compactors that are specifically designed for medical waste.

To the extent feasible, handling and movement of infectious waste from the site of generation to the treatment equipment or the loading dock should be minimized.

Special procedures must be used when handling wastes that may be contaminated with materials from patients with transmissible spongiform encephalopathies (TSEs).

Medical waste that is multihazardous requires special management procedures that must be tailored to the hazards that are present (see Section 11).

9.3.1 Source Separation and Waste Segregation

Implementation of a waste management program requires segregation of the different waste types into designated categories to allow for the safest, most efficient, and most economical treatment or disposal options. Separation of waste should be performed at the point of waste discard by personnel knowledgeable in the origin and hazard potential of the waste.

All infectious waste should be discarded directly into plastic bags or other containers that are clearly identifiable and distinguishable from the general waste stream. All containers used for infectious waste, including sharps containers, must be red in color or labeled with the "Biohazard" symbol in accordance with OSHA regulations. Red containers need not be labeled, because the color red is generally recognized as designating untreated infectious waste. Waste receptacles that are easily distinguishable and appropriately marked for contaminated and for noncontaminated waste should be readily available in each area where infectious waste is generated.

Careful separation of infectious waste from the general waste stream will reduce extra handling and treatment costs. When noncontaminated material (such as wrappings and opened but unused materials) is kept out of the infectious waste stream, further savings will result.

Once separated from the general waste stream, infectious waste may be further segregated by the intended treatment method. For example, all laboratory cultures should be autoclaved in the laboratory, whereas other treatment methods may be more appropriate for other types of infectious waste.

9.3.2 Packaging and Labeling

Infectious waste must be contained to protect patients, healthcare workers, waste handlers, and the general public from exposure to the waste and from puncture/abrasion injury and disease transmission. Infectious waste should be contained from the point of discard until the material is no longer infectious and does not pose a risk of injury. Consequently, the container should be designed to maintain its integrity throughout handling, storage, movement, and shipping. In some instances, double bagging or placement of the bags in semirigid or rigid containers may be necessary.

Selection of packaging materials should take into account the type and volume of waste, its moisture content, handling procedures, and the treatment technique. Solid and semisolid wastes can usually be packaged in plastic bags. Liquid infectious waste should be placed in leakproof, stoppered bottles/flasks, or containment tanks. Packaging of sharps requires special attention (see Section 9.8). All containers including plastic bags must be securely closed to prevent leakage and spills.

Polyethylene or polypropylene bags must be red or labeled to denote the infectious waste content. Plastic bags should have sufficient tensile strength to resist rupture from rough handling or overfill conditions; ASTM document D1709-01[1] (165 g standard) is a more reliable criterion for measuring tensile strength than bag thickness (3 mil minimum). Low-density polyethylene bags are widely used, but they are not heat-resistant and must be placed within high-density polyethylene bags for autoclaving.

The packaging should be compatible with treatment mechanisms. Specifically, the packaging materials should not thwart the decontamination process.

Waste haulers, disposal agencies, or landfill operators may specify packaging requirements when infectious waste is to be shipped off-site for treatment or disposal. However, packaging should, at a minimum, be consistent with safety practices discussed in this guideline.

Specific federal, state, and local regulations vary, but all containers used to collect and transport untreated infectious waste must be labeled with the words, "Infectious Waste," "Medical Waste," or "Biohazard" (in both Spanish and English, where appropriate), as well as the universal biohazard symbol.

Consider a system to differentiate treated and untreated waste, both on-site and when treated waste is disposed of as normal trash. On containers of treated waste, markings and the biohazard symbol can be covered or defaced (using spray paint or tape), or a "treated" label can be added. Note that this may not be sufficient for some waste haulers and landfill operators who may balk at handling any waste in red bags or other red containers, even if the waste has been treated.

9.4 Storage

Infectious waste should be stored for as brief a time as possible. Storage can be temporary (hours) or long-term (a few days). Length and conditions of storage (e.g., temperature) must be in accordance with state and local requirements. The storage area should be located near the treatment equipment or the loading dock (if the waste is shipped off-site for treatment). It must be properly identified with the biohazard emblem and have access restricted to authorized personnel. The area should be thoroughly cleaned each time it is emptied of waste contents. Direct connection to the sewer is recommended.

Waste should not be exposed to moisture, heat, or the weather. Storage conditions (temperature and duration) should prevent putrefaction; refrigeration may be necessary to limit microbial growth and noxious odors and to comply with some regulatory requirements. Storage site and waste containers should prevent the storage area from providing a food source or breeding site for rodents or vermin (which could become disease vectors).

9.5 Movement of Infectious Waste Within the Facility

Waste should be moved in clearly labeled, dedicated, leakproof carts. These carts must be decontaminated before being used to move other wastes or supplies. Carts used for waste movement should be disinfected frequently. Routes in the healthcare facility should be designed to reduce the risk of exposure to patients, staff, and visitors. Service elevators, rather than public elevators, should be used for waste movement.

It is essential to maintain the integrity of the packaging during handling, transferring, and loading of containers of infectious waste. Mechanical devices should not be used to transfer or load infectious waste, because rupture of the packaging and spillage of waste may occur. Chutes and dumbwaiters should not be used. Waste should be loaded by hand.

9.6 Treatment of Infectious Waste

9.6.1 On-Site versus Off-Site Treatment Options

Commercial treatment of infectious waste is available in most areas of the United States. Generators of infectious waste now have the option of deciding whether their infectious waste should be treated on-site at the generating institution or facility or off-site at a cooperative regional facility or a commercial treatment facility. The factors that should be considered in deciding which option is best for a particular institution include the following:

- Cost: Which option is most cost-effective?

- Current treatment equipment: How good is the existing equipment? Can it meet new regulatory requirements? How expensive will it be to retrofit equipment to bring it into compliance?

- Treatment technology alternatives: What alternatives are available? What are their comparative features?

- The physical plant: Is the space sufficient to install new treatment equipment?

- Commercial vendors: Are commercial treatment options available? Are vendors reliable?

- Liability: Will the generator be liable for waste mishandled by a commercial treatment or disposal company? Will the institution prefer to maintain control over the waste until it is treated to ensure that there will be no liability for mishandled waste?

- Regulations: Will federal and state regulations that pertain to shipment of untreated waste place an undue burden (e.g., cost, packaging requirements, and manpower) on the institution if off-site treatment and disposal is selected?

9.6.2 Treatment Technologies

Treatment of infectious waste is a process designed to reduce the level of pathogens in the waste below that which is necessary to transmit disease (decontamination), rather than their complete elimination (sterilization). Incineration and steam sterilization (autoclave) are the most frequently used methods of treatment. Other alternative treatment methods include thermal (low and high temperature), chemical, and ionizing radiation processes. Mechanical processes such as compaction, grinding, and shredding further help treatment by improving the decontamination, reducing waste volume, and/or physically changing the appearance of the waste. Each treatment technology has different requirements for monitoring decontamination, including biological and physical indicators; frequency of testing; and test methodologies.

Certain treatment technologies (e.g., autoclaving) do not alter the appearance of the treated waste. This can present difficulties in disposing of the treated waste as well as in public perception. Therefore, it is usually advisable to select a treatment technology that renders the waste unrecognizable, or else to select a two-step treatment process that meets both goals: decontamination of the waste as well as its destruction.

9.6.2.1 Incineration

Incineration converts combustible solid waste materials into residual ash and gases, which are vented to the atmosphere. The process can inactivate biological materials, as well as reduce mass and volume (up to 95%).

Incineration can be used as a treatment method for almost all types of infectious waste. It is particularly advantageous with pathologic waste and sharps, because they are rendered unrecognizable or unusable by the combustion process. Many hospitals and health service institutions use pathologic incinerators.

The effectiveness of the incineration process depends on incinerator design, the operating procedure, and the types and segregation of materials to be burned. Effective waste minimization programs can eliminate unnecessary incineration of hospital waste not considered infectious. The incineration process should destroy microorganisms, maintain stack emissions in a locally acceptable range, and preserve the integrity and proper functioning of the incinerator. Utilizing an incinerator in a manner outside its design characteristics and standards may result in release of microorganisms, toxic gas emissions, and damage to the incinerator.

Since 1997, EPA's new emission standards to reduce pollution from medical waste incinerators have required stringent air pollution control. The impact of these controls will be a large increase in the cost of on-site incineration. Many healthcare facilities will no longer install new units or will discontinue using existing ones. As a result, other on-site alternative treatment technologies or off-site commercial waste treatment and disposal will be used.

9.6.2.2 Autoclaving

Autoclaving uses saturated steam under pressure to decontaminate infectious waste. Infectious laboratory waste, instruments, and glassware can be decontaminated in a gravity displacement or prevacuum autoclave. The effectiveness of autoclaving is determined by various factors, including:

- amount of waste;
- physical characteristics of the waste load (including size, density, and organic content);
- use and number of autoclavable bags (self-venting bags or an acceptable alternative);
- type of container (metal or polypropylene);
- steam penetration throughout the entire waste load and direct contact with microorganisms;
- exposure time; and
- exposure temperature.

In addition, all autoclaves must be monitored at least weekly for proper functioning using a biological indicator (e.g., *Bacillus stearothermophilus* spores) or its chemical equivalent. It is recommended that the Association for the Advancement of Medical Instrumentation (AAMI) procedure be used for monitoring.

Decontaminating laboratory infectious waste by autoclaving is complex, because all the factors outlined above must be carefully considered. There is no standard method available for this type of monitoring. Laboratory autoclaves normally operate at a temperature of 250 °F (121 °C), a pressure of 15 psi, and a cycle time of 30 minutes. Commercial autoclaves operate at a higher temperature of 275 °F (135 °C), a pressure of 60 to 75 psi, and a cycle time of one hour. Steam sterilization can be reliable if extended exposure periods are used and conditions are optimized for appropriate heat transfer throughout the waste load.

With the exception of wastes containing prion agents or TSE, steam sterilization is the appropriate treatment method for discarded stocks of etiologic agents and for any material that may be contaminated with organisms that should be handled with CDC Biosafety Level 3 precautions. Examples include: *Mycobacterium tuberculosis, Brucella species, Francisella tularensis*, systemic fungi, rickettsial agents, and rabies virus.

Types of waste that should not be autoclaved include antineoplastic agents, toxic chemicals, and radioisotopes (which will not be destroyed), as well as volatile chemicals (which could be vaporized and disseminated by the heat). Because heating certain wastes produces hazardous fumes, autoclaves and dry heat treatment devices should be vented to the outside. Autoclaving alone does not change the physical appearance of the waste and may be combined with a shredding or grinding process to render regulated medical waste unrecognizable.

9.6.2.3 Alternative Thermal Processes

Specialized equipment that combines compacting, grinding, or shredding with low-temperature heat is available. These systems operate at temperatures less than 300 °F (149 °C) and are easily adapted for on-site treatment of infectious medical waste. The order of operation typically involves waste introduction into a treatment unit or chamber, physical destruction by either pre- or postheating, and discharge of the final unrecognizable end product into a dumpster with its shipment to a landfill for final disposal. Examples of these innovative treatment technologies include:

- high-vacuum autoclave with rotating drum and shredder;
- high-vacuum autoclave with compactor or shredder;
- chemically enhanced continuous feed autoclave with shredder;
- microwave heat-generating unit with shredder; and
- macrowave (electrothermal deactivation) heat generating unit with shredder.

High temperature heat systems use pyrolysis and oxidation, plasma, and plasma pyrolysis for treatment and disposal. Inside a pyrolysis chamber, waste is electrically heated to temperatures between 200 °F and 1,000 °F (93 °C to 538 °C) in the absence of oxygen. Vaporized gases then are oxidized in electrically heated oxidation chambers at an operating temperature of 1,800 °F to 2,000 °F (982 °C to 1093 °C). Plasma, an electrically charged gas, can heat the waste to extremely high temperatures up to 20,000 °F (11,093 °C). Plasma systems achieve the same results as incineration, but without the emission problems associated with conventional combustion incinerators.

9.6.2.4 Alternative Chemical Processes

Chemical waste treatment systems use high-level disinfectant solutions in combination with grinding or shredding to achieve decontamination. Examples of disinfectants used include chlorine dioxide and peracetic acid. The resultant liquid waste is discharged into the sanitary sewer, and unrecognizable solid waste is placed into a dumpster for final disposal in a landfill.

Reduction cremation by alkaline hydrolysis is an alternative to incineration for the treatment and disposal of infectious animal waste. The process of combining heat (230 °F to 248 °F [110 °C to 120 °C]) under pressure (15 psi) and alkali solution (sodium or potassium hydroxide) for a cycle time of 6 to 18 hours can result in complete digestion of all organic matter. The neutralized effluent can be discharged to the sanitary sewer.

9.6.2.5 Irradiation

Ionizing radiation from an electron beam source has been adapted for the off-site treatment of infectious medical waste. Electrons from the beam source interact with electrons in the molecular structure of the waste, depositing energy and breaking chemical bonds of organic compounds and inactivating the nucleic acids of microorganisms. Irradiation systems do require posttreatment shredding to render the waste unrecognizable and to reduce the waste volume. The penetration of electrons is limited so that only a thin layer of material can be treated.

9.6.3 Treatment Validation Process

All new treatment technologies should be evaluated for treatment effectiveness as well as potential environmental, occupational health, and safety problems. A report of the State and Territorial Association on Alternative Treatment Technologies (STAATT) established the first consensus guidelines for regulators and manufacturers. The recommendations for treatment efficacy testing include the following:

- Biological indicators are required for initial testing.
- Mycobacterium species and Bacillus spores should serve as surrogate pathogens.
- Microbial inactivation effected by the treatment process should achieve a 6-log reduction in the concentration of mycobacteria (e.g., *M. bovis* BCG), and a 4-log reduction in the level of bacillus spores (*B. stearothermophilus* for thermal, *B. subtilis* for chemical, *B. pumilus* for irradiation inactivation).
- Biological indicators should be included in the surrogate test load for initial testing.
- Surrogate test loads tested (minimum of three) should be comprised of different concentrations of organic-to-nonorganic material and fluid-to-solid components.
- Surrogate test loads should equal the system's treatment capacity.
- "Bench-top" testing should not be used to simulate the actual treatment conditions; the actual treatment system should be used.
- Protocols for determining treatment efficacy should be congruent with the treatment method.
- Parametric monitoring of the treatment process (e.g., time, pressure, temperature, and chemical concentration) could substitute or replace biological indicators monitoring if initial efficacy test requirements are met for validation and quality control.
- Waste from clinical microbiology laboratories should be treated on-site before being discarded with nonmedical solid waste.
- Treated medical waste need not be monitored for microorganisms.

9.7 Disposal

"Disposal" means final disposition of the waste. The term refers to disposal of the residue from treatment as well as disposal of untreated waste, some of which can be disposed of directly without treatment. The primary disposal options are the landfill and the sanitary sewer. Use of these options may be restricted, however, because of state regulations, local ordinances, or landfill operator requirements.

9.7.1 Landfill

Treated waste may be combined with the healthcare institution's general waste for landfilling. Even if decontamination has not been completely effective, most pathogens are inactivated by the temperature and acidic environments (temperature > 55 °C and pH < 5) created during degradation of waste in landfills. Cover of the landfill further contains this material.

There have been no reports of disease transmission from infectious waste in the community or landfill setting. However, state or local regulations may regulate the disposal of untreated infectious waste in a landfill. Also, some landfill operators refuse to accept infectious waste, sometimes even after it has been treated.

9.7.2 Sanitary Sewer

Disposal to the sanitary sewer is appropriate for certain types of laboratory wastes. If local health codes and agreements with the local wastewater treatment authority permit, blood and body fluids and other liquid infectious wastes may be disposed of by pouring them into a sink that is connected to the sanitary sewer. Extreme caution must be exercised to prevent splashing and aerosolization during such disposal. Water should not be running in the sink while decanting blood or body fluids, but disposal should be followed with copious amounts of water. Special sinks and protective devices can be used to minimize splashing and aerosolization and the accompanying risk of exposure.

During such disposal of liquid infectious wastes, the use of personal protective equipment is advisable, specifically facial protection and a waterproof apron, in addition to gloves and a laboratory coat. Sinks used for biohazardous waste disposal should not be used for hand washing.

Microbiological cultures should not be discarded into the sanitary sewer. These wastes should be autoclaved or incinerated before disposal.

9.8 Management of Contaminated Sharps

Sharps are of special concern, because they present a physical hazard to healthcare workers and waste handlers. They can cause accidental puncture wounds and lacerations that then allow the transmittal of pathogens through these breaks in the skin. In addition to concern about transmittal of blood-borne diseases, other considerations in sharps management are the potential for reuse of needles and syringes for drug abuse, the possibility of physical injury, and aesthetics.

The sharps category consists of all items that can easily penetrate plastic bags and many other containers. This includes not only the obvious needles and blades, but also any object that is readily breakable. The sharps category includes discarded hypodermic needles; syringes (with or without the attached needle); scalpel blades; lancets; capillary tubes; micropipettes; slides and cover slips; and wooden applicator sticks, as well as broken laboratory glassware (e.g., pipettes, blood tubes, and culture dishes).

From the management aspect, sharps are of two types: contaminated and noncontaminated. Contaminated sharps are those that were used or may have come in contact with infectious agents. Noncontaminated sharps consist of items such as broken glassware and shards of hard plastic that were not in contact with infectious agents. Contaminated sharps are discussed in this section; see Section 12 for guidelines on the management of noncontaminated sharps.

It should be noted that needles and syringes are generally managed uniformly, regardless of whether or not they are contaminated. Some state and local regulations include requirements for all sharps without distinguishing between contaminated and noncontaminated items. OSHA regulations have specific requirements regarding various aspects of sharps management, including handling and disposal of needles; use and placement of sharps containers; specifications for sharps container design, construction, and labeling; incident reporting and evaluation; and immediate and follow-up health measures after employee exposure. Some of these requirements are mentioned here; see the OSHA regulations for details.

Sharps should be discarded directly into containers that are readily accessible at laboratory stations to ensure utilization and to minimize the distance that used sharps must be carried for disposal. OSHA

requires sharps collection containers to be closable, puncture-resistant, leakproof on the sides and bottom, and labeled or color-coded. Many designs of puncture-resistant sharps containers are available; choose one that is most appropriate and works best for the waste type. Sharps should not be handled directly; loose sharps should be handled with tongs or by some other mechanical means. Needles should not be recapped, bent, or sheared, and they should be placed with syringes intact into the sharps containers.

A number of absorbent polymers that can absorb residual fluids and retain them within the sharps container are available commercially. Some of these polymers also contain disinfectants to inactivate infectious agents that might be present. The polymers may be incorporated into the sharps containers, or the user may add them.

Reusable sharps collection containers are another alternative that is offered by some waste management firms. Reusable containers must be FDA approved.

9.8.1 Management Goals

Successful management of sharps achieves the following goals:

- preventing injury from skin puncture or laceration;
- reducing the potential for disease transmission;
- complying with requirements to render needles and syringes useless or unavailable for use before disposal;
- complying with OSHA regulations for sharps management;
- ensuring that sharps are destroyed, so they are no longer recognizable; and
- complying with federal, state, and local regulations at the lowest possible cost.

9.8.2 Handling and Segregation

All sharps should be contained from the point of discard until they are no longer hazardous. They should be placed into rigid, puncture-resistant containers immediately upon discard. The containers can be of metal, wood, or rigid plastic. Polystyrene, nonrigid plastic, paper, and cardboard containers are not acceptable.

To prevent needlestick injuries during handling and disposal, the following precautions must be taken as required by OSHA regulations:

(1) Discard needles directly into rigid, puncture-resistant containers.

(2) Do not resheath needles by hand. Available devices include protective guards that permanently enclose the needle after use and needle containers with integral devices that facilitate removing needles from needle holders.

(3) Do not remove used needles from disposable syringes. A one-handed recapping technique should be used whenever the needle must be removed.

(4) Do not shear, bend, break, or clip needles.

(5) Avoid manipulating needles as much as possible.

(6) Do not place needles in biohazard bags unless they are already in a rigid, impervious, puncture-resistant container.

(7) Do not discard needles with general waste.

For detailed information on handling sharps, consult NCCLS document M29—*Protection of Laboratory Workers from Occupationally Acquired Infections.*

9.8.3 Packaging and Labeling

Because some sharps such as syringes and blood tubes may also contain residual fluids, OSHA regulations require that all sharps be placed in collection containers that are closable, puncture-resistant, and leakproof on the sides and bottom. OSHA requires that all sharps containers be imprinted or affixed with a warning label containing the words "Infectious Waste" or "Medical Waste," or a label displaying the universal biohazard symbol. The color red is recognized as an indicator of infectious waste and may be substituted for the labels. (See OSHA's Bloodborne Pathogen Standard, 1910.1030 d.4.iii.(A) and (B).) If the sharps container cannot be sealed to prevent leakage, it must be placed with a plastic bag or other leak-resistant container that can be sealed to prevent leakage.

9.8.4 Storage

Storage requirements for sharps are the same as for other infectious wastes.

9.8.5 Treatment and Destruction

"Treatment of sharps" means a processing that changes their biological character to reduce or eliminate their potential for causing disease. Steam sterilization (autoclaving) and incineration are the most commonly used methods, but any effective treatment method is also acceptable. Treatment can be performed either on-site or off-site.

Destruction renders sharps nonrecognizable and unusable. Destruction methods include incineration, grinding, shredding, crushing, and melting. Destruction can occur as part of the treatment process or as a separate step after treatment.

9.9 Contingency Planning

Each laboratory should have contingency plans for handling unexpected events. These include spills, employee injuries, unavailable/inoperable treatment equipment, and unavailable waste disposal services.

These measures are detailed in NCCLS document M29—*Protection of Laboratory Workers from Occupationally Acquired Infections.*

9.9.1 Spills

Written procedures must be available at the work site and be readily accessible by laboratory workers. These should include procedures for:

- evacuation of laboratories when a particularly virulent organism or toxic material is present in a spill and provision of immediate medical treatment when necessary;

- assessment of the nature and extent of the spill;

- obtaining appropriate personal protective equipment for personnel performing the decontamination;
- decontamination including spill containment, initial cleaning of the area and spill absorption, selection of disinfectant (with type and concentration depending on the type of spill and type of contaminated surface), decontamination, rinsing, and treatment or disposal of contaminated items;
- hand washing and associated hygiene;
- obtaining medical treatment or prophylactic measures for exposed personnel and referral to the employee health department if appropriate; and
- documentation and follow-up of exposure incidents.

The laboratory safety program should include training about the proper procedures to use for decontamination of spills.

9.9.2 Worker Injuries

Each laboratory should have written procedures that are to be followed in the event of worker injury or potential contamination (e.g., from needlesticks or exposure to spills). These procedures should define appropriate treatment agents, notification processes, and worker testing (e.g., for HIV or HBV) and/or follow-up. For details, see OSHA requirements for handling worker injuries: 29 CFR 1910.1030, Section (f) (3) "Post-exposure Evaluation and Follow-up."

The training program should include a segment on these procedures, so employees will know what they must do in case of injury. A manual that details these procedures should be readily available and accessible by employees. Procedures should concur with institutional employee health and infection control programs.

9.9.3 Disruption of Infectious Waste Treatment and Disposal Methods

In the event of disruption of the usual procedures for managing infectious wastes, there must be a contingency plan for each laboratory that specifies back-up arrangements. For example, treatment equipment may not be usable because of equipment failure or downtime for maintenance, and disposal services may be disrupted by strikes or contract disputes. These contingency arrangements may include: duplicate equipment (e.g., autoclaves); prolonged storage of infectious waste; agreements with nearby medical facilities or other entities that have treatment and/or disposal capabilities; and back-up contracts with outside waste haulers, landfills, and incinerator facilities.

Independent laboratories must establish their own contingency plans for infectious waste management. These arrangements are usually made at the institutional level if the laboratory is part of a larger facility.

9.10 Regulation of Infectious Wastes

Laboratories may be subject to various regulatory and nonregulatory agencies at the federal, state, and local levels. The regulations or guidelines regarding infectious waste management issued by these agencies may be inconsistent, and even the definitions of "infectious waste" are not uniform.

Federal regulations that are relevant to infectious waste management have been promulgated by EPA and by OSHA. EPA's medical waste tracking program was in effect from 1989 to 1991 in a limited number of states; although the federal program ended, some states did incorporate tracking into their regulations. Relevant OSHA regulations pertain to infectious waste management as it relates to protection from

occupational exposure to blood-borne pathogens. In 1997, EPA promulgated regulations that limit air emissions from hospital/medical/infectious waste incinerators; compliance with these regulations will impact the feasibility and cost-effectiveness of waste incineration.

In 1986, the EPA published the Guide for Infectious Waste Management. Some CDC guidelines have sections that pertain to infectious waste management. In addition, there are relevant guidelines and standards from accreditation agencies such as the JCAHO.

Most states now regulate infectious waste to at least some degree. In addition, many laboratories are affected by local ordinances pertaining to wastewater discharges, air pollution, and/or landfill disposal. Laboratory managers must know, understand, and comply with the various regulations and standards that apply to the management of infectious waste.

10 Radioactive Waste

10.1 Introduction

The use of radioactive materials is essential in biomedical research, patient diagnosis, and treatment. Some generation of radioactive wastes is thus an unavoidable consequence of these activities. Radioactive waste management has always been a complex, dynamic, and highly regulated activity. In recent years waste managers have been confronted with new challenges, including rapidly rising disposal costs; uncertain access to disposal facilities; potential needs for on-site contingency storage capacity; and public concern about all aspects of radioactive material use and disposal. These challenges have encouraged laboratories to place increased emphasis on finding alternatives to radioactive materials and development of waste minimization methods to reduce dependence on off-site disposal facilities.

This section will provide an overview of radioactive waste minimization and management practices for laboratories. Radioactive wastes that also contain hazardous chemicals or biohazardous agents will be covered in Section 11, Multihazardous Waste.

10.2 Characterization of Radioactive Wastes from Clinical Laboratories

10.2.1 Sources and Types

Radioactive waste is any discarded material that is known to be contaminated or potentially contaminated with radioactive material. Most of these wastes are generated by 1) laboratory procedures employing the use of radioactive materials; 2) procedures performed on specimens from patients that received radiation therapy or diagnosis; and 3) other biomedical research activities. Examples of common types of radioactive wastes generated by clinical laboratories include:

- aqueous waste and other water-soluble liquids;
- mixed insoluble liquids;
- liquid scintillation counting vials;
- contaminated solids such as glass, plastic, paper, and sharps;
- blood, urine, other body fluids, and excreta;
- solid tissues;

- animal carcasses;
- cell culture dishes;
- gases; and
- source vials and other devices used to contain or shield radionuclides.

10.2.2 Radionuclidic Content

The radionuclides typically present in clinical laboratory wastes are limited in number, and vary by type and activity concentration with the function of the laboratory. Diagnostic laboratories primarily use radioactive materials in assay procedures. These procedures involve low activity concentrations and generate wastes with correspondingly low activities. The radionuclides commonly used in diagnostic reagents are of intermediate to long half-life to allow for shipping, storage, and use and include tritium (^{3}H), ^{125}I, and ^{32}P.

Nuclear medicine procedures involve administration of radiolabeled pharmaceuticals and imaging agents to patients for diagnosis and treatment. Commonly used radionuclides include ^{51}Cr, ^{67}Ga, ^{123}I, ^{131}I, ^{111}In, ^{99}Mo, ^{32}P, ^{89}Sr, ^{99m}Tc, ^{201}Tl, and ^{133}Xe. Most of these radionuclides are short-lived and used in much higher activity concentrations than radionuclides in diagnostic laboratory procedures. Low-volume, high-activity wastes may be generated during preparation, handling, and administration of radiopharmaceuticals. Specimens and excreta from patients that have received radiopharmaceuticals may also have high activity.

Research laboratories use the widest variety of radionuclides, including most of those found in nuclear medicine and diagnostic applications, and additional radionuclides, especially ^{14}C, ^{33}P, and ^{35}S. Small quantities of waste containing uranium compounds may also be generated from staining procedures used in electron microscopy. The wastes from research laboratories tend to be high-volume, low-activity, and may include animal tissues, carcasses, and other waste types that are not routinely generated by nuclear medicine and diagnostic laboratories.

10.2.3 Other Constituents of Concern

Radioactive wastes from clinical laboratories often contain other chemical and biohazardous constituents that affect how the wastes must be managed. Biohazardous agents, body fluids, and other materials subject to regulation as medical waste are frequently present, particularly in wastes from nuclear medicine procedures, and from radioassay procedures performed with specimens of body fluids. Organic solvents and other hazardous chemicals used in reagents or as preservatives may be present in radioactive wastes and require them to be managed as mixed waste, or preclude disposal options such as atmospheric release or discharge to the sanitary sewer.

10.3 Regulatory Framework

10.3.1 Regulations

Regulations governing the use of radioactive materials depend on the origin of the materials. Source, special nuclear, and byproduct radioactive materials are regulated by the U.S. Nuclear Regulatory Commission (NRC) or by states approved by the NRC (agreement states). Any waste that contains or is contaminated with any of these materials is subject to NRC regulation. Virtually all of the radioactive wastes generated by clinical laboratories are low-level waste (LLW). LLW is waste requiring disposal at a land disposal facility and is defined by the NRC as radioactive waste not classified as high-level

radioactive waste, transuranic waste, spent nuclear fuel, or uranium or thorium mill tailings or waste. LLW is classified into three classes— Class A, B, or C— depending on the concentration of short- and long-lived radionuclides present in the waste. Most LLW generated by clinical laboratories is Class A.

Regulations governing the use and disposal of radioactive materials are found in Title 10 of the Code of Federal Regulations (CFR), Part 20. The NRC has deregulated three specific types of waste, allowing them to be disposed of without regard to their radioactive constituents (some limitations apply). These include liquid scintillation counting fluids and animal carcasses containing less than 0.05 µCi per gram of ^{3}H or ^{14}C, as well as wastes generated from generally licensed *in vitro* radioactive materials.

Naturally occurring or accelerator-produced radioactive materials (commonly referred to collectively as NARM) are not subject to NRC regulations, nor are they included in the definition of LLW. Regulations governing the production and use of NARM are generally left to the states. The NRC does not regulate any waste containing or contaminated with NARM. However, these wastes still require proper disposal under applicable state regulations.

10.3.2 Licensing

Most uses of radioactive materials in diagnosis, therapy, and research require the user to obtain a radioactive materials license from the NRC or agreement state. Licensees must assure complete internal control of the receipt, storage, use, transfer, and ultimate disposal of all radioactive materials. License conditions list the radionuclides, activities, and amounts that may be possessed; allowed uses; and may include specific waste management and disposal requirements.

10.4 Institutional Management

10.4.1 Administration

Responsibilities for administration of the radioactive waste program should be assigned to a qualified individual with management authority. The personnel used in this capacity vary with the size of the laboratory and other uses of radioactive materials in the institution. Responsibility for waste management in small laboratories is often a collateral duty of the laboratory technologist or nuclear medicine specialist. Institutions with larger radioactive materials use programs usually have radiation safety departments, employ health physicists, and assign waste management duties to them.

10.4.2 Waste Management Plan

The laboratory should develop a plan covering all aspects of radioactive waste minimization and management. All personnel that generate wastes and those responsible for disposal should be involved in development of the plan. Typical plan elements include:

- statement of management support and policy;
- designation of a person with overall responsibility for waste management operations;
- source reduction and waste minimization guidance;
- institutional waste identification, segregation, packaging, and storage procedures;
- regulatory compliance requirements;
- provisions for waste accounting, tracking, and recordkeeping;

- a training program; and
- procedures for periodic audits and review, user feedback, and updating of the plan.

10.4.2.1 Waste Profiles and Standard Operating Procedures

Many laboratories find it useful to establish profiles for each specific waste stream that the laboratory generates. Particularly for wastes generated by recurring procedures, the use of profiles can significantly simplify waste management and reduce or eliminate redundant characterization steps and confirmatory radioassays of the waste. Each profile should identify the procedure generating the waste; its physical form; radionuclides and activity ranges present; chemical and biohazardous constituents; shipping names and requirements; and disposal procedures. The specific methods for radioactive waste disposal should be requested in the license application and amendments, and approved by regulators before implementation.

10.4.2.2 Contingency Planning

The procedure manual should specify the specific actions to be followed in the event of an accidental spill. Two levels of response may be appropriate. Considerations include the amount of radioactivity estimated to have occurred and the radiotoxicity of the nuclide.

10.4.2.2.1 Response to Minor Radwaste Spills

If a minor spill of nuclides with lower to moderate radiotoxicity occurs, the following actions should be taken:

(1) Notify persons in the area that a spill has occurred.

(2) Prevent the spread. Cover the spill with absorbent paper.

(3) Clean up. Use disposable gloves and remote handling tongs. Carefully fold the absorbent paper and pad. Insert into a plastic bag and dispose of it in the radioactive waste container. Also insert into the plastic bag all other contaminated materials, such as disposable gloves.

(4) Survey. With the appropriate survey meter, check the area around the spill; also check hands and clothing for contamination.

(5) Report. Report the incident to the Radiation Safety Office.

10.4.2.2.2 Response to Major Radwaste Spills

If a major spill of a nuclide with high radiotoxicity occurs, the following actions should be taken:

(1) Clear the area. Notify all persons not involved in the spill to vacate the room.

(2) Prevent the spread. Cover the spill with absorbent paper, but do not attempt to clean it up.

(3) Ask all potentially contaminated personnel to assemble near the room entrance.

(4) Close the room. Leave the room and watch the door(s) to prevent entry.

(5) Call for help. Notify the Radiation Safety Office immediately.

10.4.2.3 Recordkeeping

Federal and state regulations require documentation of the disposition of radioactive waste. Radioactive waste records should be maintained, recording the name, activity, description of the disposed waste, and method of disposal. Maintain these records even if the radioactive material is disposed of via a radioactive waste broker.

10.5 Waste Avoidance (Source Reduction) Strategies

The costs for disposal of most types of radioactive waste are high and increasing. In some areas of the United States, options for off-site disposal are very limited, and generators may be required to develop long-term storage capacity. These factors have encouraged many laboratories to aggressively implement source reduction (waste avoidance) strategies, often greatly reducing and sometimes eliminating generation of radioactive wastes. These strategies include:

- Use of alternatives for radioactive methods. Methods employing chemiluminescent dyes, stable isotopes, and other nonradioactive materials have been developed for many procedures that previously required the use of radioactive materials.

- Substitution with short-lived radionuclides. Replacement of long-lived radionuclides with short-lived allows wastes to be decayed in storage and disposed of as nonradioactive waste.

- Minimize activities ordered and used. Avoid over ordering radionuclides, and use the minimum activity that can produce the required results.

- Restricting areas where radioactive materials are used. Limiting the areas where radioactive materials are used reduces the potential for contamination and generation of secondary wastes resulting from contamination.

10.6 Management of Unavoidable Wastes

10.6.1 On-site Accumulation and Storage

Careful selection, implementation, and supervision of on-site waste management methods will minimize potential radiation safety hazards and can greatly reduce (and sometimes eliminate) the need for off-site disposal.

10.6.1.1 Segregation

Proper segregation of wastes reduces unnecessary generation of wastes and maximizes the efficiency of disposal operations. General segregation guidance is presented in Table 7.

Table 7. General Radioactive Waste Segregation Groups

Keep These Radioactive Waste Types	Separate from These
Radioactive wastes	All other types of wastes
Wastes with known contamination	Wastes with unconfirmed contamination
Liquids	Solids
Aqueous liquids	Nonaqueous liquids
Wastes with only short-lived radionuclides	Wastes containing long-lived radionuclides
Wastes disposable on-site	Wastes that must be shipped off-site
Deregulated liquid scintillation vials	Regulated liquid scintillation vials
Radioactive sharps	Nonradioactive sharps
Deregulated animal carcasses	Regulated animal carcasses

Radionuclides should be separated by half-life whenever possible. This allows for greater use of the decay-in-storage method of waste disposal and aids in reducing the amount of storage space needed and the amount of radioactive waste that requires disposal.

10.6.1.2 Collection Containers and Labeling

10.6.1.2.1 Waste Collection Containers

Containers for radioactive waste should be specified and provided by the institution's radiation safety department and sized appropriately for the activities in the laboratory. All containers should be kept closed except when adding wastes. Wastes should be transferred to the treatment site, off-site storage area, and/or disposal site as often as practical to minimize potential exposures to laboratory personnel.

- Solid Wastes: A container that is clearly labeled and separate from general waste should be used for collection of dry, solid waste such as contaminated paper, gloves, etc. In most cases, cardboard containers or step cans with appropriate plastic bag liners are satisfactory for routine collection of contaminated solid wastes.

- Sharps: Radioactive sharps should be collected separately from nonradioactive sharps and placed in appropriately labeled, puncture-resistant sharps containers.

- Liquid Wastes: A capped, plastic container should be used for liquid waste.

10.6.1.2.2 Container Labels

Labels should be placed on all containers and should list:

- identification of the laboratory and authorized user of radioactive materials;

- date of accumulation;

- radionuclides present and the estimated activity of each; and

- source and type of waste.

A warning label with the NRC-prescribed radiation symbol and the phrase “Caution—Radioactive Material” is required.

10.6.1.2.3 Shielding

Waste collection, handling, and storage areas should be evaluated by the radiation safety officer to determine the necessity of shielding waste containers, as well as the correct shielding. For example, when shielding is necessary for storage of wastes containing ^{32}P, a beta emitter of 1/2-inch poly (methyl methacrylate), not lead, should be used. If the waste contains gamma emitters lead may be used. If the waste contains both gamma emitters and ^{32}P, lead is placed around the outside of the poly (methyl methacrylate) shield. Unnecessary use of shielding should be avoided, because it tends to become contaminated and adds to the volume of radioactive waste. Contaminated lead is particularly problematic, as it is considered a mixed waste and must be decontaminated before disposal. Small amounts of lead foil and shielding inadvertently discarded with solid LLW intended for incineration can contaminate large quantities of ash, requiring it to be managed as mixed waste. This can be extremely costly, and treatment costs may be charged back to the generator.

10.6.1.2.4 Containment

Collection and storage containers should be inspected regularly for leaks, proper closures, and signs of deterioration. Containers holding liquid wastes should be stored on trays or other devices providing secondary containment in the event of leakage or spills. Absorbent liners should be placed under containers to protect the surfaces in the holding area from contamination.

10.6.1.2.5 Security

NRC security requirements applicable to radioactive materials apply to wastes. Radioactive waste must be secured from unauthorized access or removal. Warning signs indicating the presence of radioactive materials should be placed in all areas where radioactive wastes are collected, processed, and stored. Personnel with access to waste handling and storage areas should be trained in procedures and work duties.

10.7 General Treatment and Disposal Methods

Radioactive waste may be treated and disposed of by several methods, including decay-in-storage; release into the sanitary sewer system; dispersal into the atmosphere; or transfer to a waste disposal firm for off-site processing, incineration, or burial.

The treatment process and method of disposal chosen for each type of waste is dependent on several factors, including the following:

- the waste type (aqueous, gaseous, solid, organic, or animal carcass);
- the radioisotope and its half-life;
- combustibility;
- federal and state regulations;
- institutional license conditions; and
- availability of treatment and disposal facilities.

10.7.1 On-site Waste Management

10.7.1.1 Decay-in-Storage (DIS)

Decay-in-storage (DIS) is the preferred method of radioactive waste management for all radioactive materials in any form with a half-life of 120 days or less when the licensee has sufficient space to store the volume generated. Wastes are usually held for a period of ten half-lives and then reassayed for radioactivity. If the activity level is at or below background, or meets specific license requirements, it may then be disposed of as nonradioactive waste.

10.7.1.2 Volume Reduction

Solid LLW generated by clinical laboratories primarily consists of low-density materials. Because brokers and off-site storage and disposal facilities may charge by units of volume, some laboratories find it advantageous to use compactors to reduce the volume of the wastes on-site before shipment. Some contractors also offer off-site supercompaction services for further volume reduction.

10.7.1.3 Incineration

Increasingly stringent air pollution control regulations have caused many hospitals to close their incinerators and ship medical wastes off-site for disposal. As a result, most clinical laboratories no longer have access to on-site incinerators for disposal of incinerable LLW. A very limited number of commercial facilities in the U.S. accept LLW.

Incineration is the preferred method for treatment and disposal of solid LLW, radioactive animal carcasses, or other wastes that cannot be disposed of by decaying in storage or by dilution into the sewer system. Incineration of radioactive material is permitted only by special authorization in an NRC- or state-licensed facility. Incineration of radioactive material is preferred for (and may be limited to) wastes containing ^{3}H and ^{14}C.

This limitation is to eliminate the need for monitoring the ash to determine whether radioactive residue is present. The amount of radioactive gases that may be released into the atmosphere may not exceed amounts listed in Appendix B of 10 CFR Part 20. Under most NRC licenses, incineration of radioactive material must be carried out under the following guidelines:

- No hazardous waste may be incinerated, unless such incineration is specifically authorized by the EPA.

- Radionuclides may not be incinerated without the prior approval of the Radiation Safety Department.

- The containers of LLW to be incinerated must measure less than 2.0 millirems/hour (mrem/hr) at the surface, because the incinerator operator is limited to the regulatory requirements for exposure of persons in unrestricted areas. The radioactivity of the ash must be monitored. If the limits in NRC regulations are exceeded, the ash must be sent off for final disposal.

- The emissions from the LLW incineration process must be shown by calculation or by monitoring to be less than the maximum permissible concentrations for an unrestricted area for the radionuclides in question.

10.7.1.4 Discharge to the Atmosphere

Release into the atmosphere can be used for disbursable gases, radioactive carbon dioxide, or radioactive ^{133}xenon. The radioactive gas is delivered to a hood or a dedicated ventilation system that both dilutes it and exhausts it into the atmosphere. This method, in general, requires approval by the NRC or agreement state agency. As with incineration, the following conditions must necessarily be met:

- The exposure to persons performing the disposal cannot exceed 2 mrem in any hour, which is the limit for exposure to persons in an unrestricted area.

- The instantaneous concentration of the effluent cannot exceed the specified concentrations for an unrestricted area in Appendix B of 10 CFR Part 20.

Charcoal canisters may also be used to trap the gas for decay and delayed release.

10.7.1.5 Discharge to the Sanitary Sewer

Most aqueous liquid radioactive wastes generated by clinical laboratories may be discharged to the sewer if the facility is served by a publicly owned treatment works (POTW). These wastes should not be discharged at facilities served by septic systems.

The amount of radioactive waste released into the sewerage system is regulated by NRC limits (10 CFR 20.301) and may be subject to additional license conditions. Generally, aqueous liquid radioactive waste may be disposed of via the sanitary sewer system, if the following conditions are met:

- Each approved user of radionuclides must use no more than one “hot” sink for disposing of the liquid waste, unless given an exception by the Radiation Safety Department. This is necessary to validate concentration calculations, because federal regulations limit the quantity of radioactive material that can be released into the sewer system. Alternatively, some institutions do not allow users to discharge wastes at individual laboratory sinks. Instead, all wastes are collected in containers, inventoried, and discharged from a central facility.

- The quantity that can be released to the sewer in any one day cannot exceed the larger of the following:

    1. that quantity, if diluted by the average volume of sewerage effluent, that will result in a concentration equal to that specified in Appendix B, Table 1, Column 2 of 10 CFR Part 20; or

    2. ten times the quantity specified in Appendix C of 10 CFR, Part 20.

- The average monthly concentration of radioactive material cannot exceed the limit specified in Appendix B, Table I, Column 2 of 10 CFR Part 20. Applicable state regulations, if any, should also be consulted.

- The total amount of radioactive material released into the sewer system by the laboratory (except for ^{14}C and ^{3}H) cannot exceed one curie per year. For ^{3}H, a maximum of 5 Ci (185 GBq) a year is allowed, while for ^{14}C a maximum of 1 Ci (37 GBq) a year is allowed.

- Liquid waste must be readily soluble or dispersible in water. Any radioactive solids in the waste must be in dispersible form (biodegradable solids).

- Each sink used for radioactive liquid waste disposal should be identified and display the appropriate radiation warning sign.

Other guidance on disposal of wastes to the sanitary sewer:

- Do not exceed the daily limits of radioactive material release posted on each sink by the Radiation Safety Department.

- Follow all releases of radioactive waste with copious amounts of water.

- Wastes containing oils, solvents that are in ignitable concentrations or not miscible with water, and other materials regulated as hazardous waste or restricted by the POTW should not be discharged.

- Do not dispose of radioactive material via the sewer system that can be conveniently decayed in storage.

- Excreta from persons undergoing medical diagnosis or therapy with radioactive material are exempt from any of these limitations.

10.7.2 Off-site Waste Management

Off-site disposal is usually arranged through a radioactive waste broker and is usually considerably more expensive than on-site disposal methods. However, commercial, off-site facilities may offer a variety of options that may not be available on-site, including decay-in-storage; long-term storage; supercompaction; incineration; vitrification; and burial.

Any radioactive waste transported off-site for storage or disposal must be packaged in accordance with 49 CFR 173 and 10 CFR 20.203 (7). Shipping papers must be prepared to comply with 49 CFR 173 to document the physical form and activity of the transported waste. After delivery of waste, the vehicle used must be surveyed for contamination. The institution generating radioactive waste has "cradle-to-grave" responsibility for the material. If shipment requires placarding, the generator must be ready to supply it if the transporter does not have appropriate placards.

10.7.3 Management of Specific Clinical Waste Streams

The management method used for various types of waste will vary depending on the capabilities of the laboratory; access to disposal facilities; cost factors; quantity and composition of the waste; regulatory requirements; and many other factors. The information presented below is for guidance only.

Table 8. Recommended Management Methods for Radioactive Waste Streams Commonly Generated by Clinical Laboratories

	Disposal Methods		
	Preferred	First Alternative	Second Alternative
^{131}I waste from iodinations in laboratories, waste from therapy doses administered to patients (amount: less than 10 mCi (0.37 GBq) of ^{131}I)			
Solids	Decay, then	Incineration	
Liquids	Decay, then	Sewer	
Imaging agents with half-life greater than 60 days in diagnostic amounts			
Solids	Decay	Incineration	
Liquids	Decay	Sewer	
Imaging (^{99m}Tc) in diagnostic amounts			
Solids	Decay, then	Incineration	
Liquids	Decay, then	Sewer	
Lead shielding			
Solids	Reuse	Decontaminate, then return to supplier*	Recycle
Liquid scintillation vials, nonignitable counting fluid, with only ^{14}C or ^{3}H at less than 0.05 µCi/g			
Solids	Recycle off-site	Incineration	Normal trash
Liquids	Recycle	Sewer	Incineration
Liquid scintillation vials, nonignitable counting fluid, with ^{14}C and ^{3}H greater than 0.05 µCi/g, or other radionuclides			
Solids	Decay, then	Recycle	
Liquids	Decay, then	Recycle	Sewer
Radioimmunoassay (RIA) Kits (^{125}I)			
Solids	Normal trash†	Decay, then	Incineration
Radionuclides used for *in vivo* kinetic studies			
Solids	Normal trash	Incineration	
Liquids	Sewer		
Source vials, empty			
Solids	Dispose as solid LLW		
Source vials, not empty			
Solids	Return to vendor	Case by case determination	Dispose as Solid LLW
Liquids	Return to vendor	Case by case determination	
^{133}Xenon			
Gas	Charcoal trap	Decay in hood	Release into atmosphere

* Lead decontamination solutions may require treatment as mixed waste.
†Only with general license 10 CFR 31.

11 Multihazardous Waste

11.1 Introduction

This section discusses issues relating to management of multihazardous wastes. These wastes are often the most problematic and costly of all of the types of wastes generated by clinical laboratories.

11.1.1 Definitions

11.1.1.1 Multihazardous Wastes (MHW)

Multihazardous wastes contain any combination of hazardous chemicals, radioactive materials, or biohazardous agents. Clinical laboratories may generate all types of multihazardous wastes: chemical-radioactive, chemical-biohazardous, and radioactive-biohazardous. Biomedical research facilities and clinical laboratories are probably the only sources of chemical-radioactive-biohazardous wastes.

11.1.1.2 Low-Level Mixed Wastes (LLMW)

Low-level mixed wastes are a subset of multihazardous wastes that contain both low-level radioactive waste (LLW) and chemicals regulated by the EPA or states as hazardous wastes. Some radioactive chemical wastes generated by laboratories do not meet the definition of mixed wastes, because they contain radioactive materials that are not regulated by the NRC, and/or hazardous chemicals (such as ethidium bromide) that are not regulated as hazardous waste. Regardless of their regulatory status, multihazardous wastes should be managed in a manner that assures that all hazardous constituents contained in the waste are handled safely in the laboratory and disposed of in a manner that is protective of the environment.

11.1.2 Sources of MHW

Radioactive-biohazardous wastes are the most common type of MHW generated by clinical laboratories. Laboratories supporting nuclear medicine activities generate short-lived radioactive wastes that contain biohazardous agents, sharps, or other constituents that are regulated as medical waste. Clinical laboratories may generate similar wastes if specimens from patients that have received radiopharmaceuticals are processed and tested in the laboratory. Routine clinical diagnostic procedures that use radioactive tracers (such as radioimmunoassays) generate radioactive-biohazardous wastes with longer-lived radionuclides. With the exception of liquid scintillation counting fluids, most clinical diagnostic laboratories do not routinely generate LLMW. However, significant volumes of liquid, mixed wastes are often generated by biomedical research laboratories, particularly from gel electrophoresis procedures with radiolabeled compounds.[2]

11.1.3 Regulatory Framework

There are no specific regulations for most types of multihazardous waste; rather they are subject to the regulations applicable to each type of hazardous constituent in the waste. The major exception is LLMW. The hazardous chemical portion of mixed wastes is regulated by the EPA or states authorized under RCRA. The radioactive materials are subject to oversight by the NRC or the states. This dual regulatory framework includes specific management requirements for regulated LLMW. Until recently, overlapping and sometimes conflicting requirements of NRC and EPA regulations presented serious obstacles to management of LLMW from laboratories. For example, large generators were prohibited by RCRA regulations from storing hazardous wastes longer than 90 days without a permit. Yet it was sometimes necessary to hold mixed wastes containing short-lived radionuclides longer than 90 days to meet NRC requirements for release as nonradioactive material. Few commercial facilities accept mixed wastes for treatment or disposal, because they do not have both the required NRC radioactive materials licenses and EPA hazardous waste permits. Some types of LLMW generated by laboratories have no disposal options, and must be stored indefinitely.

Problems associated with the dual regulatory framework for LLMW have been reported for some time. In 1999, the EPA proposed extensive revisions to its regulations to provide increased flexibility to facilities that manage LLMW and naturally occurring and/or accelerator-produced radioactive material (NARM) mixed with hazardous waste.[3] A final rule adopting these regulations was imminent at the publication

time of this guideline. They will exempt NRC-licensed generators of LLMW and hazardous NARM from RCRA manifest, transport, and disposal requirements when certain conditions are met. When fully implemented by EPA and adopted by the states, the new regulations will relieve many of the management problems of the current dual regulatory system. Generators should review the provisions of the final rule and confirm the status of its implementation in their state before changing mixed waste management practices developed to comply with the previous regulatory framework.

The NRC has deregulated certain types of wastes that may be classified as MHW. Regulations in 10 CFR 20.306 allow disposal of liquid scintillation counting fluids and animal carcasses containing ^{3}H and ^{14}C without regard for their radioactivity, provided that the activity concentration is less than 0.05 FCi/g (1850 Bq/g) of waste. These wastes are often referred to as "*di minimis* wastes." Generators should collect and segregate *de minimis* wastes from other waste forms to take advantage of the lower management costs and greater disposal options resulting from their deregulated status.

NRC also exempts small generators only using RIA kits from management requirements for LLRW (see 10 CFR 31).

11.1.4 Management Problems Associated with MHW

For several reasons, MHW is often highly problematic for laboratories to manage.

- Laboratories tend to classify wastes by their primary hazard and may fail to recognize the presence of subsidiary hazards.
- The analysis required to characterize the waste is difficult and costly. Most hazardous waste analysis laboratories will not accept MHW.
- Most MHW tends to be generated infrequently and in small volumes.
- Multidisciplinary expertise and oversight is required to assure appropriate management of the various types of hazardous materials in MHW.
- Regulatory burdens of dual or multiple regulatory systems complicate management.
- Determination of proper DOT shipping names, labeling, packaging, and transportation requirements can be very difficult and time consuming.
- Most commercial disposal facilities will not accept MHW.
- Costs of disposal services for LLMW, when available, may be extremely high.

11.2 Waste Avoidance (Source Reduction) Strategies

The difficulties encountered in management of MHW emphasize the need for laboratories to develop and strictly enforce policies that prevent unnecessary generation of MHW. If possible, procedures and areas where different types of hazardous materials are used should be kept separate. One of the major sources of MHW from laboratories is cross-contamination and commingling of different single-hazard wastes. In some cases, the consequences of commingling can be very serious. For example, a few milliliters of spent liquid scintillation counting fluid containing microcurie amounts of tritium placed in a collection drum for waste, nonradioactive laboratory solvents will result in the entire drum being classified as LLMW. The disposal cost of the nonradioactive solvents would probably be less than $500. As mixed waste, the cost

could be as high as $50,000, particularly if the waste contained high concentrations of halogenated solvents.

Most of the source reduction strategies recommended for single-hazard wastes can also be applied to avoid generation of MHW: use of short-lived radionuclides for long lived; use of alternatives to radioactive methods; and substitution of hazardous chemicals with less hazardous and/or nonregulated chemicals.

11.2.1 Screening and Survey Methods

Laboratories that use multiple types of hazardous materials should have waste screening and testing protocols to ensure that wastes assumed to contain a single type of hazardous material do not contain subsidiary hazards. For example, if the laboratory uses radioactive materials, medical wastes, lead shielding, solvents, and other liquid hazardous wastes, they should be tested for contamination with radioactive materials before they are released or shipped for recycling or disposal. The presence of unexpected radioactive contamination in a waste shipment, even if only exempt materials, may often result in rejection of the shipment or have other serious repercussions.

11.3 General Treatment and Disposal Strategies

11.3.1 On-site Treatment

The primary treatment objective for multihazardous wastes is usually to reduce the hazardous properties such that it can be managed as a single-hazard chemical, radioactive, or medical waste. The sequence of treatment methods should be according to the degree of risk posed by the various hazardous constituents. Examples of on-site treatment and methods include:

- Inactivation of biohazardous agents by autoclaving. This may not be advisable if volatile or thermally unstable chemicals or radioactive materials are present.

- Inactivation of biohazardous agents by chemical disinfection. Applications of this method are limited, because other components in MHW may render the disinfectant ineffective, and disinfectants may react with chemical constituents or liberate volatile radionuclides from the waste.

- Storage of wastes containing short half-life radionuclides for decay. The waste is held until the radioactivity has decayed and then managed at a medical waste or hazardous waste disposal facility, as appropriate.

- Removal or decontamination of radioactive surface contaminants on lead or other items regulated as hazardous waste.

- On-site treatment of hazardous chemical constituents where regulations and permitting requirements have been met.

- Disposal to a sanitary sewer system, e.g., disposal of radioactive, biohazardous wastes generated from human clinical and diagnostic studies.

- Alkaline hydrolysis treatment of radioactively contaminated biohazardous carcasses and tissues to sterilize the waste and solubilize radionuclides that can be discharged to the sanitary sewerage system.

11.3.2 Long-term Storage

For LLMW containing long half-lived radionuclides and for which there are limited or no disposal options, indefinite on-site storage may be required.

11.3.3 Off-site Treatment and Disposal

Most forms of MHW are not shipped for treatment or disposal off-site without pretreatment to eliminate one or more hazardous constituents. Limited options exist for untreated LLMW. These include:

- incineration at a commercial, EPA-permitted/NRC-licensed facility;
- burning as fuel in an EPA-permitted/NRC licensed facility; and
- treatment to meet EPA land disposal restrictions followed by disposal in an NRC-licensed LLRW burial site.

11.4 Guidance for Management of Common Multihazardous Waste Streams

The sequence of methods used to treat and dispose of MHW must often be determined on a case-by-case basis. The capabilities of the laboratory; access to disposal facilities; cost factors; quantity and composition of the waste; regulatory requirements; and many other factors must also be considered. The information in Table 9 is for guidance only. Following Table 9 additional guidance on management of animal carcasses and liquid scintillation fluids is presented.

Table 9. Recommended Management Methods for Common Multihazardous Streams Commonly Generated by Clinical Laboratories

Disposal Methods			
Pretreatment	Preferred	First Alternative	Second Alternative
Animal carcasses, radioactive, containing only short-lived radionuclides			
Refrigerate, freeze, or stabilize with lime if prolonged storage required. Decay short-lived radionuclides.	Incinerate.	Alkaline hydrolysis and discharge of hydrolysate to sanitary sewer.	
Animal carcasses, radioactive, contaminated with ^{14}C or ^{3}H at greater than 0.05 µCi/g, or other long-lived radionuclides. Short-lived radionuclides may also be present.			
Refrigerate, freeze, or stabilize with lime if prolonged storage required. Decay short-lived radionuclides.	Ship to radioactive waste incineration or burial.	Alkaline hydrolysis and discharge of hydrolysate to sanitary sewer.	
Animal carcasses, radioactive, contaminated with ^{14}C or ^{3}H at less than 0.05 µCi/g. Short-lived radionuclides may also be present.			
Refrigerate, freeze, or stabilize with lime if prolonged storage required. Decay short-lived radionuclides.	Incinerate as nonradioactive medical waste or nonregulated solid waste.	Alkaline hydrolysis and discharge of hydrolysate to sanitary sewer.	
Blood or other biohazardous liquid wastes, contaminated with only short-lived radionuclides			
Inactivate pathogens and retard putrefaction by autoclaving or adding chemical disinfectants (observe precautions). Decay short-lived radionuclides.	Discharge to sanitary sewer.	Incinerate as nonregulated solid waste.	
Blood or other biohazardous liquid wastes, contaminated with long-lived radionuclides. Short-lived radionuclides may be present.			
Inactivate pathogens and retard putrefaction by autoclaving or adding chemical disinfectants (observe precautions). Decay short-lived radionuclides.	Discharge to sanitary sewer.	Incinerate.	
Electron microscopy staining solutions containing uranyl acetate and lead citrate			
Solidify in cement and confirm solid meets land disposal restrictions in 40CFR 268.	Ship to LLW burial facility		
Gel electrophoresis solutions (washing and fixation) containing alcohols or other solvents and only short-lived radionuclides			
Decay short-lived radionuclides.	Ship to recycling (fuel recovery) facility.	Ship to hazardous waste incineration facility.	
Gel electrophoresis solutions (washing and fixation) containing alcohols or other solvents and long-lived radionuclides. Short-lived radionuclides may also be present.			
Decay short-lived radionuclides.	Ship to mixed waste recycling (fuel recovery) facility.		

Table 9. (Continued)

Disposal Methods			
Pretreatment	Preferred	First Alternative	Second Alternative
Lead shielding, contaminated with only short-lived radionuclides			
Decay short-lived radionuclides.	Reuse as shielding.	Ship to lead reclamation facility.	Ship to hazardous waste disposal facility.
Lead shielding, contaminated with long-lived radionuclides. Short-lived radionuclides may also be present.			
Decay short-lived radionuclides, then decontaminate.	Reuse as shielding.	Ship to lead reclamation facility.	Ship to hazardous waste disposal facility.
Lead shielding decontamination solutions, lead concentration > 5.0 mg/L			
Solidify in cement and confirm solid meets land disposal restrictions in 40CFR 268.	Ship to LLW burial facility.		
Liquid scintillation vials, hazardous (ignitable and/or corrosive) counting fluid, with only ^{14}C or ^{3}H less than 0.05 µCi/g. Short-lived radionuclides may be present.			
Decay short-lived radionuclides.	Ship to vial recycling (fuel recovery) facility.	Incinerate as hazardous waste.	
Liquid scintillation vials, hazardous (ignitable and/or corrosive) counting fluid, with ^{14}C and ^{3}H greater than 0.05 µCi/g, or other long-lived radionuclides			
Decay short-lived radionuclides.	Ship to vial recycling (fuel recovery) facility.		
Radioimmunoassay kits exempt under 10 CFR 31			
Decay short-lived radionuclides (recommended, not mandatory).	Dispose as nonregulated solid waste.		
Sharps, contaminated with short-lived radionuclides			
Decay short-lived radionuclides.	Incinerate as regulated medical waste.	Autoclave, then grind and bury in landfill.	
Sharps, contaminated with long-lived radionuclides			
Autoclave if radionuclides are not volatile.	Ship to radioactive waste facility.		
Solvents, halogenated or nonhalogenated, contaminated with only short-lived radionuclides			
Decay short-lived radionuclides.	Ship to fuel recovery facility if waste meets minimum heat content (BTU) value.	Ship to hazardous waste incineration facility.	
Solvents, nonhalogenated, contaminated with long-lived radionuclides. Short-lived radionuclides may also be present.			
Decay short-lived radionuclides.	Ship to fuel recovery facility.	Ship to hazardous waste incineration facility.	
Solvents, halogenated, contaminated with long-lived radionuclides. Short-lived radionuclides may also be present.			
Decay short-lived radionuclides.	Ship to LLMW incineration facility.	Ship for blending and burning at fuel recovery facility licensed to accept radioactive materials.	Long-term storage pending availability of disposal options.

11.4.1 Animal Carcasses

Animal carcasses should be double bagged, labeled, placed in specially designated containers, and stored in a cold room. A tag should be filled out indicating the isotope, activity, and contents in the bag. The Radiation Safety Office should collect the containers and hold them in freezer storage in a radioactive waste storage area to allow for decay of short-lived radionuclides. Carcasses containing only ^{3}H or ^{14}C can be incinerated or treated by alkaline hydrolysis and discharged to the sanitary sewer if the requirements of 10 CFR 20.306 are met. Treatment and disposal of wastes and release of residues from processing carcasses containing other isotopes and activities must be specifically authorized by the laboratory's radioactive materials license. If these treatment options are not available, carcasses can be shipped via a broker to an off-site radioactive waste management facility after being pretreated to meet disposal facility and broker requirements.

11.4.2 Liquid Scintillation Counting Fluids

Liquid scintillation counting (LSC) is typically performed on radiolabeled samples in vials using a fluid (cocktail) containing various mixtures of acetic acid, solvents, surfactants, and scintillation agents. Less frequently, LSC is performed in continuous flow counting procedures, sometimes in combination with HPLC and other analytical methods. Wastes from LSC consist of vials containing spent fluids typically with very low levels of radioactivity. If the cocktail contains RCRA-listed solvents (usually toluene or xylene), ignitable concentrations of unlisted wastes (such as Pseudocumene), or has a pH less than 2.0, the fluid is regulated as a hazardous waste and therefore an LLMW.

Several trends have greatly reduced the volumes and hazardous characteristics of LSC wastes generated by laboratories. Generally, use of LSC has declined and been replaced by other methods such as solid scintillation counting.[4] The liquid volumes required for processing an LSC sample have dropped significantly from 20 mL routinely used in the past. Changes in technology allow use of microcentrifuge tubes.[5] Manufacturers have also reformulated counting fluids, replacing ignitable solvents with non-ignitable surfactants. Sometimes these are advertised as “nonhazardous” or “biodegradable,” terms that may be somewhat misleading. As used here “nonhazardous” usually means containing no ingredients requiring disposal as hazardous waste; the fluids may still contain materials that have other hazardous properties. All solvents used in LSC, including toluene and xylene, are biodegradable; usually the term is used to indicate that that formulation does not contain ingredients prohibited from discharge to the sanitary sewer. For a more detailed discussion of LSC fluids, refer to the review by Klein and Gershey.[6]

Where feasible, laboratories should use nonhazardous counting fluids. If the radionuclides and activity concentrations meet the requirements for *de minimis* waste the fluids can be incinerated, managed as nonregulated solid waste, or discharged to the sanitary sewer. While discharge to the sewer may be acceptable, the practice is somewhat labor intensive and may not be cost-effective compared with shipment to a vial recycling facility.

12 Hazardous Glass and Plastic, and Other Laboratory Solid Waste

Various other wastes are generated in the laboratory that are not hazardous; that is, they do not pose substantial hazards or potential hazards to human health or the environment. Nonhazardous waste may be solid, liquid, or gaseous. In terms of regulations, it is defined by exclusion: waste that is not regulated, because it is not defined as hazardous, toxic, or radioactive.

The nonhazardous wastes generated in the laboratory include glass, plastic, paper, and metal items, cardboard, general trash, and liquids. These wastes can usually be disposed of with the general waste streams. Nevertheless, the use of proper management practices will provide safety for waste handlers, increased recycling of certain wastes, greater efficiency, and cost savings.

This section discusses the precautions that must be taken in handling sharps that are not biohazardous, the options for recycling and waste reduction, and the alternatives for disposal of nonhazardous laboratory wastes.

12.1 Management of Broken Glass and Plastic

Laboratories do generate sharp objects that are neither biohazardous nor radioactive. This waste includes items such as micropipettes that were used with noninfectious materials, broken glass, and broken hard plastic. These items do not have to be managed as infectious or radioactive waste, and they should not be so managed.

The concern with these sharps is the risk of puncture wounds or lacerations. Therefore, special precautions are necessary to minimize/eliminate the risks of physical injury that any sharp presents to waste handlers. Inasmuch as these items are not biohazardous, they do not need decontamination or sterilization; therefore, they should not be placed in sharps containers that are used for infectious sharps. They should be placed in puncture-resistant containers such as strong cardboard boxes that are labeled "broken glass" but are not labeled "biohazard."

Proper management of broken glass and plastic provides the necessary protection from sharps while avoiding the increased costs of waste treatment and disposal that would result from unnecessarily mixing wastes that are not biohazardous with wastes that are.

12.2 Management of Other Laboratory Solid Waste

All other nonhazardous wastes generated in the laboratory do not present special concerns for containment and handling. Good management practices that include waste reduction and recycling programs will reduce the amount of waste generated and, therefore, the costs of disposal. The waste management program for the laboratory should also include specifics for management of nonhazardous wastes to ensure that they are managed in accordance with established policies in the most cost-effective manner.

12.2.1 Disposal Options

General trash is almost always removed from the facility for disposal. The waste that is sent off-site may become part of the municipal waste stream, or a private contractor may handle it separately. Either way, there are two options for its ultimate disposal: incineration or landfilling. It is unlikely that the facility operates its own landfill for trash disposal, and regulations for prevention of air pollution from incineration will probably result in closure of most incinerators operated by healthcare facilities. Local ordinances may require special packaging of certain wastes (e.g., sharps) and segregation of certain types of waste (e.g., those that cannot be incinerated for energy recovery).

12.2.2 Management of Liquid Wastes

All liquid wastes from a laboratory that are not hazardous, biohazardous, radioactive, or multihazardous do not need any special type of handling. They should be disposed of into a sink or drain that leads to the sanitary sewer system or, if that is not available, into a septic tank system. (Acidic and basic liquid wastes can be neutralized on-site before they are discharged into the sanitary sewer system. Some hazardous, biohazardous, radioactive, and multihazardous liquid wastes can also be disposed of into the sanitary sewer system with certain limitations and precautions. See the relevant sections.)

References

[1] ASTM D1709-01. *Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.* West Conshohocken, PA: ASTM; 2001.

[2] U.S. Department of Energy. National Institutes of Health: Mixed Waste Stream Analysis. Idaho Falls, ID: EG&G Idaho, Inc. DOE/LLW-208; 1994; and Mixed Waste Minimization and Treatment. Idaho Falls, ID: Lockheed Idaho Technologies Company. DOE/LLW-218; 1995.

[3] U.S. Environmental Protection Agency. Environmental Fact Sheet: Proposed Rule for Storage, Treatment, Transportation, and Disposal of Mixed Waste. Washington, DC: Office of Solid Waste and Emergency Response. EPA. EPA530-F-99-045; 1999; and 40 CFR Part 266. Storage, Treatment, Transportation, and Disposal of Mixed Waste; Proposed Rule. Fed Reg 64(223):63464–63501; 1999.

[4] Wonderly SW. Solid scintillation counting: a new technique for measuring radiolabeled compounds. *Appl Radiat Isotopes*. 1989;40(7):569-573.

[5] Elliot J. Liquid scintillation sample analysis in microcentrifuge tubes. *Health Physics*. 1993;64(10):86-90.

[6] Klein RC, Gershey EL. Biodegradable liquid scintillation counting cocktails. *Health Physics*. 1990;59(4):461-470.

Additional References

Laws, Regulations, and Guidelines from Governmental Agencies and Accreditation Organizations

Centers for Disease Control. Guidelines for prevention and transmission of human immunodeficiency virus and hepatitis B virus to health-care and public-safety workers. *MMWR*. 1989;38(suppl. 6).

Centers for Disease Control. Recommendations for prevention of HIV transmission in health care settings. *MMWR*.1987;36(suppl 2S).

Centers for Disease Control. Update: universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus and other blood borne pathogens in health-care settings. *MMWR*. 1988;37:377-388.

Centers for Disease Control. Recommendations for prevention and control of hepatitis C virus (HCV) infection and HCV-related chronic disease. *MMWR*. 1998;47(RR-19):1-39.

Centers for Disease Control/National Institutes of Health. *Biosafety in Microbiological and Biomedical Laboratories*. 4th ed. HHS (CDC) 93-8395. U.S. Centers for Disease Control and National Institutes of Health. Washington, DC: U.S. Government Printing Office; 1999.

Code of Federal Regulations. CFR 40, Parts 260 to 299. *Protection of the Environment*. Office of the Federal Register National Archives and Records Administration.

Code of Federal Regulations. CFR 40, Part 60. *Protection of the Environment.* Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Hospital/Medical/Infectious Waste Incinerators. Office of the Federal Register National Archives and Records Administration.

College of American Pathologists: Commission on Laboratory Accreditation. Inspection checklist; Section I "Laboratory General."

Joint Commission for Accreditation of Healthcare Organizations. Hospital Accreditation Standards: Standards, Intents.

National Fire Protection Association: NFPA99-Health Care Facilities.

National Fire Protection Association: Flammable and combustible liquid code; 30.

National Institutes of Health. NIH Guidelines. Recombinant DNA and Gene Transfer. Available: http://www4.od.nih.gov/OBA/guidelines.html. 11 April 2000.

Pennsylvania Department of Environmental Protection. Requirements for Low-Level Radioactive Waste Minimization Plans. Harrisburg, PA: Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection. July 1998.

State and Territorial Association of Alterative Treatment Technology. Technical Assistance Manual: State Regulatory Oversight of Medical Waste Treatment Technologies. STAATT. December 1998.

U.S. Department of Energy. Guidelines for Mixed Waste Minimization. Idaho Falls, ID: DOE. DOE/LLW-144; 1992.

U.S. Department of Health and Human Services, Public Health Services Agency for Toxic Substances and Disease Registry. *The Public Health Implications of Medical Waste: A Report to Congress*. 1990.

U.S. Department of Labor, Occupational Safety and Health Administration. Occupational Exposure to Blood Borne Pathogens: Final Rule. *Federal Register*. 1991;56:64003-64182. Codified as Title 29, CFR, Part 1910, Section 1910.1030. Bloodborne pathogens.

U.S. Department of Transportation, Research and Special Programs Administration. Hazardous Materials: Revision to Standards for Infectious Substances and Genetically Modified Micro-Organisms; Notice of proposed rulemaking. *Federal Register*. January 22, 2001;66:6941.

U.S. Environmental Protection Agency. Title 40, CFR, Section 60.51c. Definitions, medical/infectious waste.

U.S. Environmental Protection Agency. Approach to reinventing regulations on storing mixed low-level wastes. *Federal Register*. 1999;64(39):10063-10073.

U.S. Environmental Protection Agency. 40 CFR Part 266. Storage, Treatment, Transportation and Disposal of Mixed Waste; Final Rule. *Federal Register*. 2001;66(95):27218-2726.

U.S. Environmental Protection Agency. 40 CFR Parts 261 and 268. Hazardous Waste Identification Rule (HWIR): Revisions to the Mixture and Derived-From Rules; Final Rule. *Federal Register*. 2001; 66(95):27266-27297.

U.S. Environmental Protection Agency. Environmental Management Guide for Small Laboratories. Washington, DC: Office of Small Business Ombudsman. 1998; EPA 233-B-98-001.

U.S. Environmental Protection Agency. *EPA Guide for Infectious Waste Management.* Washington, DC: EPA. May 1986; EPA/530-SW-86-014.

U.S. Environmental Protection Agency. Guides to Pollution Prevention: Selected Hospital Waste Streams. Washington, DC: EPA. 1990; EPA/625/7-90/009.

U.S. Environmental Protection Agency. Profile and Management Options for EPA Laboratory Generated Mixed Waste. Washington, DC: EPA, Office of Radiation and Indoor Air. 1996; EPA 402-R-96-015.

U.S. Environmental Protection Agency. Title 40, CFR, Parts 260-265. Hazardous Waste Management System.

U.S. Environmental Protection Agency. Waste Minimization Opportunity Assessment Manual. Cincinnati, OH: EPA. 1988; EPA/625/7-88/003.

U.S. Environmental Protection Agency. Reducing Mercury Use in Health Care. Promoting a Healthier Environment. Available: http://www.epa.gov/glnpo/bnsdocs/merchealth/

U.S. Environmental Protection Agency. Risk Reduction Engineering Laboratory, Office of Research and Development. *Guide to Waste Minimization in Selected Hospital Waste Streams*. USEPA; 1990.

U.S. Environmental Protection Agency. Waste Reduction Resource Center. Available: http://wrrc.p2pays.org/default.htm

U.S. Nuclear Regulatory Commission. Title 10, Chapter 1, CFR-Energy. Part 19: Notices, instructions, and reports to workers; inspections.

U.S. Nuclear Regulatory Commission. Title 10, Chapter 1, CFR-Energy. Part 20: Standards for protection against radiation.

U.S. Nuclear Regulatory Commission. Title 10, Chapter 1, CFR-Energy. Part 30: Rules of general applicability to domestic licensing.

U.S. Nuclear Regulatory Commission. Title 10, Chapter 1, CFR-Energy. Part 31: General domestic licenses for byproduct material.

U.S. Nuclear Regulatory Commission. Title 10, Chapter 1, CFR-Energy. Part 35: Medical use of byproduct material.

Wisconsin Department of Natural Resources, Bureau of Watershed Management. Mercury Use: Laboratories. Available: http://www.p2pays.org/ref/05/04015.pdf

General Waste Management

Block SS, ed. *Disinfection, Sterilization, and Preservation.* 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2001.

Chaff L, Blevins-Doll C. *Progressive Waste Management: A Policy Guide for Health Care*. Clarendon Hills, IL: Chaff & Co.; 1988.

Crookham J, Dapson R. *Hazardous Chemicals in the Histopathology Laboratory; Regulations, Risks, Handling, & Disposal*. 2nd ed. Battle Creek, MI: Anatech Ltd.; June 1991.

Goldman BA, et al. *Hazardous Waste Management: Reducing the Risk*. Washington, DC: Island Press; 1986.

Hoeltge GA. Managing hazardous waste in the laboratory. *Clin Lab Med*. 1986;9(3):573-585.

The Massachusetts Water Resources Authority/Medical Academic and Scientific Community Organization, Inc. Mercury Work Group. Available: http://www.masco.org/mercury/index.htm.

National Research Council. *Prudent Practices in the Laboratory.* Washington, DC: National Academy Press; 1995.

Rau EH, Alaimo RJ, Ashbrook PC, et al. Minimization and management of wastes from biomedical research. *Env Health Pers*. 2001;108(6):953-957.

Reinhardt PA, Gordon JG. *Infectious and Medical Waste Management*. Chelsea, MI: Lewis Publishers; 1991.

Wagner KD, ed. *Environmental Management in Health Care Facilities*. Philadelphia: W.B. Saunders; 1998.

Pollution Prevention and Waste Minimization

American Chemical Society, Department of Government Relations and Science Policy. *Less is Better*. Washington, DC; 1993.

Falk-Marzillier J, Fitchmun M. Method to reduce the volatility of radioactive iodine waste. *Biotechniques*. 2000;28(1):130-131.

Gordon JG, Denys GA. Minimization of waste generation in medical laboratories. In: Reinhardt P, et al., eds. *Pollution Prevention and Waste Minimization in Laboratories*. Boca Raton, FL: CRC Press/Lewis Publishers; 1996:163-193.

Hancock AA. A rapid, economical technique for removing radioactivity from receptor binding assay aqueous wastes. *Health Physics*. 1984;47(4):640-641.

Hoeltge G. How to reduce hazardous laboratory waste. *CAP Today.* June 1992.

The Lowell Center for Sustainable Production. Sustainable Hospitals Project. Available: http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi

Murphy PH, Anderton NS. Inexpensive, convenient xenon disposal. *Health Physics*. 1975;29(5):779-780.

Pacy PJ, Cheng KN, Thompson GN, Halliday D. Stable isotopes as tracers in clinical research. *Ann Nutr Metab*. 1989;33(2):65-78.

Palo Alto, California, City of. Hospital/Medical Facility Source Control Program. http://www.city.palo-alto.ca.us/cleanbay/pdf/hospital.pdf; 1999.

Palo Alto, California, City of. Best Management Practices for Hospitals and Medical Facilities. http://www.city.palo-alto.ca.us/cleanbay/pdf/hosp.pdf; 1995.

Party E, Gershey EL. Recommendations for radioactive waste reduction in biomedical/academic institutions. *Health Physics*. 1989;56(4):571-572.

Party E, Gershey EL. A review of some available radioactive and non-radioactive substitutes for use in biomedical research. *Health Physics.* 1995*;*69(1):1-5.

Pennsylvania Department of Environmental Protection. Requirements for Low-Level Radioactive Waste Minimization Plans. Harrisburg, PA: Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection. July 1998.

Ornelas D, Hogrefe RH, Dapson RW, Dapson JC. CE Update – Pollution Prevention. I: The role of chemical substitution in pollution prevention programs. *Lab Med*. 1998;29(5):287–290.

Ornelas D, Hogrefe RH, Dapson RW, Dapson JC. CE Update – Pollution Prevention. II: The laboratory's role in reducing hazardous waste. *Lab Med.* 1998;29(6):356–359.

Reinhardt PA, Ashbrook PC, Leonard KL. *Pollution Prevention and Waste Minimization in Laboratories.* Boca Raton, FL: CRC Press/Lewis Publishers; 1996.

Ring J, Osborne F, Shapiro J, Johnson R. Radioactive waste management at a large university and medical research complex. *Health Physics*. 1993;65(2):193-199.

Smith GD, Vetter RJ, Classic KL. *An evaluation of environmentally benign liquid scintillation cocktails*. Poster paper. Albuquerque, NM: Health Physics Society Annual Meeting; 1989.

Tellus Institute. Healthy Hospitals: Environmental Improvements Through Environmental Accounting. Available: http://www.tellus.org/risk/publications/Tellus%20hospital%20report.pdf

Warbritton AR, Mangravite JA. Solvent Recycling in the histology lab: a comparison of fractional distillation and flash evaporation techniques. *National Meeting of the National Society for Histotechnology*. Monterey, CA; September 1992.

Winterbourne DJ. Reutilizing 32P-labeled probes to reduce radioactive waste. *Anal Biochem*. 1994: 218, 233-235.

Chemical (Hazardous) Waste Management

Albuquerque, New Mexico, City of. Biomedical Laboratory Code of Practice. Introduction and Checklist. Albuquerque, NM: City of Albuquerque, Public Works Department of Wastewater Utility/Pollution Prevention Program; 1997.

Albuquerque, New Mexico, City of. Biomedical Laboratory Code of Practice. Reference Materials. Albuquerque, NM: City of Albuquerque, Public Works Department of Wastewater Utility/Pollution Prevention Program; 1997.

American Chemical Society. *Laboratory Waste Management: A Guidebook.* Task Force on Laboratory Waste Management. Washington, DC; 1994

Armour MA. *Hazardous Laboratory Chemicals Disposal Guide*. Boca Raton, FL: CRC Press; 1996.

Palo Alto, California, City of, Stanford University Medical Center Water and Wastewater Copper Evaluation. Available: http://www.city.palo-alto.ca.us/cleanbay/pdf/sumc.pdf; 1995.

Infectious Waste Management

American Neurological Association. Committee on Health Care Issues. Precautions in handling tissues, fluids, and other contaminated material from patients with documented or suspected Creutzfeldt-Jakob disease. *Ann Neurol*. 1986;19:75-77.

American Medical Association. Council on Scientific Affairs. Infectious medical wastes. *JAMA*. 1989; 262:1669-1671.

Association for the Advancement of Medical Instrumentation. *Good Hospital Practice: Steam Sterilization and Sterility Assurance*. Arlington, MD: AAMI. 1988:12-16.

Denys GA. Infectious waste management. In Lederberg J, ed. *Encyclopedia of Microbiology*. 2nd ed. Orlando. FL: Academic Press. 2000;(2):782-796.

Garcia R. Effective cost-reduction strategies in the management of regulated medical waste. *Am J Infect Control*. 1999;27(2):165–175.

Garner JS. Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. *Infection Control Hosp Epidemiol*. 1996;17:54-80.

Gordon JG, Denys GA. Infectious Wastes: Efficient and Effective Management. In Block SS, ed. *Disinfection, Sterilization, and Preservation.* 5th ed. Philadelphia: Lippincott Williams & Wilkins. 2001:1139-1157.

Gordon JG, Reinhardt PA, Denys GA, Alvarado CJ. Medical Waste Management. In Mayhall CG, ed. *Hospital Epidemiology and Infection Control.* 2nd ed. Chelsea, Michigan: Lippincott Williams & Wilkins; 1999.

Keene JH. Regulated medical waste handling and disposal. In Fleming DO, Hunt DL, eds. *Biological Safety Principals and Practices*. 3rd ed. Washington, DC: ASM Press; 2000.

Marsik FJ, Denys GA. Sterilization, decontamination and disinfection procedures for the microbiology laboratory. In Murray TR, et al., eds. *Manual of Clinical Microbiology*. 6th ed. Washington, DC: American Society for Microbiology. 1995:86-98.

Prusiner HB. Biosafety of prion diseases. In Fleming DO, Hunt DL, eds. *Biological Safety Principals and Practices*. 3rd ed. Washington, DC: ASM Press; 2000.

Rutala WA, Weber DJ. Uses of inorganic hypochlorite (bleach) in health-care facilities. *Clin Microbiol Rev*. 1997;(4):597-610.

Spurgin RA. Nonincineration treatment technologies. In Wagner KD, ed. *Environmental Management in Health Care Facilities.* Philadelphia: W.B. Saunders. 1998:28–39.

Taylor DM. Transmissible degenerative encephalopathies. In Russell AD, Hugo WB, Ayliffe GAJ, eds. *Principles and Practice of Disinfection, Preservation, and Sterilization*. London: Blackwell Science. 1998:222–236.

Taylor DM. Inactivation of prions by physical and chemical means. *J Hosp Infect*. 1999;43 (suppl):S69–S76.

Taylor DM. Inactivation of transmissible degenerative encephalopathy agents: a review. *Vet J*. 2000;159:10–17.

Vesley D, Laurer JL, Hawley RJ. Decontamination, sterilization, disinfection and antisepsis. In: Fleming DO, Hunt DL, eds. *Biological Safety Principals and Practices*. 3rd ed. Washington, DC: ASM Press; 2000.

Radioactive Waste Management

Falk-Marzillier J, Fitchmun M. Method to reduce the volatility of radioactive iodine waste. *Biotechniques*. 2000;28(1):130-131.

Hancock AA. A rapid, economical technique for removing radioactivity from receptor binding assay aqueous wastes. *Health Phys*. 1984;47(4):640-641.

Murphy PH, Anderton NS. Inexpensive, convenient xenon disposal. *Health Physics*. 1975;29(5):779-780.

Pacy PJ, Cheng KN, Thompson GN, Halliday D. Stable isotopes as tracers in clinical research. *Ann Nutr Metab*. 1989;33(2):65-78.

Party E, Gershey EL. Recommendations for radioactive waste reduction in biomedical/academic institutions. *Health Physics*. 1989;56(4):571-572.

Party E, Gershey EL. A review of some available radioactive and non-radioactive substitutes for use in biomedical research. *Health Physics*. 1995;69(1):1-5.

Ring J, Osborne F, Shapiro J, Johnson R. Radioactive waste management at a large university and medical research complex. *Health Physics*. 1993;65(2):193-199.

Smith GD, Vetter RJ. Low-Level radioactive waste management. In Wagner KD, ed. *Environmental Management in Health Care Facilities*. Philadelphia: W.B. Saunders. 1998:89-94.

Multihazardous Waste Management

Astill ME, Nuttall KL. Undisclosed radioactivity in specimens: how much of a problem? *Clin Chem*. 1997;43(6):1097.

Costello RG, Emery RJ, Pakala RB, Charlton MA. Radioactive waste minimization implications of clinically indicated exsanguination procedures. *Health Physics*. 2000;79(3):291-293.

International Technology Corporation. Treatment Methods and Waste Forms for Long-Term Storage and Ultimate Disposal of Radioactive Biological Materials. DOE/LLW-151. Idaho Falls, ID: National Low Level Management Program; 1992.

Kaye GI, Weber PB, Evans A, Venezia RA. Efficacy of alkaline hydrolysis as an alternative method for treatment and disposal of infectious animal waste. *Contemporary Topics*. 1998;37(3):43-46.

Linnis I, Klein RC, Gershey EL. Management of mixed wastes from biomedical research. *Health Physics*. 1991;61(3):421-426.

Methe BM. Managing radioactively contaminated infectious waste at a large biomedical facility. *Health Physics*. 1993;64(2):187-191.

Rau EH. Trends in management and minimization of biomedical mixed wastes at the National Institutes of Health. *Technology: J Franklin Inst.* 1997;334(A):397–419.

Stinston MC, Green BL, Marquardt CJ, Ducatman AM. Autoclave inactivation of infectious radioactive laboratory waste contained within a charcoal filtration system. *Health Physics*. 1991;61(1):137-142.

Vetter RJ. Incineration of biomedical low-level radioactive wastes. *Health Physics*. 1992;62(2):121.

Appendix. Annual Review of Waste Management Program

Checklist for annual review of the waste management program.

1. Are the scope, goals, and objectives of the waste management program clearly defined?

2. Must the facility's EPA classification as a hazardous waste generator be revised?

3. Has the local sanitary sewerage code been reviewed recently for applicability?

4. Is the disposal of chemicals and biological substances in compliance with the local sanitary sewerage code?

5. Has an annual survey of the hazardous chemicals used in the laboratory been completed? For each chemical:

   - Is the chemical specifically listed within current EPA code?

   - If not, does the discarded chemical have the general characteristics of a hazardous waste (i.e., is it ignitable, corrosive, reactive, or highly toxic)?

6. Does the laboratory's procedure manual and/or written chemical hygiene plan specify the method to be used for disposal of each hazardous chemical?

7. Are all infectious wastes that require decontamination properly treated before being discarded?

8. Are all sharps properly segregated and discarded in puncture-resistant containers?

9. Does the method for disposal of all radioactive waste comply with NRC regulations?

10. Are hazardous wastes consistently segregated from nonhazardous wastes at the point of generation?

11. Is the laboratory's hazardous waste safely packaged for transport? Are appropriate warning label placards applied consistently to the exterior of the packaging?

12. Are wastes properly stored before being discarded? Is the area sanitary and uncluttered? Are appropriate warning signs and emergency procedures posted? Are the waste handling records up to date and readily retrievable? (This includes records of waste inventories with accumulation dates, shipping, manifests, inspection records, and results of the waste analysis.)

13. Is there an active program for hazardous waste minimization?

14. Have the laboratories' contracts with carriers of hazardous waste been recently reviewed for evidence that the carrier has obtained the required permits from all relevant authorities?

15. Has each disposal facility provided the laboratory with a complete description of all disposal processes?

16. Is there a training program for all employees who generate or handle hazardous waste?

    - Is it provided for new employees, as well as in-services for current employees?

- Does it include the proper use of personal protective equipment and the details of safe work practices?

- For employees who use a chemical that meets the requirement of OSHA's Hazard Communication Standard and OSHA's Rule on Hazardous Substances in Laboratories, does the program specify the location of all written materials, including the location of the Material Safety Data Sheets and other pertinent references, as well as how employees may access them?

17. Have appropriate contingency plans for spills and other accidents been drawn up and implemented?

NCCLS consensus procedures include an appeals process that is described in detail in Section 9.0 of the Administrative Procedures. For further information contact the Executive Offices or visit our website at www.nccls.org.

Summary of Comments and Working Group Responses

GP5-A: *Clinical Laboratory Waste Management; Approved Guideline*

Section 2.1.2 (Current Section 9.3.2)

1. Determining and ensuring proper packaging and labeling for shipments of hazardous waste and/or regulated medical waste is not a practical responsibility for a bench technologist. This task must be the laboratory waste manager or emergency coordinator's responsibility.

- **We agree that packaging and labeling for shipment is not a practical responsibility for a bench technologist; this has been clarified. We have retained the point, however, that because bench technologists have the best knowledge of the waste that they generate, they must be responsible for segregating and labeling all waste that requires special handling in the laboratory.**

Section 2.2 (Current Section 2.1)

2. Change "infectious waste" category to "infectious/regulated medical waste."

- **We have added a definition for "regulated medical waste" and have made some clarifications to the text. However, we have retained our nomenclature, because the regulation of infectious and medical waste and legal terminology varies from state to state and law to law.**

Section 3.4.1 (Current Section 3.3.1)

3. The term "sanitary sewerage system" could be misleading; "local sewer system" would be more appropriate.

- **We have retained our nomenclature because it is standard, and because we wish to specifically refer to the sanitary sewer system, not a local storm, septic, or other wastewater system.**

Section 4

4. Accumulation of waste definition should include a reference to EPA- and state-required limitations on the time period waste is allowed to be stored.

- **"Accumulation" has been redefined as "satellite accumulation" to clarify EPA requirements. However, because laws change and definitions are complex, readers are referred to current regulatory definitions. Hazardous chemical waste satellite accumulation and storage limits are detailed in Section 8.2.3.**

5. The definition of "hazardous waste" is not the definition used by EPA/RCRA.

- **Because laws change and definitions are complex, readers are referred to current regulatory definitions. Hazardous chemical waste is described in detail in Section 8.1.1.**

Section 5

6. Separation of sharps into puncture-resistant, closable containers is required by OSHA. The document must therefore state medical waste regulations and that this practice must be considered mandatory, not prudent.

- **This section has been extensively revised. See Section 9.8 for appropriate containers for waste sharps.**

Section 5.1.2.3

7. Add information to this section stating that RCRA employee waste handling requires annual RCRA employee training.

- **This is mentioned in Sections 7.2 and 8.6.**

Section 5.1.2.4

8. Reference should be made to regulatory limitations on storage duration.

- **Hazardous chemical waste satellite accumulation and storage limits are detailed in Sections 8.2.2 and 8.2.3. Section 5.2.5 (of the revised document) now refers readers to that information.**

Section 5.5 (Current Section 5.6)

9. The point is made that laws place responsibility for compliance on managers who have knowledge of illegal practices; however; recent EPA case law also places responsibility on persons who were "in a position to know" as well. Managers who had no actual knowledge of illegal practices have been prosecuted due to their supervisory responsibilities.

- **As sufficiently pointed out in the guideline, this is indeed an area of concern.**

Section 6.1

10. Second paragraph: Infectious waste is NOT necessarily hazardous by EPA definition.

- **Revised Section 8.1.1 makes this clear.**

Section 6.2.3

11. "Management has the responsibility to ensure that its employees comply with safety directions" regardless of the "degree of hazard."

- **We have incorporated this suggested change in Section 2.3.2. Thank you.**

Section 6.2.4

12. Using a hazardous waste label is required, as well as properly identifying the waste on the label (e.g., "waste xylene") at the satellite or main accumulation point.

- **This suggestion has been included in Section 8.2.3.**

13. The point should also be made that Department of Transportation regulations (effective in October 1993) require all employees involved in the transportation of hazardous materials to be trained as required by 49 CFR 173 "Training for Safe Transportation of Hazardous Materials."

- **This has been referred to in Section 7.1.**

Section 6.4.1

14. All identification numbers are required to properly complete a manifest, and a manifest is required of small-quantity generators by EPA. Consequently, waste should not be offered for transport by a generator without obtaining an identification number.

- **EPA law does allow conditionally exempt small-quantity generators to ship hazardous waste without a manifest or ID number. However, we agree that an ID number is a good idea, and this has been added to Section 8.3.**

Section 6.4.3

15. Update the description of marking requirements to reflect DOT HM181, which requires more specific identification of a waste's hazardous constituents.

- **DOT requirements are important, and we have augmented Sections 5.2.6, 7, and 8.3 to make laboratories aware of these stringent rules. Specific marking and identification requirements are complex and changing, so we refer readers to the applicable DOT rules.**

Section 6.7.1

16. Cleanup of hazardous chemical waste must be performed only by laboratory staff trained per OSHA 1910.120.

- **The OSHA 1910.120 (HAZWOPER) training requirement is explained in Sections 7.1 and 7.4. Section 7.4 explains that the definition of "emergency response" in OSHA 1910.120(a)(3) considers responses by "employees in the immediate release area" to be outside the rule's scope and therefore would not require HAZWOPER training.**

Section 6.7.4

17. Reference to Section 10.2.3 does not apply to OSHA training standards.

- **Section 7 has been revised to clarify these specific OSHA training requirements.**

Section 7.2

18. The number of infectious particles per unit volume, i.e., inoculum, should be included. If one ignores the number of infectious particles present or required to infect, one reinforces the misconception that sterilization rather than decontamination must be practiced when handling infectious waste.

- **Infectiousness cannot be reliably measured, even by infectious particles per unit volume. This is why infectious waste is defined by type in Section 9.1. The effectiveness of different treatments is discussed in Section 9.6.3.**

Section 7.4

19. Paragraph three instructs the employee to wear puncture-resistant gloves to handle infectious waste that contains sharps, in direct contrast with OSHA regulations, which require the use of tongs or other mechanical means. (Refer to 29 CFR 1910.1030, Section (d) (4) (ii) (D).)

- **This sentence has been clarified in Section 9.3. It refers to handling *containers of* infectious waste that contains sharps. This point has been added to Section 9.8.**

Section 7.4.1 (Current Section 9.3.1)

20. Is autoclaving all "infectious waste" generated in a microbiology laboratory to be a CAP requirement regardless of a facility's handling and packaging procedures and its final disposal process?

- **CAP does not require autoclaving of all contaminated waste. Autoclaving requirements depend on the waste type. Please note that CAP requirements are independent of this NCCLS guideline.**

Section 7.4.2 (Current Section 9.8)

21. Transporters of regulated medical waste offer reusable, hard plastic containers that provide waste handler protection for superior to corrugated boxes. These containers should be considered in areas where "sharps" are used in large numbers.

- **The alternative of reusable sharps collection containers has been added to Section 9.8. Note that corrugated boxes do not meet the OSHA requirement that sharps containers be puncture resistant.**

22. When disposing of phlebotomy "winged" needles and associated tubing, one-way flap or double-door entrance sharps containers are a hazard. A sharps container with an entrance that offers no resistance to the "lightweight" tubing is a must, or the waste generator will be inclined to push/force the tubing and needle into the sharps container.

- **We agree that sharps containers differ in their suitability. Many designs are available. Choose the design most appropriate for the type of waste. This has been added to Section 9.8.**

Section 7.4.3 (Current Section 9.3.2)

23. A specific instruction to remove or cover the biohazard symbol after properly treating the waste would be useful.

- **This has been added to Section 9.3.2.**

24. This section instructs that sharps containers must be labeled with the "Biohazard" warning label; however, Section 9.3.4 correctly notes that the color red is an indicator in infectious waste and may be substituted for the labels.

- **Section 9.8.3 now states that for sharps collection containers, the color red may be substituted for a label.**

Section 7.4.4

25. Recommended packaging must meet the requirements set forth in OSHA's Bloodborne Pathogen Standard, 1910.1030 d.4.iii.(A) and (B).

- **This reference has been added to Section 9.8.3.**

Section 7.5.1

26. Is there a minimum steam pressure in addition to temperature, duration, etc. for proper autoclaving?

- **Recommendations for autoclaving infectious waste are in Section 9.6.2.2.**

27. This section would be improved by the addition of a caution to assure that autoclaves (as well as dry heat treatment devices) be vented to the outside. Heating various plastics produces hazardous fumes, which may include volatilized plasticizers, etc.

- **This important point has been added to Section 9.6.2.2.**

Section 7.7 (Current Section 9.5)

28. Carts or containers used to transport waste must be closable.

- **This section (now Section 9.5) has been revised to clarify that it pertains only to movement of waste *within* the facility, where safe, unclosed carts are acceptable.**

Section 7.8.1 (Current Section 9.6)

29. A primary off-site disposal option is autoclaving/shredding/landfilling; this option deserves mention in this guideline.

- **This section (now Section 9.6) has been thoroughly revised and updated.**

Section 7.10.1

30. This section fails to reference OSHA requirements for handling worker injuries, per 29 CFR 1910.1030, Section (f) (3), "Post-exposure Evaluation and Follow-up."

- **This reference has been added to Section 9.9.2.**

Section 8.4 - Table 5

31. Table 5 recommends disposal methods for various medical radioactive wastes. I suggest that "charcoal trap" be listed as the preferred disposal method for Xenon-133. "Decay in hood" should be Option 1, and release into the atmosphere should be moved down to Option 2.

    The capture of Xenon-133 is easily accomplished and is more in compliance with the radiation safety philosophy of "As Low As Reasonably Achievable" (ALARA). Eliminating medical radioactive gaseous waste from the atmosphere is a way to reduce radiation exposure to the environment. Charcoal trapping is efficient and not very costly, because the traps last a long time and can be stored for decay and reuse.

- **Table 8 has been revised to incorporate the suggestion. Thank you.**

Section 9.3.1 (Current Section 9.8.2)

32. There is a statement referring to "leak-resistant container." We wondered if you meant "puncture-resistant container" since a leak-resistant container cannot be properly autoclaved.

- **We agree that autoclaving sharps containers can be problematic. However, OSHA regulations require that all sharps be placed in rigid, leak-resistant, puncture-resistant containers. Manufacturers and the literature can help the user select models of such containers that are also autoclavable.**

Section 10.2.1

33. The suggestion is made that generation of solid waste can be reduced by switching from disposable to durable goods. Although this appears to be true on the surface, a careful analysis should be performed to assure that the activities required to clean and disinfect the reusable good does not actually produce increased waste for disposal.

- **Section 6.2 now includes "impact of cleaning" as a decision factor for considering reuse of durable goods.**

Related NCCLS Publications*

GP17-A **Clinical Laboratory Safety; Approved Guideline (1996).** This document contains general guidelines for implementing a high-quality laboratory safety program. The framework is adaptable to any laboratory.

M29-A2 **Protection of Laboratory Workers from Occupationally Acquired Infections; Approved Guideline—Second Edition (2001).** Based on U.S. regulations, this document provides guidance on the risk of transmission of hepatitis viruses and human immunodeficiency viruses in any laboratory setting; specific precautions for preventing the laboratory transmission of blood-borne infection from laboratory instruments and materials; and recommendations for the management of blood-borne exposure.

NRSCL8-A **Terminology and Definitions for Use in NCCLS Documents; Approved Standard (1998).** This document provides standard definitions for use in NCCLS standards and guidelines, and for submitting candidate reference methods and materials to the National Reference System for the Clinical laboratory (NRSCL).

* Proposed- and tentative-level documents are being advanced through the NCCLS consensus process; therefore, readers should refer to the most recent editions.

NOTES

NCCLS ▼ 940 West Valley Road ▼ Suite 1400 ▼ Wayne, PA 19087 ▼ USA ▼ PHONE 610.688.0100
FAX 610.688.0700 ▼ E-MAIL: exoffice@nccls.org ▼ WEBSITE: www.nccls.org ▼ ISBN 1-56238-457-0