JAN 4 1974

Docket Nos. 50-424/425/426/427

Voss Moore, Assistant Director for Light Water Reactors, Group 2, L

RADIOACTIVE WASTE MANAGEMENT SECTION FOR ALVIN W. VOGTLE NUCLEAR PLANT, UNITS 1, 2, 3, and 4 - SER

Plant Name: Vogtle, Units 1, 2, 3, and 4
Licensing Stage: CP
Docket Numbers: 50-424/425/426/427
Responsible Branch: LWR 2-2
Project Leader: L. Crocker
Description of Response: Radioactive Waste Management Section for SER
Requested Completion Date: December 7, 1973
Review Status: Complete

Enclosed is the Radioactive Waste Management Section for use in the Safety Evaluation Report for Alvin W. Vogtle, Units 1, 2, 3, and 4.

The applicant has proposed to use state-of-the-art technology for the liquid, gaseous, and solid radwaste systems. We fx find these systems acceptable. We also find the system to be designed to acceptable codes and standards, and that the process and area monitoring systems are acceptable.

Robert Tedesco, Assistant Director
for Containment Safety
Directorate of Licensing

Enclosure:
As stated

cc: w/o enclosure
A. Giambusso
W. McDonald

w/enclosure
S. Hanauer
J. Hendrie
D. Muller
K. Kniel
B.J. Youngblood
J. Kastner
J. Glynn
R. Clark
L. Crocker
V. Benaroya
J. Collins

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SURNAME			JCollins:cc	VBenaroya	RTedesco
DATE			1/2/74	1/2/74	1/3/74

Form AEC-318 (Rev. 9-53) AECM 0240 GPO C43 16 81465-1 445-678

11.0 RADIOACTIVE WASTE MANAGEMENT

11.1 Design Objective And Criteria

The radioactive waste management system for Alvin W. Vogtle Nuclear Plant Units 1, 2, 3 and 4 will be designed to provide for the controlled handling and treatment of radioactive liquid, gaseous and solid wastes. The applicant's design objective for these systems is to restrict the amount of radioactivity released from normal plant operation to unrestricted areas to within the limits set forth in 10 CFR Part 20.

The Technical Specifications issued as part of the operating license will require the applicant to maintain and use existing plant equipment to achieve the lowest practicable releases of radioactive materials to the environment in accordance with the requirements of 10 CFR Part 20 and 10 CFR Part 50. The applicant will also be required to maintain radiation exposures to inplant personnel and the general public "as low as practicable" in conformance with the requirements of 10 CFR Part 20.

Our evaluation of the design and expected performance of the waste management systems for Vogtle Units 1, 2, 3 and 4 are based on the following design objectives:

Liquids

(1) Provisions to treat liquid waste to limit the expected releases of radioactive materials in liquid effluents to the environment to less than 5 Ci/yr/unit; excluding tritium and dissolved gases.

(2) The calculated annual average exposure to the whole body or any organ of an individual at or beyond the site boundary not to exceed 5 mrem for expected releases.

(3) Concentrations of radioactive materials in liquid effluents not to exceed the limits in 10 CFR Part 20, Appendix B, Table II, Column 2, for the expected and design releases.

Gaseous

(1) Provisions to treat gaseous waste to limit the expected release of radioactive materials in gaseous effluents from principal release points so that the annual average exposure to the whole body or any organ of an individual at or beyond the site boundary not to exceed 5 mrem.

(2) Provisions to treat expected radioiodine released in gaseous effluent from principal release points so that the annual average exposure to the thyroid of a child through the pasture-cow-milk pathway be less than 15 mrem. For Alvin W. Vogtle, Units 1, 2, 3 and 4 the estimated dose is evaluated at the nearest potential pasture, approximately one mile north of the site.

(3) Concentrations of radioactive materials in gaseous effluents not to exceed the limits in 10 CFR Part 20, Appendix B, Table II, Column 1, for the expected and design releases.

Solid

(1) Provisions to solidify all expected liquid waste prior to shipment to a licensed burial ground.

(2) Containers and method of packing to meet the requirements of 10 CFR Part 71 and applicable Department of Transportation regulations.

The following sections present our evaluation of the liquid, gaseous, and solid waste treatment systems; the design codes and quality assurance criteria; and the radiation monitoring of process effluents and of inplant areas. The liquid, gaseous, and solid waste systems are designed to accommodate the waste produced during simultaneous operation of Units 1, 2, 3, and 4. Except for the liquid radwaste systems the reactors will be constructed as a two-group facility. Units 1 and 2 will share certain radwaste treatment equipment and support buildings as a group, and likewise Units 3 and 4 will be constructed and operated as a group. Each unit will have a separate liquid waste treatment system.

Our evaluation and calculation of annual releases of radioactive materials model adjusted to these reactors and uses somewhat different operating conditions and parameters than those assumed by the applicant. Our calculated effluents are therefore, different than the applicants. Based on our evaluation, we find the proposed liquid, gaseous and solid radwaste systems proposed for Units 1, 2, 3, and 4 to be acceptable.

11.2 Liquid Waste Systems

Treatment of the liquid waste is dependent on the source, activity and composition of the particular liquid waste and on the intended disposal procedure. The liquid waste system is divided into two main subsystems;

(1) the reactor coolant treatment system which includes the chemical and volume control system (CVCS) and the boron recovery system (BRS); and (2) the liquid radwaste processing system which includes drain channel A (recycleable wastes), drain channel B (non-recycleable waste) and the steam generator blowdown treatment system.

Cross connections between the subsystems provide flexibility for processing by alternate methods. Treated wastes will be handled on a batch basis to permit optimum control and release of radioactive waste. Prior to the release of treated liquid wastes, samples will be analyzed to determine the type and amount of radioactivity in each batch. Based on the analytical results, these wastes will either be released through the circulating water direct to the Savannah River or retained for further processing. Radiation monitoring equipment will automatically trip a valve on the discharge pipe terminating the release of liquid waste if the levels of activity exceed a predetermined value.

The chemical and volume control system (CVCS) consists of redundant mixed-bed demineralizers for the removal of corrosion and fission products and cation bed demineralizers for the removal of radioactive cation products. During normal operations the CVCS will process reactor coolant letdown at approximately 75 gpm. Approximately 93% of the treated letdown stream will be collected in the volume control tank and returned to the primary coolant system. Approximately 1.3 gpm of the treated letdown stream will be diverted to the boron recovery system (BRS) for chemical shim control.

The shim bleed will be processed through two mixed-bed demineralizers and stored in one of two 112,000 gal. recycle holdup tanks. After a sufficient quantity has been collected, the liquid from the holdup tank will be processed through a 15 gpm boric acid evaporator. The evaporator condensate will be processed through an anion polishing demineralizer and collected in the reactor makeup water storage tank. We assume that approximately 10% of the effluent from the anion demineralizer will be diverted to the waste monitor tanks and discharged, to maintain the plant water balance. The evaporator bottoms will be either stored in the boric acid holdup tank for reuse or processed in the solid waste system.

Drain channel A (DCA) and drain channel B (DCB) will share the waste evaporator and polishing demineralizer. However, the DCA and DCB wastes will be kept separated since processing will be batchwise. DCA will collect high purity waste from primary system equipment drains and leakoffs in a 10,000 gal. waste holdup tank. In our evaluation we assumed the DCA flow to be approximately 166 gpd at primary coolant activity. The DCA wastes will be processed through the 15 gpm waste evaporator and mixed-bed polishing demineralizer. The treated waste will be sampled in a 5000 gal. monitor tank and normally recycled to the primary system for reuse. We estimate that approximately 90% of the treated stream will be reused to meet plant water requirements, and 10% will be discharged.

DCB will collect low purity waste from floor drains, decontamination operations, and laboratory operations in a 10,000 gal. floor drain tank. In our evaluation we assumed the DCB volume to be approximately 900 gpd at 7% of primary coolant activity. DCB wastes will be processed through the same system as DCA, however, collected in a separate 5000 gal. tank for sampling and analysis. DCB will be 100% discharged after processing. One mixed-bed demineralizer will be avaiable to process wastes as required during unexpected operational occurrances or equipment downtime. Units 1 & 2, and Units 3 & 4 will share a common 10,000 gal. laundry and shower drain tank. Based on reactor operating experience, we assumed these wastes will total approximately 450 gpd/unit at approximately 10^{-4} uCi/ml. We consider these wastes to be released without treatment following sampling and analysis.

The steam generator blowdown processing system will process blowdown through heat exchangers prior to entering the blowdown tank to prevent flashing. The blowdown will be processed through two cation demineralizers and two mixed-bed demineralizers in series, at approximately 7 gpm and secondary coolant activity. The treated stream will be collected in the 1500 gal. surge tank. In our evaluation we assumed 100% discharge of the treated blowdown wastes.

Turbine building floor drain wastes will be collected in the turbine building drain collection tank, monitored, and released without treatment. We estimate these wastes to be approximately 7200 gpd at 0.1% of secondary coolant activity.

We estimate that liquid waste releases will be less than 0.2 Ci/yr/unit, excluding tritium and dissolved gases. We have normalized these releases to 0.4 Ci/yr to compensate for equipment downtime and anticipated operational occurrances. The applicant estimates the liquid releases to be approximately 2 Ci/yr/unit excluding tritium. Based on operating experience at other pressurized water reactors using zircalloy clad fuel, we estimate that approximately 350 Ci/yr/unit of tritium will be released. The applicant estimated tritium releases to be approximately 70 Ci/yr/unit.

We calculate the whole body and critical organ dose to individuals to be less than 5 mrem/yr. The applicants also calculate these doses to be less than 5 mrem/yr.

Based on our evaluation that the liquid radwaste system will process the expected wastes to less than 5 Ci/yr/unit, with a resultant dose of less than 5 mrem/yr from the site, we conclude that the system is acceptable. We conclude that the system is capable of processing radwastes in accordance with 10 CFR Part 20 and 10 CFR Part 50, and to levels which are "as low as practicable".

11.3 Gaseous Waste Systems

The gaseous waste systems consist of a cover gas recycle system for primary system gases, an air ejector treatment system, and systems for removing iodine and particulates from the containment, fuel handling, and auxiliary building atmospheres prior to release.

The cover gas recycle system strips hydrogen and small amounts of radioactive fission gases from the primary coolant in the volume control tanks. Units 1 and 2 and Units 3 and 4 will share a cover gas recycle system consisting of a continuously recirculating nitrogen loop, two compressors, two recombiners, and sixteen pressurized storage tanks. Fourteen storage tanks will be used during normal operation and two tanks will be used for shutdowns. Gases stripped from the primary coolant will be diluted with nitrogen, and blended with stoichiometric amounts of oxygen. The hydrogen and oxygen will be catalytically recombined to form water. The resultant nitrogen stream, containing small amounts of fission gases, will be routed to one of the fourteen pressurized storage tanks to permit decay of the short-lived radionuclides. After decay, the nitrogen, containing small amounts of long-lived radioactive gases, will be recycled back to the primary system as cover gas. Valves will equipped with bellows seals or leakoffs piped to low pressure portions of the system. Four gas analyzers will monitor hydrogen and oxygen concentrations upstream and downstream of the catalytic recombiners. These analyzers will alarm should hydrogen or oxygen concentrations approach the lower combustion limit (LCL). Both hydrogen and oxygen feed will be automatically terminated should either hydrogen or oxygen exceed a predetermined level.

The system will be designed to store radioactive gases indefinitely to reduce releases of radioactive materials. In our evaluation we assumed 50,000 ft^3/yr of gaseous waste will be processed by this system.

We considered the waste to be discharged after 90 days, at which time Kr-85 will be the major isotope released. Gaseous wastes from the secondary system will be processed through condenser air ejectors, HEPA filters, and charcoal adsorbers prior to release. The plant ventilation systems will be designed to ensure that air flow will be from areas of low potential to areas having a greater potential for the release of airborne radioactivity. The auxiliary fuel handling, and containment building atmospheres will be processed through HEPA filters and charcoal adsorbers prior to release. In addition, a 30,000 cfm internal recirculation system will process containment air through charcoal adsorbers for approximately 16 hours prior to purging the containment. The recirculation system will have the capacity to reduce airborne iodine concentrations to below the levels in 10 CFR Part 20, Appendix B, Table 2, Column 1 prior to entry by operating personnel.

The steam generator blowdown processing system will be vented to the main condenser thereby eliminating this effluent stream. Main steam will be used for the gland sealing system. The gland seal leakoff steam will be routed to the gland seal condenser. Noncondensibles will pass through a charcoal adsorber and be vented to the roof vent and the condensibles will be drained to the condensate storage tank. We estimate the gland seal gaseous releases to be negligible.

Based on our evaluation of the gaseous waste systems we calculated that the radioactivity released from Units 1, 2, 3 and 4 during normal operation will be 1340 Ci/yr/unit of noble gases and 0.04 Ci/yr/unit of iodine-131.

The applicant estimated these releases to be 3580 Ci/yr/unit of noble gases and 0.017 Ci/yr/unit for iodine-131.

For the simultaneous operation of all four units, we calculate the whole body dose due to noble gases to be less than 5 mrem/yr to an individual at or beyond the site boundary. We calculate the potential dose to a child's thyroid through the pasture-cow-milk chain, at the nearest potential pasture located one mile north of the site to be approximately 24 mrem/yr. The applicant calculated a whole body dose of less than 5 mrem/yr and a dose to a child's thyroid of less than 15 mrem/yr. Even though the calculated potential thyroid dose to a child's thyroid through the pasture-cow-milk path appears to exceed the 15 mrem/yr objective of our as low as practicable guidelines, the applicant has proposed to use state-of-the-art technology to reduce iodine releases in conformance with Regulatory Guide 1.42, and therefore, find the calculated thyroid dose acceptable.

To assure that the actual doses do not exceed the "as low as practicable" guidelines, the applicant will be required to provide an extensive monitoring program in the surrounding environs. This program will be delineated in the Technical Specifications and will relate to measuring the iodine releases from the plant. Should the actual measured iodine releases appear to exceed a dose rate of 7.5 mrem averaged over any calendar quarter, the applicant will be required to make the necessary modifications to the plant to reduce these releases as delineated in the Technical Specifications.

Based on our evaluation the gaseous radwaste system has the capability to process the expected noble gases to a calculated whole body dose of less than 5 mrem/yr to an individual. In addition, state-of-the-art equipment will be used to process gaseous waste and the applicant is committed to monitor the environs to ensure releases will be "as low as practicable". We, therefore, conclude that the gaseous radwaste systems are acceptable.

11.4 Solid Waste Systems

The solid radwaste system will be designed to collect, monitor, process, package, and provide temporary storage for radioactive solid wastes prior to offsite shipment and disposal in accordance with applicable regulations.

Spent demineralizer resins from the various treatment systems will be dewatered and solidified with cement and vermiculite. The resins will be encapsulated in a 55 gal drum fitted with a cement and steel liner to provide shielding. Evaporator concentrates and chemical wastes will be mixed with a cement-vermiculate mixture and sealed in 55-gal. drums. The drums will be remotely filled under a vacuum to preclude airborne releases to the plant atmosphere. Mechanical vibrators will be used to homogenize the waste mixture. When filled, drums will be sealed and moved to a storage area by remotely operated equipment.

A radiation monitor will keep the operator informed of the activity level in each drum. Highly radioactive drums will be stored in shielded sleeves prior to shipment to reduce radiation levels. Miscellaneous low level dry compressable wastes will be compacted into 55-gal. drums using a hydraulic baler. During baling, the drums will be enclosed in a shroud. The shroud will be vented to the plant ventilation system to remove dust particles generated during baler operation and to reduce airborne activity levels in the plant. An interlock system will prevent inadvertant releases due to baler operation with the shroud door open.

We estimate the solid wastes to total approximately 235 drums/yr/unit of wet wastes at approximately 21 Ci/drum and approximately 600 drums/yr/unit of low level dry wastes containing less than 5 Ci/yr total. The applicant estimates the quantity of solid waste generated to be approximately 240 drums/yr/unit of wet wastes containing an average of 25 Ci/drum. The applicant estimates dry wastes to total approximately 120 drums/yr/unit. The applicant estimates that an additional 300 drums/yr/unit of spent resins from the steam generator blowdown processing system containing less than 0.05 Ci/drum will be processed for bulk shipment. Low level wastes will be shipped monthly.

All containers will be shipped to a licensed burial site in accordance with AEC and Department of Transportation regulations. The proposed system design is similar to systems which have been previously approved and installed at other operating reactors. Based on the solid waste system's similarity to previously approved and operating systems, we conclude that the solid radioactive waste system will be able to package and store radioactive wastes according to existing regulations. We also conclude that the system will allow handling of the wastes so that doses to operators will be in accordance with existing regulations. We therefore, find the solid waste system to be acceptable.

11.5 Design

Major components of the gaseous and liquid waste systems will be designed to Quality Group C and non-seismic Category I in accordance with Regulatory Guides 1.26 and 1.29. The radwaste equipment will be housed in a seismic Category I structure. We conclude that the radwaste system design codes are in accordance with appropriate codes and standards and are acceptable.

11.6 Process and Area Radiation Monitoring Systems

The process radiation monitoring system is designed to provide information on radioactivity levels of systems throughout the plant, on leakage from one system to another, and on levels of radioactivity released to the environment. The system will consist of process and effluent monitors for the following gaseous systems:

1) waste gas processing, containment air (particulate, radioactive gas, and iodine); 2) condenser air ejector and turbine building exhaust (particulate, radioactive gas, and iodine); 3) plant vent (particulate, radioactive gas, and iodine); 4) fuel handling building exhaust (radioactive gas); 5) gas decay tank and compressor area ventilation exhaust (radioactive gas); 6) control room ventilation intake (radioactive gas). Scintillation detectors for liquid process and effluent monitoring will be provided for

the following systems: 1) boron recycle system; 2) component cooling water system; 3) auxiliary component cooling water systems; 4) waste processing liquid effluent; 5) steam generator liquid sample systems; 6) steam generator blowdown processing system; 7) nuclear service water system; 8) turbine building drains. All monitors will alarm in the control room if radiation measurements exceed a predetermined level. Radiation monitoring channels will be checked daily, tested monthly, and calibrated during plant shutdowns.

The area radiation monitoring system is designed to provide information on radioactivity fields in various areas in the plant where the potential for personnel exposure to radiation exists. Upon high radiation signal alarms will be initiated in the control room and in the detector area. The monitors will consist of ionization chambers with a sensitivity range from 10^{-4} to 1 rem/hr. Setpoints will be based on local background levels. Monitors will be located in the following areas: 1) containment interior, 2) containment incore instrument area, 3) enclosure building, 4) spent fuel pool, 5) control room, 6) radiochemistry laboratory, 7) sampling room, 8) drumming station, 9) charging pump room, 10) auxiliary building low activity filter area, 11) auxiliary building ion exchanger valve area, and 12) laundry room.

The system will detect, indicate, annunciate and/or record the levels or fields of activity to verify compliance with 10 CFR Part 20 and keep the radiation levels as low as practicable. We conclude that the plant is adequately provided with process and area monitoring equipment to monitor effluent discharge paths as specified in Criterion 64 in Appendix A to 10 CFR Part 50.

11.7 Conclusions

Based on our model and assumptions, we calculate an expected whole body and organ dose of less than 5 mrem/yr to an individual from gases and less than 5 mrem/yr from liquids at or beyond the site boundary. We calculate the potential dose to a child's thyroid from the pasture-cow-milk chain to be greater than 15 mrem/yr, but the applicant has proposed to use state-of-the-art technology to control radioiodine releases and will implement a monitoring program to verify that the actual dose to the thyroid will not exceed our as low as practicable guidelines. Therefore, we conclude that the proposed liquid, gas and solid waste treatment systems meet the requirements of "as low as practicable" of 10 CFR Part 20 and 10 CFR Part 50.

We also conclude that the radwaste systems will be designed in accordance with acceptable codes and standards, and that the process monitoring system is adequate for monitoring effluent discharge paths as specified in Criterion 64 of Appendix A to 10 CFR Part 50.