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U.S. ATOMIC ENERGY COMMISSION

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 3.10

LIQUID WASTE TREATMENT SYSTEM DESIGN GUIDE FOR PLUTONIUM PROCESSING AND FUEL FABRICATION PLANTS

A. INTRODUCTION

Section 70.22, "Contents of Applications," of 10 CFR Part 70, "Special Nuclear Material," requires each applicant for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant, as defined in § 70.4(r), to submit in addition to the other information required by § 70.22, a description and safety assessment of the design bases of equipment and facilities which will be used by the applicant for the treatment of radioactive liquid waste. This submittal should show that the selected process is capable of reducing the radiological hazard of waste to a level as low as practicable in accordance with 10 CFR Part 20 and that the design bases of the system components and quality assurance program provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents as required by Part 70. This guide describes engineering guidelines for design of principal components of the radioactive liquid waste treatment system acceptable to the Regulatory staff..

B. DISCUSSION

Operation of plutonium processing and fuel fabrication plants may include a variety of scrap processes, processing equipment, and techniques to recover the plutonium content of all but low-level scrap generated in manufacturing operations. In most cases, the liquid wastes from these scrap processes and contaminated liquids from other plant areas are treated by a radioactive liquid waste treatment system. Since this is the last treatment step prior to the release of waste materials from the facility, careful selection of the methods of treatment and processing components should be made not only to confine radioactive material under normal and credible accident conditions but to reduce the radioactivity of waste materials to the lowest practicable level.

C. REGULATORY POSITION

Prior to commencement of construction of a plutonium processing and fuel fabrication plant, the Commission should be provided with sufficient information to evaluate whether satisfactory provisions have been made by the applicant for the treatment of liquid radioactive wastes.

1. **Information to be Submitted**

In order to provide sufficient information, a submittal to the Commission should include, as a minimum, the following:

a. A description of the liquid waste to be generated, the proposed liquid waste treatment system including the specific process steps, the initial and planned ultimate capacity and a description of the physical and chemical form of the final wastes;

b. Plan and elevation drawings of the liquid waste treatment process area showing location of equipment including ventilation and filtration systems, glove boxes and hoods, shielding, monitoring and signal systems, fire-fighting equipment, tanks, and drains;

c. Liquid waste system process flow diagrams indicating planned material flow, the quantity of materials to be used in each process step and the process conditions;

d. Preliminary specification sheets of the liquid waste system which detail materials of construction, capacities, and capabilities of system components;

e. A discussion of the design bases of the liquid waste system which justifies selection of the process and engineering used in lieu of other accepted engineering and treatment practices and which demonstrates that the process or processes selected and methods of operation to be used meet the as low as practicable criterion; and

f. A safety analysis of all engineering, processing, or production methods presented in a manner which will permit an evaluation by the Commission.

2. Design Guidelines

Reference will be made to the following guidelines by the Regulatory staff in determining whether satisfactory provisions have been made by a license applicant for treatment of radioactive wastes.

a. General Design Guidelines

(1) The liquid waste system, its components and required supporting services should be capable of handling the expected volume of potentially radioactive waste generated during normal plant operations and under credible emergency conditions resulting from internal accidents or natural phenomena.

(2) The system design should provide for redundancy or diversity of components required to prevent release of radioactive materials to the environment or needed for the safe operation of the liquid waste system.

(3) All components of the liquid waste system should be designed for safe shutdown during normal operation or under emergency conditions. Provisions for emergency power should be included for critical process components.

(4) Tank and piping systems used for liquid waste handling and treatment should be of welded construction to the fullest extent practicable.

(5) Tank and piping systems used for liquid waste handling and treatment should be designed to take advantage of gravity flow to reduce the potential for contamination associated with pumping and pressurization.

(6) The area in which liquid radioactive waste is treated should be isolated from production, loading, storage and support facilities by compartmentalization and access controls to reduce the potential for cross contamination.

(7) Cleanup systems should be provided which are designed to contain safely water collected from firefighting activities and provide for retrievability of radioactive liquids and solids for cleanup and decontamination through the scrap recovery and/or waste treatment system(s).

(8) The design of the radioactive waste system should assure that accidental criticality will not occur under normal operating conditions or under any credible accident condition.

b. Collection System Guidelines

(1) Liquid collection systems may consist of sink and container collection systems or drain line and central collection tankage systems or a combination of both.

(2) Materials used in the liquid waste collection system should be capable of safely handling waste to be collected. Containers used in a sink and container system should be constructed of durable materials. All components of the system expected to be in contact with strong acids or caustics should be corrosion resistant, e.g., lined with suitable synthetic resin materials or stainless steels.

(3) Shipping containers approved by the DOT for the shipment of solid waste contaminated with plutonium should be used for collection of solid waste materials produced in the liquid waste treatment system to eliminate the necessity of repackaging prior to shipment to a licensed burial ground.

(4) Drain systems for storm water and sanitary sewage should be separate from contaminated waste drain systems. Laundry facilities and personnel decontamination facilities should be designed so that effluents will be sent to the radioactive liquid waste treatment system when contaminated with radioactivity.

(5) Individual lines should be used for each waste stream fed to the central collection tank(s) where necessary to prevent chemical reaction or introduction of contaminants such as complexing agents which could interfere with waste decontamination and to permit determination of flows and monitoring of waste streams from each source area.

(6) The use of traps in radioactive liquid waste lines should be avoided and the piping should be designed to minimize entrapment and buildup of solids in the system.

(7) Measurement capability should be provided to determine the volume and radioactivity of wastes fed to the collection tank(s). The measurement devices should be provided with recorders, indicators, and alarms. Appropriate detectors should be used to measure radioactivity.

(8) Waste collection system pipe and drain lines should be tagged, labeled or painted in a manner which permits easy identification.

(9) Consideration should be given to providing at least two collection tanks to achieve a capability for segregating higher level waste materials. The collection tank(s) should be of stainless steel construction and designed to prevent nuclear criticality.

(10) Bypasses which would permit waste streams to be routed around collection tank(s) should be avoided.

c. Waste Treatment System Guidelines

(1) The waste treatment system should include means (solidification, evaporation, flocculation, or other process) for conversion of radioactive waste to liquid and/or solid forms suitable for disposal.

(2) The radioactive liquid waste treatment system should be designed to achieve a decontamination factor for each radionuclide sufficient to reduce total radioactivity of normal operational liquid waste to an acceptable release level on a "once through" treatment basis. Provisions should be made for recirculation for further decontamination when radioactivity is above an acceptable release level.

(3) Provisions should be made to adjust liquid waste characteristics prior to treatment to minimize adverse chemical reactions in the treatment system, i.e., noxious gas evolution or explosive mixtures. If chemical hazards cannot be eliminated, they should be controlled and monitored with suitable detectors and alarms.

Radioactive liquid waste treatment processes should be such as to minimize the comingling of plutonium with combustible waste.

(4) There should be no bypasses or drains in the radioactive liquid waste treatment system by which waste may inadvertently circumvent treatment equipment components or be released directly to the environment.

(5) All liquid effluents from the radioactive liquid waste treatment system should be collected in a quarantine or holdup tank for analysis before transfer to a storage tank. Liquids transferred to a storage tank should be analyzed a second time prior to disposal.

d. **Quarantine and Storage System Guidelines**

(1) Quarantine and storage systems may consist of tanks, interconnecting lines and associated equipment.

(2) Design of handling systems for liquid radioactive waste may be based on a continuous or batch process. If based on a continuous process, consideration should be given to processing and storage capacity for unusual or emergency situations. If on a batch process basis, consideration should be given to maintaining a tank capacity by batch treating before tankage is full. Generally the minimum sufficient capacity of a liquid waste storage system tank is that required to store waste generated during twice the maximum period anticipated for radioanalysis and discharge of the largest storage tank in the system.

(3) At least two holdup or quarantine tanks should be provided. They should be constructed of material capable of withstanding the expected corrosive effect of the liquids to be handled.

(4) At least two storage tanks for treated liquid waste should be provided. Tankage should be fitted with a liquid level indicator, equipped so that leaks may be detected, and located within a confinement system sufficient to confine the entire capacity of the tanks.

(5) Agitators or other means of circulation capable of mixing the contents should be installed on quarantine and storage tanks so that representative samples of liquid waste from each tank may be obtained.

(6) Provisions should be made to permit recycle of liquid waste from storage tanks to holdup or quarantine tanks.

(7) The system should be designed to prevent discharging of liquid from the quarantine or holdup tankage to the plant effluent drain line. Provisions should be made so that liquids to be transferred to a storage tank can be analyzed prior to transfer.

(8) Use of interlocking of systems is preferred to one-way check valves to prevent accidental transfer from one tank to another.

(9) Analytical equipment should be provided at the facility to properly determine the radioactivity of the waste prior to release from the facility.

e. **Work Areas**

(1) Systems and devices should be evaluated to determine the need for hoods, glove boxes, and shielding for personnel protection. Generally, wet processing operations involving gram quantities of plutonium and operations involving 50 micrograms or more of plutonium in respirable form should be conducted in a glove box. Wet processing operations involving milligram quantities of plutonium and dry processing operations involving less than 50 micrograms of plutonium could be performed in a suitable closed system or hood.

(2) Glove box and containment enclosure construction are described in USAEC documents TID-10620, "Report on Glove Boxes and Containment Enclosures" and TID-24236, "Glove Box Fire Safety."

(3) Exhausts from glove boxes and other ventilated containment enclosures used in the liquid waste treatment system should be passed through a suitable filter system prior to being released to the atmosphere. The system should consist of a minimum of three high efficiency particulate air (HEPA) filters in series, each capable of removing at least 99.97% of the airborne particles 0.3 microns or larger in size and have an Underwriters' Laboratory Class 2 fire resistance rating as set forth in the current edition of the Underwriters' Laboratories Building Materials List.[1]

(4) Surface finishes in the work area should be of materials which have satisfactory decontamination characteristics for their particular application. In general, epoxy coatings are sufficient for most waste treatment areas and components; however, the use of suitable stainless steels or polyester resins should be considered where high acid concentrations may be expected.

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[1] Copies may be obtained from Underwriters' Laboratories, Inc., 333 Pfingsten Road, Northbrook, Ill. 60062.

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