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11.0 RADIOACTIVE WASTE MANAGEMENT

.1 Summary Description

The radioactive waste management systems are designed to provide for the controlled handling and treatment of liquid, gaseous, and solid wastes. Since the construction permit was issued, the applicant has modified the radwaste system to reduce radioact releases. These modifications include installation of an evaporator distillate poli demineralizer in the liquid radwaste system and charcoal filters in the gaseous ~~radw~~ radwaste and containment purge systems. The design criteria of the liquid, gaseous, and soli radwaste system components have also been upgraded.

The liquid waste system will process liquid waste streams such as reactor coolant letdown, equipment and floor drains, leakage from equipment, condensate demineralize backwash wastes, decontamination and laboratory waste liquids, and laundry and showe waste water. The treated liquid waste will be recycled for reuse if the reactor coo balance requires makeup and if the water quality is adequate. The liquid waste syst will process waste liquid utilizing evaporation, demineralization, and filtration fo removal of radioactive material, chemical impurities, and particulates.

Gaseous wastes will be generated during the operation of the plant from degassing of primary coolant from displacement of liquid storage tank cover gases, from the main steam condenser air ejector, from venting of equipment handling radioactive material and from leakage of systems and components containing radioactive material. The gaseous waste system will remove radioactive materials from gaseous streams by filtration, and holdup for radioactive decay. The treated gas streams will be released the environment through the station vent.

Solid wastes will be generated during plant operation and will consist of radioactiv material from liquid waste evaporator concentrates, spent resins, spent filter cartridges, and contaminated items such as clothing, equipment, and tools. Treatment w consist of solidification of wet solid wastes and compaction of dry solid wastes. Disposal will consist of packaging and shipping to a licensed burial site.

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~~The capability of the liquid and gaseous radioactive waste treatment systems to meet the dose design objectives of Appendix I to 10 CFR 50 will be discussed in a supplem to this report.~~

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In the FES, we indicated that we had not completed our review of the radwaste systems to meet the requirements of Appendix I of 10 CFR Part 50, issued May 5, 1975, since the assumptions and models for calculating radioactive effluent releases were being reassessed. We have completed the reassessment of our models and assumptions, and the applicant has chosen to comply with the September 4, 1975 amendment to Appendix I rather than submit a cost-benefit analysis as required by Paragraph II.D. On this basis, we have reassessed the radwaste systems using source terms calculated with the revised models and methodology described in NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs)," April 1976. The source term for Unit No. 1 is given in Appendix A of this report.

Based on our reassessment, the liquid radioactive waste management systems are capable of maintaining releases of radioactive material in liquid effluents such that the total body dose to an individual in an unrestricted area will not exceed 3 mrem or any organ dose greater than 10 mrem/yr from Unit No. 1 in accordance with Section II.A of Appendix I to 10 CFR Part 50. Based on our reassessment, the gaseous radioactive waste management systems are capable of maintaining releases of radioactive materials in gaseous effluents such that air doses in the unrestricted area will not exceed 10 mrads/yr for gamma radiation, 20 mrads/yr for beta radiation, or 15 mrem/yr for radioiodine and radioactive particulates from Unit No. 1 in accordance with Sections II.B and II.C of Appendix I to 10 CFR Part 50. Also, the calculated release of radioactive materials in liquid effluents from Unit No. 1, exclusive of tritium and dissolved gases, will be less than 5 Ci/yr/reactor, and the total body and any organ dose will be less than 5 mrem/yr from Unit No. 1, in accordance with the option to Section II.D of Appendix I as provided for in the Annex to Appendix I. Also, the effluents from Unit No. 1 will not result in an annual gamma air dose greater than 10 mrads, a beta air dose greater than 20 mrads, a release of iodine-131 greater than 1 Ci/reactor, or a dose from radioiodine and radioactive particulates released greater than 15 mrem, in accordance with the option to Section II.D of Appendix I. Therefore, we conclude that the liquid and gaseous radwaste treatment systems of Davis-Besse, Unit No. 1 are capable of reducing gaseous radioactive effluents to as low as is reasonably achievable levels in accordance with 10 CFR Part 50.34a, Appendix I to 10 CFR Part 50, and the Annex to Appendix I to 10 CFR Part 50.

Based on our evaluation, as described below, we find the liquid and solid radwaste and associated process and effluent radiological monitoring systems to be acceptable. However, we find the gaseous radwaste system to be unacceptable because of the potential for gaseous releases due to hydrogen explosions.

2 Liquid Waste

The liquid radioactive waste systems are described in the Final Environmental Stateme related to operation of Davis Besse Nuclear Power Station Unit 1, October 1975. Subse quent to our construction permit review of this facility, the system was modified to include an evaporator condensate demineralizer in the Miscellaneous Liquid Radioactiv Waste portion of the system. The demineralizer will be a mixed bed resin type with a 40 gpm design flow and a 14 cu.ft. resin volume.

The design criteria of major processing equipment in the liquid radwaste system were upgraded to the American Society of Mechanical Engineers standards, Section III, Clas III which more than meet the guidelines of Branch Technical Position ETSB 11-1, Rev. 1, "Desi Guidance for Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Plants."

The addition of the demineralizer was considered in the Final Environmental Statement the operating license and was included in that evaluation. We calculate that approximately 0.1 curies per year, excluding tritium and dissolved gases, will be released from the liquid radioactive waste systems to the environment. To account for anticip operational occurrences and equipment downtime, we increased this estimate to 0.25 cur per year. We estimate the tritium release will be 550 curies per year based on data obtained from operating pressurized water reactors.

We have determined that during periods of fission product leakage from the fuel at de levels, releases of radioactive materials in liquid effluents will be within the requ ments specified in 10 CFR Part 20.106.

The liquid radwaste system includes the equipment and instrumentation to control the release of radioactive materials in liquid effluents. The scope of our review incluc the system's capability to reduce releases of radioactive materials in liquid effluer to as low as practicable levels in accordance with 10 CFR Part 20 considering anticip operational occurrences, and the design provisions incorporated to preclude uncontrol releases of radioactive materials in liquids due to leakage or overflows in accordanc with General Design Criterion 60 and the quality group classification and seismic design criteria in conformance with the guidelines of the Branch Technical Position, ETSB 11-1, Rev. 1, "Design guidance for radioactive waste management systems installed in lig water-cooled nuclear power plants."

Included in the review were piping and instrumentation diagrams, schematic diagrams, and descriptive information from the Final Safety Analysis Report for the Davis Besse facility.

The basis for our acceptance is that the applicant's design, design criteria, and design bases for the liquid radwaste system conforms to the Commission's Regulations, as well as to Commission staff positions and industry standards.

Based on our evaluation summarized above, we conclude that the [redacted] liquid radwaste system is [redacted] acceptable.

.3 Gaseous Waste

.3.1 Description and Evaluation

The gaseous radioactive waste system and building ventilation systems are described in the Final Environmental Statement for the operating license of the Davis Besse facility. Since our construction permit review, the applicant modified the gaseous radwaste system to include a charcoal filter downstream of the waste gas decay tanks. [redacted] ~~filter will be a disposable cartridge type, with a~~ [redacted] ~~feet per~~ [redacted].

The components in the gaseous waste system which delay or filter process gas are designed to the American Society of Mechanical Engineers Standards, Section III, Class III standards which more than meet the guidelines of Branch Technical Position ETSB 11-1, Rev. 1.

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The modifications to the systems were considered in the Final Environmental Statement and were included in that evaluation. We calculate that approximately 5700 [redacted] curies per year of noble gases and 0.22 [redacted] curies per year of Iodine-131 will be released from the gaseous radwaste system to the environment. The applicant estimates that [redacted] curies per year of noble gases and [redacted] curies per year of Iodine-131 will be released from the system.

We have determined that during periods of fission product leakage from the fuel at design levels the releases of radioactive materials in gaseous effluents will be within the requirements specified in 10 CFR Part 20.106.

The gaseous radwaste system includes the equipment and instrumentation to control the release of radioactive materials in gaseous effluents. The scope of our review included the system's capability to reduce releases of radioactive materials in gaseous effluents to as low as practicable levels in accordance with 10 CFR Part 20 considering anticipated operational occurrences and the quality group and seismic design criteria. Our review included an evaluation of effluent releases based on the modified treatment processes. Effluent releases for pathways due to process vents and leakage affecting building ventilation systems were considered. Included in our review were piping and instrumentation diagrams, schematic diagrams, and descriptive information from the Final Safety Analysis Report for the Davis Besse facility.

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The gaseous waste system consists of 2 compressors, one surge tank, and three waste gas decay tanks. None of the GWS components are designed to withstand a hydrogen explosion. The system will be designed to operate at positive pressure with a nitrogen blanketing system to prevent air (oxygen) buildup as a result of infiltration. The system design includes one oxygen analyzer which will initiate an alarm if oxygen concentrations vary beyond the design concentration limits. The system design will limit the concentration by providing for dilution with nitrogen. It is our position that the GWS be designed to withstand a hydrogen explosion or be provided with redundant instrumentation to annunciate and prevent the buildup of potentially explosive mixtures. We find the design provisions incorporated to reduce the potential of a hydrogen explosion to be unacceptable.

The basis for our acceptance is that the applicant's designs, design criteria, and design bases for the gaseous waste system conform to the applicable Commission Regulations as well as to Commission staff technical positions and industry standards.

Based on our evaluation summarized above, we conclude that the proposed modified gaseous radwaste system is [redacted] **unacceptable because of the potential for gaseous releases due to hydrogen explosions.**

1 Solid Waste System

4.1 Description and Evaluation

The solid waste system is designed to collect, monitor, process, package, and provide temporary storage for radioactive solid waste prior to offsite shipment for disposal accordance with applicable regulations.

Radioactive solid wastes resulting from operation of the plant include concentrates from the radwaste evaporators, spent resins, spent filter cartridges, and contaminate dry waste such as disposable filters, clothing, equipment, and tools. The solid radw system uses a solidification system in which the evaporator concentrates, spent resin and high activity filter cartridges will be mixed with the solidifying agent, loaded 50 cubic foot cask liners and stored prior to shipment. Low activity filter cartridg will be loaded into 55 gallon drums. Dry wastes will be compacted into 55 gallon dru and stored for shipment. The high radioactivity level drums will be handled by use c remote handling equipment.

The equipment in the solid waste system which handle liquid wastes is designed to the American Society of Mechanical Engineers Standards, Section III, Class III which more than meet the guidelines of BTP ETSB 11-1. Rev. 1.

Based on the operating experience of similar plants we estimate that annual disposal will be 13000 cubic feet of high level wastes and 4100 cubic feet of dry compacted waste. Our estimates of total activity after 180 days decay is 1600 curies per year.

Based on operating experience at other plants and the capacity of the drumming statio the applicant estimates 500 drums of high level and 150 drums of low level waste (480 ft^3) will be shipped annually to a licensed burial ground. All solid waste will be packaged and shipped in conformance with all applicable Commission and Department of Transportation regulations.

The solid radwaste system includes the equipment and instrumentation for solidifying and packaging radioactive wastes prior to shipment for offsite burial. Our review included an evaluation of the system's capability for processing the types and volume of wastes expected during normal operation. Anticipated operational occurrences are accordance with General Design Criterion 60, the quality group design criteria, and t provisions for handling wastes with regard to the requirements of 10 CFR Parts 20 and 71, and §40 CFR Parts 170-189.

Included in our review were piping and instrumentation diagrams, schematic diagrams, and descriptive information from the Final Safety Analysis Report for the Davis Besse facility.

The basis for our acceptance is that the applicant's designs, design criteria, and design bases for the solid radwaste system conform to the Commission's Regulations referenced above, as well as Commission staff technical positions and industry standards.

Based on our evaluation summarized above, we conclude that the proposed solid radwast system is acceptable.

5 Process and Effluent Monitoring

5.1 Description and Evaluation

In our evaluation of the process and effluent monitoring system we considered the system's ability to (1) monitor all normal and potential pathways for release of radioactive materials to the environment, (2) control the release of radioactive materials to the environment, and (3) monitor the performance of process equipment and detect radioactive material leakage between systems.

The process and effluents radiological monitoring system will be designed to provide information concerning radioactivity levels in systems throughout the plant, and indicate radioactive leakage between systems. The system will monitor equipment performance and monitor and control radioactivity levels in plant discharges to the environs.

Scintillation detectors will be used for monitoring liquids and for monitoring radioactive gases and particulates in vent effluents. Gaseous iodine will be collected in replaceable, impregnated charcoal adsorbers which will be continuously monitored while in use by scintillation detectors. Systems which are not amenable to continuous monitoring or for which detailed isotopic analyses are required will be periodically sampled and analyzed in the plant laboratory.

Table 11.1 indicates the locations and types of continuous monitors. Monitors on effluent release lines will automatically terminate discharges should radiation levels exceed a predetermined value.

We have reviewed the locations and types of effluent and process monitoring provided. Based on the plant design and on the continuous monitoring locations and intermitten sampling locations, we have concluded that all normal and potential release pathways will be monitored. We have also determined that the sampling and monitoring provisions will be adequate for detecting radioactive material leakage to normally uncontaminated systems and for monitoring plant processes which affect radioactivity releases. On this basis, we conclude the monitoring and sampling provisions meet the requirements of General Design Criteria 13, 60 and 64 and the guidelines of Regulator Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Co Nuclear Power Plants."

Table 11.1

Process and Effluent Monitoring

Stream Monitored	Detector Type
Reactor Coolant Purification System	Scintillation
Component Cooling Water	Scintillation
Steam Headers	Scintillation
Service Water Discharge Header	Scintillation
Miscellaneous Radwaste Effluent	Scintillation
Clean Radwaste Effluent	Scintillation
Station Liquid Radwaste Effluent	Scintillation
Radioactive Waste Gas Discharge	Scintillation
Fuel Handling Area Exhaust (Particulate)	Scintillation
(Iodine)	Scintillation
(Gas)	Scintillation
Radwaste Area Exhaust (Particulate)	Scintillation
(Iodine)	Scintillation
(Gas)	Scintillation
Station Vent Stack (Particulate)	Scintillation
(Iodine)	Scintillation
(Gas)	Scintillation
Containment (Particulate)	Scintillation
(Iodine)	Scintillation
(Gas)	Scintillation
Condenser Vacuum Pump Discharge	Scintillation

5.2 Process and Effluent Radiological Monitoring Evaluation Findings

The provisions for process and effluent radiological monitoring include the instrumentation and controls for monitoring and controlling the releases of radioactive materi in plant effluents and monitoring the level of radioactivity in process streams. The scope of our review included the provisions for monitoring and controlling the releas of radioactive materials in plant effluents in accordance with General Design Criteri 60 and 64 and Regulatory Guide 1.21, and for monitoring radioactivity levels within t plant in process streams in accordance with General Design Criterion 13.

The basis for our acceptance is that of the applicant's design, design criteria, and design bases to the Commission's Regulations as set forth in the General Design Crite for the process and effluent monitoring system and to the applicable Regulatory Guide referenced above, as well as to Commission staff positions and industry standards.

Appendix A

TABLE 1

Calculated Releases of Radioactive Material in
Gaseous Effluents from Davis-Besse Nuclear Station, Unit No. 1
(Ci/yr/unit)

Radionuclide	Decay Tanks	Building Reactor	Ventilation Auxiliary	Turbine	Air Ejector Off-Gas	Total
Kr-83m	a	a	a	a	a	a
Kr-85m	a	1	2	a	1	4
Kr-85	350	46	2	a	a	400
Kr-87	a	a	1	a	a	1
Kr-88	a	2	4	a	3	9
Kr-89	a	a	a	a	a	a
Xe-131m	5	37	2	a	1	45
Xe-133m	a	32	4	a	3	39
Xe-133	9	4700	320	a	200	5200
Xe-135m	a	a	a	a	a	a
Xe-135	a	9	7	a	4	20
Xe-137		a	a	a	a	a
Xe-138		a	a	a	a	a
I-131	a	1.3(-1)[b]	5.4(-2)	1.1(-3)	3.4(-2)	2.2(-1)
I-133	a	2.8(-2)	7(-2)	1.4(-3)	4.4(-2)	1.4(-1)
Mn-54	4.5(-5)	2.2(-4)	1.8(-4)	c	c	4.4(-4)
Fe-59	1.5(-5)	7.5(-5)	6(-5)	c	c	1.5(-4)
Co-58	1.5(-4)	7.5(-4)	6(-4)	c	c	1.5(-3)
Co-60	7(-5)	3.4(-4)	2.7(-4)	c	c	6.8(-4)
Sr-89	3.3(-6)	1.7(-5)	1.3(-5)	c	c	3.3(-5)
Sr-90	6(-7)	[illegible](-6)	2.4(-6)	c	c	6(-6)
Cs-134	4.5(-5)	2.2(-4)	1.8(-4)	c	c	4.4(-4)
Cs-137	7.5(-5)	3.8(-4)	3(-4)	c	c	7.5(-4)
C-14	7	1	a	a	a	8
Ar-41	a	25	a	a	a	25
H-3	c	280	280	c	c	560

a = less than 1.0 Ci/yr for noble gases and carbon-14, less than 10^{-4} Ci/yr for iodine

b = exponential notation; 1.0(-4) = 1.0×10^{-4}

c = less than 1% of total for this nuclide

Appendix A

TABLE 2

Calculated Releases Of Radioactive Materials
In Liquid Effluents From Davis-Besse, Unit No. 1

Nuclide	Ci/yr/unit
Corrosion & Activation Products	
Cr-51	2.2(-4)[a]
Mn-54	1(-3)
Fe-55	2.2(-4)
Fe-59	1.2(-4)
Co-58	6.1(-3)
Co-60	9.0(-3)
Zr-95	1.4(-3)
Nb-95	2(-3)
Np-239	6(-5)
Fission Products	
Br-83	3(-5)
Rb-86	2(-5)
Sr-89	5(-5)
Sr-91	1(-5)
Mo-99	3.1(-2)
Tc-99m	2.1(-2)
Ru-103	1.5(-4)
Ru-106	2.4(-3)
Ag-110m	4.4(-4)
Te-127m	3(-5)
Te-127	5(-5)
Te-129m	1.7(-4)

Nuclide	Ci/yr/unit
Fission Products (cont'd)	
Te-129	1.1(-4)
I-130	1.3(-4)
Te-131m	6(-5)
Te-131	1(-5)
I-131	6.5(-2)
Te-132	1.4(-3)
I-132	2.5(-3)
I-133	3.6(-2)
I-134	1(-5)
Cs-134	2(-2)
I-135	6.3(-3)
Cs-136	2.4(-3)
Cs-137	2.9(-2)
Ba-137m	5(-3)
Ba-140	2(-5)
La-140	2(-5)
Ce-144	5.2(-3)
All Others	6(-5)
Total except Tritium	0.25
Tritium	550

a = exponential notation; 1.0(-4) = 1.0×10^{-4}

b= nuclides whose release rates are less than 10^{-5} Ci/yr are not listed individually but are included in the category "All Others".

15.7.3 Postulated Radioactive Releases Due to Liquid Tank Failures

The consequences of component failures which could result in release of liquids containing radioactive materials to the environs were evaluated for components located outside the reactor containment. Considered in the evaluation were (1) the radionuclide inventory in each component assuming a 1% operating power fission product source term, (2) a component liquid inventory equal to 80% of its design capacity, (3) the mitigating effects of plant design including the location of storage tanks in curbed areas designed to retain spillage, and (4) the effects of site geology and hydrology.

The applicant has incorporated provisions in the design to retain releases from liquid overflows as discussed in section 11.2.1 of this SER. The site is adjacent to Lake Erie. In the event of a spill resulting in radionuclides entering the ground water, the ground water flow will move the spillage towards Lake Erie.

Based on our evaluation, the potential tank failure resulting in the greatest quantity of activity released to the environment is failure of one of the clean waste receiver tanks. The tank is assumed to contain radionuclides at 50 percent of primary coolant activity levels for the design basis fission product inventory stated above. In our evaluation, we have determined the liquid transit time for the leakage to the reservoir to be 72 years. Considering the leakage transit time, the calculated radionuclide concentrations in Lake Erie result in values that are small fractions of the limits of 10 CFR Part 20, Appendix B, Table II, Column 2, for unrestricted areas. Based on the foregoing evaluation, we conclude that the provisions incorporated in the applicant's design to mitigate the effects of component failures involving contaminated liquids, are acceptable.