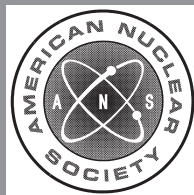


American Nuclear Society

**mobile low-level radioactive
waste processing systems**

an American National Standard



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**American National Standard
Mobile Low-Level Radioactive
Waste Processing Systems**

Secretariat
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Prepared by the
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Foreword

(This Foreword is not a part of American National Standard “Mobile Low-Level Radioactive Waste Processing Systems,” ANSI/ANS-40.37-2009.)

A key aspect for the further development of nuclear technology is the effective management of low-level radioactive wastes (LLWs) generated during the facility operation. Fundamental to the effective management of radioactive wastes is the design, construction, and operation of radioactive waste processing systems. This standard was originally issued in 1993 in response to interest in the use of mobile radioactive waste processing systems that could be transported from facility to facility, retained in service at a facility for an extended period of time or quickly replaced by alternate treatment technology. In 2001, the U.S. Nuclear Regulatory Commission (NRC) cited this standard for mobile treatment systems in Rev. 2 of Regulatory Guide 1.143 (RG 1.143). The NRC also granted design relief in Rev. 2 of RG 1.143 when it allowed Power Piping (ANSI/ASME B31.1) versus Process Piping (ANSI/ASME B31.3) to be used for radioactive waste systems.

Unfortunately, this standard failed to be reaffirmed in 2003. This standard is being reissued to incorporate the design relief granted by the NRC in 2001 and to service continued operation at nuclear facilities and new nuclear facility construction.

It is the purpose of this standard to provide requirements for the design and operation of the mobile low-level radioactive waste processing (MRWP) system. It is the intent of this standard to identify a basis for establishing uniform practices and minimum requirements for the design, fabrication, and operation of MRWP systems as applied to nuclear facility operations (e.g., power plants, institutions, and laboratories that generate wastes approved for disposal at 10 CFR 61 LLW disposal sites). This standard’s scope does not address systems used to process waste from nuclear facilities that potentially contain fissile material in sufficient quantities to require controls to avoid criticality; i.e., ANSI/ANS-40.37-2009 requirements do not address wastes containing quantities of fissile or long-lived radionuclides that are classified as high-level or transuranic radioactive waste atypical of NRC-licensed commercial facilities and beyond the scope of 10 CFR 61. Systems applicable to non-low-level waste that use this standard might have to meet additional requirements beyond the scope of this standard. This standard addresses the technical practices and requirements necessary for radioactive waste processing operations while maintaining consideration for reducing radiation exposures to the environment, the public, and facility operating personnel.

This standard might reference documents and other standards that have been superseded or withdrawn at the time the standard is applied. A statement has been included in the references section that provides guidance on the use of references.

This standard does not incorporate the concepts of generating risk-informed insights, performance-based requirements, or a graded approach to quality assurance. The user is advised that one or more of these techniques could enhance the application of this standard.

This standard was prepared by Working Group ANS-40.37 of the Standards Committee of the American Nuclear Society, whose membership at the time of the standard’s approval was as follows:

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Mobile Low-Level Radioactive Waste Processing System

1 Scope

This standard sets forth design, fabrication, and performance recommendations and requirements for mobile low-level radioactive waste processing (MRWP) systems (including components) for nuclear facilities that generate low-level radioactive wastes (LLWs) as defined by the Atomic Energy Act as amended [1].¹⁾ The purpose of this standard is to provide guidance to ensure that the MRWP systems are designed, fabricated, installed, and operated in a manner commensurate with the need to protect the health and safety of the public and plant personnel.

For the purpose of this standard, a nuclear facility MRWP system begins at the interface with a permanent plant system or waste collection area, or both; it terminates at the interface where processed waste or secondary waste, or both, is either returned to the facility or removed from the facility, or both.²⁾

This standard refers throughout to vendors, system users, facility operators, and owners; however, these references are not intended to assign specific responsibilities of these parties for compliance with the requirements of this standard. These references are for convenience and are based on typical responsibilities of these parties. It is recognized that the facility owner or operating license holder, or both, is ultimately responsible for compliance with these requirements. The body of this standard identifies both requirements and recommendations/guidelines for systems.³⁾

2 Definitions

2.1 Limitations

The definitions that follow are of a restrictive nature for the purpose of this standard.

2.2 Glossary of terms

compactible solid waste: Solid waste that can be compressed by applying external pressure less than 1000 psi.

dry, combustible solid waste: Solid waste, including materials that contain incidental amounts of drainable liquids, that can be easily oxidized by conventional incineration techniques.

dry, noncombustible solid waste: Solid waste that cannot be easily oxidized by conventional incineration techniques.

gaseous waste: The waste streams of noncondensable fluids that are radioactively contaminated with gases, condensable vapors, entrained liquids, or particles.

interface requirements: Requirements pertaining to all the connections facilitating all mass and energy flow to and from an MRWP system. Also included are health, safety, and chemistry support requirements.

liquid radioactive waste: Aqueous wastes and/or other fluids containing radioactive materials that result from the operation of a nuclear facility. Radioactive contaminated water is the predominant volumetric waste form generated by nuclear facilities, but liquid radioactive waste can include other liquids or be

¹⁾ Numbers in brackets refer to corresponding numbers in Sec. 14, "References."

²⁾ Standards concerning permanent systems for processing radioactive waste are identified in Appendix A and are specifically referenced in this standard where applicable.

³⁾ Appendix B provides guidelines that are intended to be helpful to users who are designing and evaluating MRWP systems, interfacing MRWP systems for application at a facility, and designing facilities to interface with MRWP systems.

aqueous solutions containing a combination of chemical species.

low-level radioactive waste (LLW): Radioactive waste that is not classified as either high-level radioactive waste, transuranic waste, spent nuclear fuel, or by-product material (uranium or thorium tailings and waste) as defined in Section IIe (2) of the Atomic Energy Act of 1954, as amended [1] and not greater than class C concentration limits as defined under 10 CFR 61 [2].

mixed waste: Low-level radioactive waste that is co-contaminated with hazardous waste as defined in 40 CFR 261 [3], 40 CFR 262 [4], and 40 CFR 268 [5].

mobile low-level radioactive waste processing (MRWP) system: Any radioactive waste processing system or component that is designed to be transportable and that is not considered permanently installed as used in Regulatory Guide 1.143 (RG 1.143), “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants,” Rev. 2 [6].

noncompactible solid waste: Solid waste that cannot be compressed by applying external pressure less than 1000 psi. (The 1000 psi value is based on current technology.)

nuclear facility: Any facility that, as a result of its operation, generates waste material containing or potentially containing radioactive materials. This includes, but is not limited to, nuclear power plants, hospitals, fuel fabrication facilities, fuel reprocessing facilities, radioactive waste disposal facilities, industrial facilities, and research facilities.

oily radioactive waste: Liquid and slurry wastes that contain more than 5% oil, grease, and other immiscible organic liquids⁴⁾ by weight and radioactive materials resulting from the operation of a nuclear facility.

process control program: A systematic procedure for providing reasonable assurance that the final waste form is in accordance with disposal facility acceptance criteria.

radioactive materials: Radioactive fission products, activation products, and concentrated naturally occurring radioactive substances.

raw wastes: Waste as received by an MRWP system.

safe operation, safety: Actions and activities that pose no immediate hazard to the public or facility personnel. This specifically excludes “safety related” as detailed in 10 CFR 50 [8].

secondary waste: Waste generated as a by-product from operation of the MRWP, or separated from the raw waste, which must be handled, processed, and disposed of in accordance with local and federal regulations (e.g., concentrates, wet waste, dry active waste, and toxic chemicals).

shall, should, may: The word “shall” is used to denote a requirement; the word “should” is used to denote a recommendation; and the word “may” is used to denote permission, neither a requirement nor a recommendation.

slurry waste: Liquid radioactive waste of high insoluble-solids content (greater than 0.1% solids by weight). For example, bead resin is transferred with a high enough water-to-resin ratio and linear velocity to keep the resin suspended creating a slurry stream.

solid radioactive waste: Wastes in a physically solid form containing radioactive materials that result from the operation of a nuclear facility. Solid wastes can be radioactive due to neutron activation or surface contamination, or both.

temporary: A system, subsystem, or component whose design, construction, or intent is not of a permanent nature with respect to facility license design.

ultimate disposal: Placement of radioactive waste in a disposal facility with no intention of removing the waste, e.g., disposal at a shallow land burial facility licensed in accordance with 10 CFR 61 [2].

wet waste: Waste media containing appreciable amounts (greater than 1 vol %) of free liquid, for example, spent bead or powdered resin, filter sludge, and cartridge filters.

⁴⁾ For guidance, see EPA Procedure SW-846 [7].

3 Objectives

This standard establishes minimum requirements for the design, fabrication, installation for use, and operation of MRWP systems to achieve the performance, safety, and operational objectives specified in this section.

3.1 Performance objectives

The MRWP system shall be designed, constructed, and operated in accordance with the requirements of this standard, but not necessarily with its recommendations. The mobile systems used for processing radioactive waste shall be designed and fabricated such that they are capable of being operated in a manner that complies with the requirements in this section.

The MRWP systems shall be designed to

- (1) receive raw wastes;
- (2) condition and process such wastes;
- (3) handle and contain any secondary wastes for appropriate disposition.

Waste packaged for disposal shall be acceptable for ultimate disposal. Acceptability for ultimate disposal may be demonstrated through the use of a Process Control Program.

The basic system design objectives shall be to

- (1) minimize the overall packaged waste product volume that results from the system's operation;
- (2) minimize the quantity of secondary waste generated by the system;
- (3) provide for ease of system installation, maintenance, decontamination, and demobilization;
- (4) provide for reliable, safe, and flexible system operation while maintaining radiation exposure to operating personnel and the public via radioactive effluents "as low as is reasonably achievable" (ALARA).⁵⁾

3.2 Safety objectives

The MRWP system shall be designed, fabricated, installed, and operated so that the conse-

quences of a single active component failure or operator error will not result in an uncontrolled release of radioactive materials to the environment. For radioactive waste systems, the U.S. Nuclear Regulatory Commission (NRC) has determined that the allowable consequences of operation shall result in a discharge of liquid material off-site with a concentration less than those in 10 CFR 20 [10] and a discharge of liquid and gaseous material off-site having a dose that meets the limits of 10 CFR 20.1301 [11].

3.3 Operating objectives

The MRWP system shall be designed, fabricated, and installed such that it can be satisfactorily operated by qualified personnel.

3.4 Regulations and guidelines

MRWP systems used at a nuclear facility shall be designed, fabricated, and operated in a manner to meet the applicable requirements of the following⁶⁾:

- (1) *Code of Federal Regulations*, Title 10, "Energy," Part 50, "Domestic Licensing of Production and Utilization Facilities" [12];
- (2) *Code of Federal Regulations*, Title 10, "Energy," Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material" [13];
- (3) *Code of Federal Regulations*, Title 10, "Energy," Part 40, "Domestic Licensing of Source Material" [14];
- (4) *Code of Federal Regulations*, Title 10, "Energy," Part 70, "Domestic Licensing of Special Nuclear Material" [15];
- (5) *Code of Federal Regulations*, Title 10, "Energy," Part 20, "Standards for Protection Against Radiation" [10];
- (6) *Code of Federal Regulations*, Title 49, "Transportation," Part 171, "General Information, Regulations, and Definitions," and Part 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information,

⁵⁾ For additional guidance, see Regulatory Guide 8.8 (RG 8.8), Rev. 3 (1978) [9].

⁶⁾ For additional guidance, see "Additional Guidance Documents" at the end of Sec. 14.

Training Requirements, and Security Plans” [16]; *Code of Federal Regulations*, Title 49, “Transportation,” Part 173, “Shippers—General Requirements for Shipments and Packagings” [17];

(7) *Code of Federal Regulations*, Title 10, “Energy,” Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste” [2];

(8) *Code of Federal Regulations*, Title 10, “Energy,” Part 74, “Material Control and Accounting of Special Nuclear Material” [18];

(9) *Code of Federal Regulations*, Title 40, “Protection of Environment,” Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations” [19];

(10) *Code of Federal Regulations*, Title 10, “Energy,” Part 830, “Nuclear Safety Management” [20] (for U.S. Department of Energy facilities).

The MRWP systems shall meet other federal and state regulations as applicable.

4 Identification of waste sources

This section identifies the potential sources of LLW that may be considered for treatment by MRWP systems in accordance with the specifications of this standard.

4.1 Waste generators

There are three primary generators of LLW addressed in defining waste streams in this standard:

- (1) government agencies;
- (2) commercial nuclear fuel cycle operations;
- (3) commercial non-fuel-cycle operations.

4.1.1 Waste Source Restrictions

Where the design of the MRWP precludes its use for specific waste sources, the waste source restrictions and limitation shall be identified.

4.2 Physical, chemical, and radiological characteristics

The physical forms of LLW are generally categorized as

- (1) gaseous;
- (2) liquid;

- (3) oily;
- (4) slurry;
- (5) wet solids;
- (6) dry, combustible, compactable solids;
- (7) dry, noncombustible, compactable solids;
- (8) dry, combustible, noncompactible solids;
- (9) dry, noncombustible, noncompactible solids;
- (10) contaminated soils;
- (11) activated hardware.

The chemical characteristics of LLW vary widely. Nuclear power plant wastes frequently include aqueous solutions containing materials such as boric acid and sodium sulfate in moderate concentrations. Decontamination solutions, as generated at both government and commercial facilities, could contain detergents, chelating agents, weak acids, and oxidizing or reducing chemicals. Other wastes might contain chromates, phosphates, chlorides, nitrates, nitrites, and other chemicals. Non-fuel-cycle-operation wastes include a wide range of organic materials such as animal tissues, scintillation fluids, and various chemicals used in medical diagnostic and therapeutic procedures. Note that some of these wastes can be hazardous and will result in mixed waste.

Radiological characteristics of LLW streams vary, primarily depending on their point of origin. Radioactive material in fuel fabrication LLW is primarily uranium and its daughters. The radioactive materials in nuclear power plant LLW are primarily fission products and activation products with traces of transuranics. This guide is not applicable to systems, components, or equipment utilized to process radioactive wastes that potentially contain sufficient fissile materials to require controls to prevent criticality events (e.g., systems designed to routinely process wastes containing quantities of fissile or long-lived radionuclides that would generate high-level or transuranic radioactive waste). LLW generated during operation at facilities other than fuel reprocessing facilities is generally lower in specific activity than waste generated by the nuclear fuel reprocessing facilities and usually contains well-identified radionuclides.

4.3 Liquid, oily, slurry, and wet waste products

Liquid LLW varies widely in chemical and radioactive content. Liquid wastes commonly generated at many nuclear facilities derive from the control and removal of radioactive contamination, e.g., laundry and decontamination solutions. Other wastes are by-products specific to certain operations, e.g., scrubber solutions from gaseous effluent cleanup processes. Nuclear facilities also generate wet wastes such as filter sludge and process media, e.g., resins, carbon, filter elements and membranes, and evaporator concentrates. Oily radioactive wastes include radioactively contaminated aqueous solutions with some quantity of lubricant introduced during equipment operation or maintenance as well as spent lubricants from equipment operating in a contaminated environment or containing contaminated process streams. Wastes from non-fuel-cycle operations include animal carcasses, radiopharmaceuticals, and scintillation fluids.

4.4 Dry solid waste products

Dry solids are either combustible or noncombustible and compactable or noncompactible. They can be further classified by the ease of decontamination. The applicable classifications depend primarily upon the waste treatment processes being used.

If wastes are sorted and decontaminated for disposal, ease of decontamination is important; if waste is to be incinerated, the combustibility and the combustion products are important; and if the waste is being compacted, compactibility is important. Combustible wastes typically include cloth, paper, plastic, rubber, wood, etc.; noncombustible wastes typically include concrete, metal, glass, insulation, etc.; compactible wastes typically include cloth, paper, plastic, rubber, glassware, etc; and noncompactible wastes typically include concrete, wood, metal, insulation, etc. In general, easily decontaminated wastes have non-adsorptive, smooth, hard surfaces without crevices, cracks, corners, and other crud traps. An exception to the general statement is wood that can be decontaminated by planing. In practice, solid waste usually contains a mixture of combustible and noncombustible items, so pretreatment, sorting, or segregation can be required prior to processing wastes in some systems. They can include various types of

soil (including rocks and gravel) that are radioactively contaminated. Contaminated soil and rock (in addition to metals) are generally non-compactible but can be treated by vitrification processes. Activated components can take a wide variety of forms.

4.5 Gaseous waste products

Radioactive gaseous wastes are generally of two forms: (a) radionuclides from fission products or neutron activation, e.g., noble gases and iodine, and (b) airborne radionuclides, e.g., airborne particulate. The noble gases are chemically inert but have relatively short half-lives and are therefore typically processed by transfer to a monitored hold-up or release system for radioactive decay. Particulate is filtered using mechanical filtration, and iodine is concentrated using adsorptive carbon beds where the iodine is held for decay. Most facilities that generate these waste forms are designed with collection and storage to isolate them from the airborne effluents from the facility and thereby minimize their environmental impact. If a process methodology for other waste forms generates airborne or gaseous wastes, they may be routed to the installed facility gaseous waste system if applicable. If an MRWP system must process airborne or gaseous wastes, the design shall meet the applicable requirements of Sec. 5.3.15 to address the unique containment, monitoring, and transport characteristics of gases including temperature, pressure, and diffusion.

5 System and process design requirements

5.1 General

MRWP systems are frequently designed and fabricated by vendors who provide the systems to nuclear facilities on a service basis. Thus, the MRWP system is generally not designed specifically for use at a particular nuclear facility. Under such circumstances, the vendor shall comply with all design requirements, site license basis, local, State, and Federal requirements applicable to MRWP systems, and the facility operator has the responsibility for ensuring that the MRWP system to be used is suitable for meeting the facility performance and safety objectives.

5.1.1 Radiation exposure (ALARA)

The MRWP system shall be designed to minimize radiation exposure to personnel and the public in accordance with the objectives of the facility's personnel and site boundary dose limits. For example, the system should have the capability to remotely transfer higher-activity wastes by selective routing through the MRWP system or appropriate use of temporary shielding.

5.1.2 Contamination control

Potential sources of contamination shall be eliminated where feasible. Provisions for controlling the spread of radioactive material shall be included. When equipment or process transfer equipment (hoses) are used out of doors, in class I or II zones (Table 1), or in areas that are normally considered general access areas, particular attention regarding contamination control shall be paid to mobile equipment so that the consequences of a component failure, equipment failure, personnel error, or a combination of the above shall not spread contamination away from the equipment.

5.1.3 Safety considerations

The process and system design shall address the chemical and radioactive natures of the waste streams to ensure facility personnel and adjacent equipment safety during normal operation and off-normal events.

Instrumentation shall be provided for continuous monitoring of radiation fields and airborne contamination levels of all normally occupied areas associated with the MRWP system in a temporary installation where radiation fields and airborne contaminated exposure could rise beyond permissible limits defined in licensing documents or facility procedures. The scope of instrumentation and area monitoring provided by the MRWP design will depend on the location and capabilities provided by existing facility design. See Sec. 5.4.4 for additional detail. All other normally occupied areas shall be monitored for radiation fields and airborne contamination levels by nuclear facility instrumentation in accordance with the nuclear facility procedures.

The process and system design shall provide for safe operation, and in the case of system malfunction, the system shall fail to a safe con-

Table 1 – Typical radiation zone classification*

Zone	Maximum radiation dose rate (mrem/h)
I	<0.25
II	<2.5
III	<15
IV	<100
V	≤1000

* Basis: NRC Standard Review Plan NUREG-0800 (SRP NUREG 0800), Rev. 3, March 2007, Sec. 12.3 - 12.4, "Radiation Protection Design Features" [21].

NOTE

In Chapter 12, Sec. 12.3 - 12.4 of SRP NUREG 0800 [21], areas within the restricted area are to be divided into radiation zones. The dose rate criterion for each of these zones is derived from expected occupancy and access restrictions (e.g., zone I = 0.25 mrem/hour is based upon a 50 week/year, 40 hours/week worker staying below an annual dose of 0.5 rem (10 CFR 20.1301(c) [11])). These criteria are then used as the basis for the radiation shielding design. This allows for arrangements of radioactive equipment that are in accordance with the requirements of 10 CFR 20 [10] and the guidelines of RG 8.8 [9]. The plant design and layout facilitate the control of access to and work within plant areas in accordance with the requirements of 10 CFR 20.1601 [22], 10 CFR 20.1602 [23], 10 CFR 20.1901 [24], 10 CFR 20.1902 [25], and 10 CFR 20.1903 [26] and access control alternatives in the standard technical specifications (NUREG-1430 [27], NUREG-1431 [28], NUREG-1432 [29], NUREG-1433 [30], and NUREG-1434 [31]) and are acceptable.

MRWP systems and/or equipment designed for use at a specific facility should utilize the design-basis documents for that facility to determine the proper implementation of the above guidance. Table 1 is provided as an example of generic radiation zone classification but may be modified to align with applicable design-basis documents at a specific site.

dition such that it will not result in a hazard to facility operators, adjacent equipment, or the public.

The process and system design and operation shall comply with applicable Occupational Safety and Health Administration (OSHA) requirements. It is the responsibility of the facility operator to identify the applicable OSHA requirements.

The areas where combustible or flammable materials, or both, are used or stored shall have provisions for fire protection in accordance with American National Standard “Standard for Fire Protection for Facilities Handling Radioactive Materials,” ANSI/NFPA 801-2003 [32].

5.1.4 Waste segregation

Provisions to segregate potentially contaminated process or waste streams and noncontaminated process streams shall be made.

To minimize the volume of the higher-activity waste, waste streams with significantly different levels of contamination should not be mixed.

Provisions shall be made to assure that only wastes that can be satisfactorily processed by the system being used are fed into it. This should include the segregation of the various waste streams that require different process designs, e.g., wet wastes, solid wastes, and liquid wastes. These provisions may be included as part of the Process Control Program.

5.2 Process design requirements

5.2.1 General

It is recognized that there are numerous types of MRWP systems with varying system configurations. Selection of processes is an engineering and economic decision that should be based upon consideration of the waste type, generation rate, and facility strategy and process goals. Various process combinations are possible, and specifications for “standard systems” are not presented in this section. There are generic process requirements, however, that MRWP systems shall meet. The systems and components shall be designed to accommodate the specified waste streams at the specified waste generation and/or transfer rates.

5.2.2 Physical and chemical pretreatment

Physical and chemical pretreatment provisions for physical and chemical conditioning of the

waste shall be included where required by the process. The extent and nature of the physical and chemical conditioning will depend upon the process and the nature of the waste being processed. Physical and chemical conditioning should assure that the process will work satisfactorily; optimize the waste form, volume, mass, and costs of waste dispositioned; and ensure that operational radiation exposure and release of radioactive material to the environment are ALARA.

5.2.3 Sampling and instrumentation

Sampling provisions and instrumentation shall be included in the MRWP system design to take representative samples of the process streams and to ensure proper and safe operation of the system such that process control parameters are maintained within specifications. Table 2 lists sampling and monitoring recommendations. Measurement and test instrumentation shall meet applicable standards in Sec. 14 and Appendix A, e.g., be traceable to National Institute of Standards and Technology (NIST) standards where applicable.

5.2.4 Secondary wastes and final product

Secondary waste from an MRWP system can be (a) returned to the plant for further processing, reuse, discharge, or storage or (b) released or discharged directly to the environment based on facility requirements.

The final product from the nuclear facility shall meet NRC, U.S. Department of Transportation (DOT), disposal facility, and other applicable requirements if the final product is to be shipped to a licensed LLW disposal site. The waste may be released or discharged to the environment as nonradioactive materials or, for radioactive wastes, in accordance with the limits in 10 CFR 20 [10] following the facility monitoring requirements.

Any portion of the raw waste or secondary waste returned to the plant shall be consistent with facility requirements for such waste.

5.2.5 Dust control

Provisions to prevent dust from spreading as a result of the operation of MRWP systems shall

Table 2 – Sampling and monitoring recommendations

	Process monitoring	Process control program	ALARA	National pollutant discharge elimination system permit	Return to plant
Raw wastes		X	X	X	
Conditioning secondary wastes				X (if discharged)	X
Conditioned waste	X	X			
Process secondary wastes				X (if discharged)	X
Final product	X	As required for verification	X		
Typical parameters					
1. Organic and inorganic constituents 2. Physical characteristics (slurry, aggregate, solid) 3. Flow rate 4. Mass/weight data 5. Pressure 6. Temperature 7. Radionuclide distribution 8. Dose rates 9. Voltage			10. Amperage 11. Revolutions per minute 12. Density 13. Viscosity 14. Total dissolved solids 15. Conductivity 16. Entrained particulate 17. Valve positions 18. Level		

be included in the design of systems that generate dry, powdery, or dusty materials (e.g., solidification systems using cement, dryers, incinerators, etc.).

5.2.6 Hazardous gaseous waste

Provisions shall be made to prevent the spread of hazardous chemical gaseous waste (e.g., trimethylamine).

5.3 System design requirements

5.3.1 General

Physical, chemical, and radiological conditions associated with the process shall be addressed in the design.

5.3.2 Materials of construction

Materials of construction for system equipment should be selected carefully to ensure critical factors are addressed such as strength to

withstand abnormal system operating conditions, corrosion resistance, fire resistance, long operating life to avoid frequent replacement of contaminated components, and smooth surface finish to aid in cleaning and decontamination.

5.3.3 Code requirements

As a minimum, equipment for radioactive service shall be designed, inspected, fabricated, and tested in accordance with the requirements of the applicable codes and standards listed in Table 3.

5.3.4 Seismic design requirements

MRWP systems are not required to be designed to withstand the effects of a seismic event.

The MRWP equipment shall be designed and/or located to ensure the structures housing the MRWP equipment shall be designed to contain the fluid inventory of the MRWP equipment in