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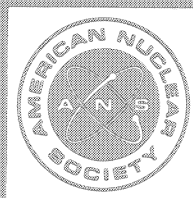
liquid radioactive waste processing system for light water reactor plants



an American National Standard

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**American National Standard
for Liquid Radioactive Waste Processing
System for Light Water Reactor Plants**

Secretariat
American Nuclear Society

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American National Standard

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Foreword

(This foreword is not a part of American National Standard for Liquid Radioactive Waste Processing System for Light Water Reactor Plants, ANSI/ANS-55.6-1993, but is included for information purposes only.)

Management of the liquid radioactive waste generated as a by-product of nuclear power plant operation constitutes a major responsibility of management. Quantities of liquid radioactive waste generated during operation are dependent upon several factors, including design conditions, type of equipment, equipment arrangement, and operating philosophy.

The purpose of this standard is to establish uniform practices and set forth minimum requirements for design, construction, and performance, with due consideration for operation, for acceptable liquid radioactive waste handling and processing systems. Adherence by system designers to the criteria contained in the standard will enable the operator: (a) to control to within regulatory levels radiation exposures to operating personnel; (b) to assure a low probability of accidental release of radioactivity from the system; and (c) to control system releases of radioactivity to levels as low as reasonably achievable.

In accordance with ANS policy to maintain standards on a five-year basis, the standard was revised to update its contents and to reflect changes in industry practices. Members of Working Group 55.6, and their affiliations at the time of their approval of this standard, were as follows:

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Liquid Radioactive Waste Processing System for Light Water Reactor Plants

1. Scope and System Description

1.1 Scope. This standard sets forth minimum design, construction, and performance requirements, with due consideration for operation, of the Liquid Radioactive Waste Processing System (LRWPS) for light water reactor (LWR) plants for design basis inputs. It is applicable to routine operation, including design basis fuel leakage and other design basis occurrences.

1.2 System Description. For the purpose of this standard, the LRWPS begins at the interfaces with the reactor coolant system pressure boundary, at the points of discharge for lines from other systems or at the discharge from the building sumps that are provided for the collection of liquid waste that has the potential of containing radioactive material. The system excludes drywell sumps and safety-related systems. The system terminates at the point of controlled discharge to the environment, at the point of interface with the waste solidification system, and at the point of recycle back to storage for reuse.

The LRWPS components are nonnuclear safety related and the system is classified as Non-nuclear Safety (NNS). See Section 3.3 of both American National Standard for Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, ANSI/ANS-51.1-1983 (R1988) [1],¹ and American National Standard for Nuclear Safety Criteria for the Design of Stationary Boiling Water Reactor Plants, ANSI/ANS-52.1-1983 (R1988) [2], for definitions of "Safety Class" and "Nonnuclear Safety."

2. Definitions

chemical wastes. Liquid radioactive wastes having high conductivity (>200 microsiemens), variable insoluble solids content, variable radioactivity content, and not containing soaps, detergents, oils, or similar organic materials.

controlled area. That portion of a nuclear facility, including outside yard areas, enclosed equipment, systems, and facilities, which may contain radio-active material by definition or design. Controlled area does not normally, but may temporarily, include portions of secondary system areas of the plant.

crud. Insoluble particulate materials in the process streams.

decontamination factor (DF). The ratio of the concentration of the radioactive material in the influent stream to its concentration in the effluent.

decontamination wastes. Liquid radioactive wastes generated by decontamination of radioactive plant components, equipment, and tools, other than personnel protective clothing and equipment.

deep bed plants. Those plants utilizing deep bed demineralizers in the condensate polishing system.

design basis radioactivity concentrations. Concentration of radiochemical constituents provided in the reference Safety Analysis Report (SAR) by Nuclear Steam Supply System (NSSS) supplier.

detergent wastes. Liquid radioactive waste containing detergents, soaps, or similar organic materials.

dry cleaning waste. Liquid solvent wastes generated in the operation of dry cleaning laundry equipment.

expected basis radioactivity concentrations. Radiochemical constituents as provided in American National Standard Radioactive Source Term for Normal Operation of Light Water Reactors, ANSI/ANS-18.1-1984 [3].

high purity (clean) wastes. Liquid radioactive wastes of low conductivity (normally less than 50 microsiemens) and low insoluble solids content

¹ Numbers in brackets [] refer to corresponding numbers in Section 7, References.

(normally less than 20 ppm).

ion exchanger and filter waste. Liquid radioactive wastes generated as a result of back-flushing, regeneration, transfer, or replacement of filters and ion exchange resins.

liquid radioactive waste. Liquids containing radioactive material, resulting from operation of a nuclear power reactor, which by design, definition, operating practice, or procedure are intended to be processed prior to final disposition.

low purity waste (e.g., floor drains). Liquid radioactive wastes of normally moderate conductivity (50-200 microsiemens) and moderate insoluble solids content (20-500 ppm).

miscellaneous liquid wastes. Liquid radioactive wastes which may not be readily amenable to processing and reuse as reactor coolant make-up water.

outdoor controlled area wastes. Liquid from diked areas outside plant buildings but within the controlled area of the plant.

process piping. Piping used to collect, process, and discharge liquid radioactive wastes. Does not include instrumentation and sampling lines beyond the first root valves.

reactor makeup quality wastes. Liquids which originate from reactor or reactor auxiliary closed systems and are normally processed and reused as reactor coolant makeup.

sampling station radioactive waste. Liquids originating from operation of centralized reactor and reactor auxiliary system sampling stations.

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

slurry wastes. Liquid radioactive wastes of high insoluble solids content (greater than 0.1% solids by weight).

system and equipment wastes. Liquid from radioactive components, equipment, or systems, and from component cooling systems.

3. Criteria

3.1 Performance Criteria

3.1.1 Releases. The LRWPS shall be designed so that radioactive materials in liquid effluents from the plant meet the requirements of the following:

(a) Title 10, "Energy," Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," (10 CFR 50) Section 50.34a [4].

(b) The limits specified in Title 10, "Energy," Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation" (10 CFR 20) [5].

(c) Control and monitoring of releases of radioactive materials to the environment shall meet the requirements of Title 10, "Energy," Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," Criteria 60 and 64 [6].

(d) The numerical guide for design objectives and limiting conditions for operation to meet the criterion "as low as reasonably achievable" (ALARA) for radioactive material in light water-cooled nuclear power plant effluent, Title 10, "Energy," Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents" [7].

(e) Federal, state, and local environmental requirements.

3.2 Safety Criteria. The LRWPS shall be designed so that concentration of radioactive material released to the environment or exposure to the general public do not exceed the requirements of 10 CFR 20 [5].

3.3 Operational Criteria. The design, construction, and operation of the LRWPS shall be such that radiation exposures to operating and maintenance personnel are maintained ALARA in accordance with 10 CFR 20 [5].

4. Design Requirements

4.1 Code Classification. Equipment and piping shall be designed, constructed, and tested in accordance with the requirements of the applicable codes as given in Table 1.

4.2 Seismic Design. The LRWPS equipment is not required to be designed to withstand the effects of a seismic event.

The building(s) housing the principal LRWPS equipment shall be designed to contain² the liquid inventory of the building in the event of an operating basis earthquake (OBE). The building(s) need not be designed in accordance with Seismic Category I requirements.³

Dikes and retention basins for outdoor liquid radwaste tanks shall be capable of preventing runoff in the event of a tank overflow and should have provisions for sampling collected liquids and routing them to the LRWPS. The dikes and retention basins need not be designed in accordance with Seismic Category I requirements.

4.3 Quality Assurance. The design, procurement, fabrication, and construction activities shall conform to the quality assurance provisions of the codes and standards specified in Table 1. In addition, the following quality control features shall be established as a minimum.

4.3.1 System Designer and Procurer

4.3.1.1 Design and Procurement Document Control. Design and procurement documents shall be verified for conformance to the requirements of this standard by an individual or individuals within the design organization who are not the originators of the document. Changes to these documents shall be verified or controlled to maintain conformance to this standard.

4.3.1.2 Control of Purchased Material, Equipment, and Services. Measures shall be established to ensure that suppliers of material,

² The term "contain" means that the building shall have sufficient volume so that the liquid would not overflow, and does not imply absolute containment for an indefinite period of time.

³ Guidance for seismic design requirements can be found in the U.S. Nuclear Regulatory Commission's Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, D.C.

equipment, and construction services are capable of supplying these items to the quality specified in the procurement documents. This may be done by an evaluation or a survey of the supplier's products and facilities.

4.3.1.3 Handling, Storage, and Shipping.

Instructions shall be provided in procurement documents to control the handling, storage, shipping, and preservation of material and equipment to prevent damage, deterioration, and reduction of cleanliness.

4.3.2 System Constructor

4.3.2.1 Inspection. In addition to required code inspections, a program for inspection of activities affecting quality shall be established and executed by, or for, the organization performing the activity to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity. This shall include the visual inspection of components prior to installation for conformance with procurement documents and the visual inspection of items and systems following installation, cleaning, and passivation (where applied).

4.3.2.2 Inspection, Test, and Operating Status. Measures shall be established to provide for the identification of items which have satisfactorily passed required inspections and tests.

4.3.2.3 Identification and Corrective Action for Items of Nonconformance. Measures shall be established to identify items of nonconformance with regard to the requirements of the procurement documents or applicable codes and standards and to identify the action taken to correct such items.

4.4 Materials. Materials for pressure retaining components of process systems shall be selected from those covered by the material specifications listed in Table 1, except that malleable, wrought, or cast iron materials shall not be used. The components shall meet all of the mandatory requirements and the material specifications with regard to manufacture, examination, repair, testing, identification, and certification.

4.5 Welding. All welding constituting the pressure boundary of pressure retaining components and piping shall be performed in accordance with the requirements of Table 1.

Pressure retaining components of the LRWPS shall

utilize welded construction to the maximum practical extent.

Nonconsumable backing rings shall not be used in lines carrying high concentrations of solids, resins, or other particulate material.

Butt weld joints or butt welds with consumable inserts shall be used on all process piping with the following exceptions:

(a) Flanged joints or suitable rapid disconnect fittings shall be used only where maintenance or operational requirements clearly indicate such construction to be preferable.

(b) For lines, other than slurry lines, that have nominal sizes between $\frac{3}{4}$ -in. and $2\frac{1}{2}$ -in., socket welded or mechanical joints may be used.

(c) Screwed connections in which threads provide the only seal shall not be used, except for instrumentation connections or pump casing vents and drains, where welded connections are not suitable.

4.6 Sampling. Provisions shall be made to allow adequate recycle and mixing to ensure that representative samples can be obtained from waste monitoring and hold-up tanks. The purposes for sampling and the analytical determinations to be made on each sample might differ from station to station. However, sample points shall be provided in accordance with Table 2 as a minimum.

Sample lines for all frequently taken samples should be routed to a common sample station. This station should be located in an area that is easily accessible to the operator, and so that operator exposure can be maintained ALARA (unless the sample station is so remote from the sample point that representative samples could not be obtained). Connections of sample lines to process piping shall be via a probe or other method capable of obtaining a representative sample of the stream being sampled. Connections shall be made at the side or the top of horizontal piping.

Sample lines shall be routed so as to be as short and direct as possible. Sample lines shall be American Iron and Steel Institute (AISI) Type 304 or 316 stainless steel (or appropriate corrosion resistant material) tubing that has been sized to maintain turbulent flow. The Reynolds number (Re) at the minimum sample flow shall be at least 4,000. Sample tubing shall be 0.049 inches minimum wall

thickness for flareless and 0.065 inches minimum wall thickness for tubing with welded fittings. Welded fittings are preferred; refer to American National Standard for Sample Line Piping and Tubing for Use in Nuclear Power Plants, ANSI/ISA 567.10-1986 [8].

Wherever slurries are sampled, the minimum tubing diameter shall be $\frac{3}{8}$ -in. outside diameter, and all bends shall have a minimum radius of five tubing diameters. Connections shall be provided for the flushing of the sample lines after each sampling.

Sample return shall be to the collector tank of the subsystem being sampled or to a subsystem of poorer quality water.

Heat tracing should be used on sample lines when temperature must be maintained above ambient for sample quality.

Samples of detergent waste shall be returned to the detergent waste collection system only.

4.7 Capacity and Storage for BWR Plants

4.7.1 Design Basis Inputs. For system design purposes, the design basis inputs shown in Tables 3 through 6 should be used for the expected radioactivity levels and volumetric inputs to the system. The reactor coolant isotope concentrations referenced in the tables should be those given in ANSI/ANS-18.1-1984 [3]. To accommodate transient conditions (for up to one month/year) the short-term design basis should be obtained by multiplying the design reactor water concentrations of radionuclides in the reference Safety Analysis Report (SAR) provided by the Nuclear Steam Supply System (NSSS) supplier by a factor of 3.5 for fission products and by one for activation products. The design basis inputs shown in the aforementioned tables are the inputs for a single 3800-MWt plant. The expected average volumetric inputs (except for those from a common radwaste building)⁴ should be multiplied by the number of generating units being served by the LRWPS to determine the expected average system inputs for multi-unit plants.

⁴ The expected volumetric inputs from the radwaste building (e.g., floor drains) should be the same as for a single unit. For equipment located in the building, the expected volumetric inputs should be based upon the expected input from each component (given in the "basis") but shall be increased by the appropriate factors to account for the actual number of components in the buildings.