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ENVIRON, FILE (NEPA)

Docket No. 50-263

Harold R. Denton, Assistant Director for Site Safety, DL
Thru: Robert L. Tedesco, Assistant Director for Containment Safety, DL

RADWASTE SECTION FOR ENVIRONMENTAL STATEMENT FOR MONTICELLO NUCLEAR GENERATING PLANT

In response to your request, we have prepared and attached to this memo the Radwaste Section for Monticello Nuclear Plant. The numerical source terms were transmitted to you informally on April 12, 1972.

The source terms were prepared by J. T. Collins from data supplied by ORNL. The principal assumptions used are documented in the writeup, other assumptions are those transmitted to you by my memo of April 24, 1972. The glossy prints showing the liquid and gaseous waste treatment systems were transmitted to you informally on April 28, 1972 and May 3, 1972, respectively.

Original signed by
Victor Benaroya

Victor Benaroya, Chief
Effluent Treatment Systems Branch
Directorate of Licensing

Attachment:
As stated above

cc: F. Schroeder
A. Giambusso
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CS Branch Chiefs
D. Muller
R. Boyd
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G. Knighton
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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

May 12, 1972

Docket No. 50-263

Harold R. Denton, Assistant Director for Site Safety, DL
Thru: Robert L. Tedesco, Assistant Director for Containment Safety, DL

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WASTE TREATMENT SECTION FOR ENVIRONMENTAL STATEMENT
MONTICELLO NUCLEAR PLANT

2. Radioactive Wastes

During the operation of the Monticello Nuclear Generating Plant, radioactive material will be produced by fission and by neutron activation reactions in metals and other materials in the reactor system. Small amounts of gaseous and liquid radioactive wastes will enter the wastes streams, which are monitored and processed within the plant to minimize the amount of radioactive nuclides that will ultimately be released to the atmosphere and to the Mississippi River. The radioactivity that may be released during operation of the plant will be in accordance with the Commission's regulations, as set forth in 10 CFR Part 20 and 10 CFR Part 50.

The waste handling and treatment systems installed at the plant are discussed in the Final Safety Analysis Report of October 17, 1968, and in the applicant's Environmental Report dated November 5, 1971. The waste treatment systems described in these reports and in the following paragraphs are designed to collect and process the gaseous, liquid and solid waste which may contain radioactive materials.

a. Gaseous Wastes

During power operation of the plant, radioactive materials that may be released to the atmosphere in gaseous effluents include fission-product noble gases (krypton and xenon) and halogens (mostly iodine); activated argon, oxygen and nitrogen; tritium contained in water vapor; and particulate material including both fission products and activated corrosion products. Fission products are released to the primary coolant and carried to the turbine by the steam.

The major source of gaseous radioactive waste during normal plant operation will be the offgas from the main steam condenser air ejectors. In the present system, offgases from the main condenser consist of approximately 200 cfm of hydrogen and oxygen from decomposition of water and 20 cfm of air from inleakage plus trace concentrations of radioactive xenon and krypton. The noncondensible gases are delayed for a minimum of thirty minutes in a holdup pipe to allow for the decay of short-lived fission product noble gases and activation gases, filtered through high efficiency particulate filters, and released to the atmosphere through the main stack with dilution air. The radioactive materials released through this system represent greater than 90% of the activity available from gaseous effluents. In our evaluation we assumed that 90% of the radioiodine which may be present in the offgas from the air ejectors will be removed in the steam jet condenser.

Other sources of gaseous waste include the main steam turbine gland seal system; offgases from the mechanical vacuum pump used during startup; ventilation air released from the radwaste, reactor and turbine building exhaust systems; and purging of the drywell and suppression chamber. The systems for the processing of radioactive gaseous waste and ventilation paths are shown schematically in Figure III-5.

The turbine gland seal system which provides a seal on the turbine packing gland is being operated with primary steam and therefore expected to be a contributing source of airborne activity. The steam air exhaust from this system passes through a gland seal condenser where the steam is condensed and non-condensibles exhausted to the gland seal holdup line. Radioactive gases released by way of this system are delayed for about 2 minutes to allow decay of the major activation gases (N-16 and O-19) and released without additional treatment through the 328 ft stack. The mechanical vacuum pump, used during startup, exhausts air and radioactive gases from the main steam condenser. Offgases from this system are discharged to the gland seal holdup line before being released to the main stack. In our evaluation we assumed that the mechanical vacuum pump will be operated approximately 10 hours per year with an estimated release of 1040 curies of noble gases. The isotopic mixture will vary depending on the decay time in the condenser.

The turbine building, reactor building and radwaste building ventilation systems are once-through ventilation with air passing from relatively clean areas to those with higher radioactivity potential. Normally the ventilation air in the reactor building is discharged to the building vent without treatment; however, in the event of abnormal air activity levels, this air will be routed through the standby gas treatment system (HEPA and charcoal adsorbers in series) prior to being released through the main stack. Potentially contaminated areas of the radwaste building are exhausted through prefilters and HEPA filters and released through the plant vent.

Release of radioactivity from the upper area of the turbine building through a roof mounted exhaust fan is not anticipated. The purpose of this system is to maintain desired ambient conditions above the operating floor utilizing once-through ventilation. The ventilation air from equipment areas and lower levels of the turbine building is exhausted to the main plenum and released through the plant vent without treatment.

The primary containment (drywell) is normally a sealed volume. However, during periods of refueling or maintenance it may be necessary to purge the drywell and suppression chamber and, when this occurs, the potential exists for the release of airborne radioactivity to the environment. The system is arranged such that the purge exhaust can be directed to the standby gas treatment system in the event of abnormal air activity levels. Releases through this system are not expected to be a contributing source of radioactivity.

Estimated annual releases of radioactive materials in gaseous effluent from the plant during normal operation, including expected operational occurrences, are shown in Table III-1. Estimated releases from primary and secondary sources are summarized in Table III-2. The estimated releases were based on a minimum holdup time of 30 minutes for gaseous effluent released from the main condenser air ejectors. Conditions and principal assumptions considered in our evaluation of the waste treatment systems are given in Table III-3.

During the first year of operation of the plant (March 1971), releases of radioactivity have been lower than expected. From the values shown in Table III-1, a release rate of 44,000 μCi/sec is expected; however, the level of release during the startup and shakedown period at full power operation has been approximately 10,000 μCi/sec as shown in Table III-7.

To reduce the quantities of radioactive gaseous effluents released to the atmosphere, Northern States Power Company has undertaken a plant modification to install additional holdup equipment. In the modification, expected to be completed by December 1972 (see Figure III-5); offgases from the main condenser will be processed through a catalytic recombiner where the hydrogen and oxygen will be reacted to form water, thereby reducing by tenfold the volume of gases which must be treated. The water will be removed by the offgas condenser and moisture separator and discharged to the liquid waste system for further treatment. The noncondensible gases will be delayed for a minimum of five hours in the present holdup pipe, filtered through charcoal adsorbers and HEPA filters, compressed to 300 psig and stored in one of five (1250 ft^3) holdup tanks. Prior to discharge through the main stack, the offgases will again be filtered through charcoal adsorbers and HEPA filters. The system will provide at least 50 hours additional decay time. In our evaluation we assumed that nearly all of the radioiodine which may be present in the offgas from the main condenser will be removed in either the recombiner condenser or by the double treatment through the charcoal adsorbers. The calculated annual releases of gaseous waste after the modification has been completed are shown in Table III-4. Based on our evaluation, the calculated annual

TABLE III-1

ESTIMATED RELEASES OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENT FROM MONTICELLO NUCLEAR GENERATING PLANT

CURIES PER YEAR

Nuclide	Reactor Building	Turbine Building	Gland Seal 2 min. Holdup	Main Condenser Air Ejector 30 Min. Holdup	Total
Kr-83m	------	15	42	35,500	35,600
Kr-85m	------	25	70	65,000	65,170
Kr-85	------	0.1	0.4	364	365
Kr-87	------	75	207	160,500	160,800
Kr-88	------	81	226	201,300	201,600
Kr-89	------	280	517	1,150	1,950
Xe-131m	------	0.1	0.3	320	320
Xe-133m	------	1.6	4.5	4,430	4,440
Xe-133	------	44	125	124,600	124,800
Xe-135m	------	129	333	96,800	97,300
Xe-135	------	127	357	344,200	344,700
Xe-137	------	484	953	5,900	7,340
Xe-138	------	406	1055	336,300	337,800
Total		1670	3890	1,376,000	1,382,000
I-131	0.009	0.57	0.16	8.0	8.7
I-133	0.03	2.8	0.8	39.	42.6

TABLE III-2

GASEOUS EFFLUENTS
SUMMARY

Present System	Ci/yr Noble Gas	Ci/yr I-131
Main Condenser Air Ejector	1.38×10^6	8.0
Turbine Building	1.67×10^3	5.7×10^{-1}
Reactor Building	---	9×10^{-3}
Mechanical Vacuum Pump	1.04×10^3	
Gland Seal	3.89×10^3	1.6×10^{-1}
	1.38×10^6	8.77

Augmented System	Ci/yr Noble Gas	Ci/yr I-131
Main Condenser Air Ejector	1.06×10^5	7×10^{-3}
Turbine Building	1.67×10^3	5.7×10^{-1}
Reactor Building	---	9×10^{-3}
Mechanical Vacuum Pump	1.04×10^3	
Gland Seal	3.89×10^3	1.6×10^{-1}
	1.12×10^5	7.5×10^{-1}

TABLE III-3

CONDITIONS USED IN DETERMINING
RELEASES OF RADIOACTIVITY IN EFFLUENTS
FROM MONTICELLO NUCLEAR GENERATING PLANT

Thermal Power	1670 Megawatts
Total Steam Flow	6,770,000 lb/hr
Plant Factor	0.8
Cleanup Demineralizer Flow	80,000 lb/hr
Failed Fuel	equivalent to 100,000 μCi/sec with 30 min. holdup
Leaks	
Reactor Bldg.	480 lb/hr - liquid
Turbine Bldg.	2,400 lb/hr - steam
Condenser Air Inleakage	20 cfm - air
Turbine Gland Seal Steam	0.1% of steam flow
Partition Coefficients (Iodine)	
Steam/Liquid in reactor	0.012
Reactor Bldg. liquid leak	0.001
Turbine Bldg. seam leak	1.0
Gland Seal	0.1
Air Ejector	0.005
Holdup Times	
Gland Seal Gas	2 minutes
Air Ejector Gas	30 minutes
Modified System	50 hours
Clean Waste System - liquids	1 day
Dirty Waste System - liquids	1 day
Chemical Waste System - liquids	1 day
Flow Rate	
Clean Waste System	21,000 gpd
Dirty Waste System	8,200 gpd
Chemical Waste	500 gpd
Decontamination Factors	
Powder filter/demineralizers (except Y, Mo and ^3H)	10
Mixed bed demineralizer	100
except: Cs and Rb	10
Y, Mo and ^3H	1
Removal factors to account for plateout	
Mo and Tc - 99m	100
Y	10
Dilution Flow	280,000 gpm

TABLE III-3 (cont'd)

Number and Capacity of Collector Tanks

No.	Name	Capacity (gals.)
1	Waste Surge Tank	35,000
2	Waste Sample Tanks	10,000 each
1	Condensate Backwash Receiving Tank	8,500
1	Waste Collector Tank	10,000
2	Condensate Phase Separator Tanks	12,000 each
2	Condensate Storage Tank	220,000 each
1	Waste Sludge Tank	7,500
2	Clean-up Phase Separator Tanks	3,000 each
2	Laundry Drain Tanks	1,000 each
1	Floor Drain Collector Tank	10,000
1	Floor Drain Sample Tank	10,000
1	Chemical Waste Tank	4,000

TABLE III-4

CALCULATED CURIE RELEASES OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENT FROM MONTICELLO NUCLEAR GENERATING PLANT AUGMENTED SYSTEM*

Nuclide	Reactor Building	Turbine Building	Gland Seal 2 Min. Holdup	Main Condenser Air Ejector 50 Hr. Holdup	Total
Kr-83m	------	15	42	------	57
Kr-85m	------	25	70	27	120
Kr-85	------	0.1	0.4	364	365
Kr-87	------	75	207	------	282
Kr-88	------	81	226	0.9	308
Kr-89	------	280	517	------	798
Xe-131m	------	0.1	0.3	280	280
Xe-133m	------	1.6	4.5	2,360	2,366
Xe-133	------	44	125	95,000	95,170
Xe-135m	------	129	333	------	460
Xe-135	------	127	357	8,300	8,790
Xe-137	------	484	953	------	1,440
Xe-138	------	405	1,005	------	1,460
Total		1,670	3,890	106,340	111,900
I-131	0.009	0.57	0.16	.007	0.75
I-133	0.03	2.8	0.8	.007	3.64

*To be installed by the end of calendar year 1972.

release rate of 44,000 μCi/sec of noble gases from the 30-minute holdup pipe will be reduced to about 3600 μCi/sec after the modification which consists of a 50-hour holdup. The total iodine and particulate releases have been calculated at about 0.75 curie per year as I-131.

b. Liquid Waste

Radioactive and potentially radioactive liquid wastes are collected, monitored, processed, stored and prepared for disposal by the radwaste treatment system. These wastes are classified, collected and treated as high purity, low purity, chemical, laundry and sludge or concentrated wastes. The system is designed to handle these wastes separately or on a combined basis. Cross connections between the subsystems provide flexibility for processing by alternate methods.

High purity wastes (low-conductivity) consist of liquids collected by equipment drains from the drywell and the reactor turbine and radwaste buildings and the decantate from the centrifugation of backwashed resins and sludges. Low-purity wastes (high conductivity) are collected by floor drains from the drywell and the reactor turbine and radwaste buildings. Miscellaneous chemical wastes are collected from the laboratory and from the laundry and decontamination areas.

The applicant plans to recycle water as a fundamental plant process. Both the condensate powdex filter and the reactor water powdex filter are designed to assure requisite purity and activity levels to permit recycling of most of the water processed by the liquid radwaste system. In addition, nearly all of the high purity and low purity, along with some portions of the miscellaneous chemical wastes and laundry rinses, are combined, processed and reused in the reactor. The sources of liquid waste and the systems for processing these wastes are shown in Figure III-6.

To carry out this program of combined treatment, the liquids in the waste collector tank and floor drain collector tank are blended and continuously recirculated through a powdex filter and sent back to the waste collector tank with occasional input from the chemical waste collector tank. These latter wastes are normally mixed with cement to aid in solidification of sludges as solid wastes. The combined wastes are recycled through the filter system until the collector tank is filled, at which time the waste is processed through a fresh powdex filter and mixed-bed demineralizer and collected in one of two waste sample tanks. The design of the system is such that one of the fuel-pool storage filter-demineralizers can be used as a backup for the radwaste filter-demineralizers. After the batch has been sampled and analyzed, the wastes are normally returned to the condensate storage tanks for reuse in the reactor. A recycle line is provided to return off-standard water either to the waste collector or the waste surge tanks for reprocessing. Presently, all liquid wastes generated during normal operation are being returned to the plant for reuse. In our evaluation, considering expected operational occurrences and equipment availability, we assumed that 10 percent of the water processed through the mixed-bed demineralizer will be released from the plant each year.

Liquid waste from the plant can only be released by one pathway, i.e., from the floor drain sample tanks in the radwaste treatment system. If after sampling and analysis the radioactivity is below a prescribed level, it will be discharged and monitored. Should the liquid waste require further processing, it will be routed back to the waste collector tank.

Chemical wastes, including laundry rinses, are collected in the chemical waste tank where they are sampled and analyzed. If found suitable for combining with the lower conductivity wastes, they are sent to the floor drain collector tank for further processing. The chemical wastes and filtered laundry wastes, which would require too much processing to render the water suitable for eventual reuse as coolant, are used as a wetting agent for the cement in the solid waste packaging system. For purposes of this analysis, it was assumed that 10 percent of the chemical and laundry wastes are released after filtration through a precoated filter unit to the discharge canal.

Phase separator tanks receive sludges and spent resins from the reactor cleanup system and the condensate demineralizer system. The backwash liquid decantate is returned to the waste collector tank and recovered for reuse. The waste filter sludge, the fuel pool filter/demineralizer sludge, and the floor drain filter sludge are collected in the waste sludge tank and eventually dewatered and solidified with cement in 55-gallon drums.

Based on our evaluation of the liquid waste treatment, it appears that the system as installed is capable of reducing the amount of radioactivity in liquid effluents during normal operation to well within the limits specified in 10 CFR Part 20. This is particularly true if the treatment system is operated as it presently is, through combining of waste streams coupled with continuous recirculation through filters and polishing with a mixed-bed demineralizer. Based on the first year of operation, releases have been a fraction of those values shown in Table III-5. However, to compensate for process

TABLE III-5

CALCULATED ANNUAL RELEASE OF RADIOACTIVE MATERIAL
IN LIQUID EFFLUENTS FROM MONTICELLO NUCLEAR STATION
(100% Power)

Nuclides	Ci/yr	Nuclides	Ci/yr
Rb-86	0.00040	Rh-103m	0.0017
Sr-89	0.26	Rh-105	0.0018
Sr-90	0.015	Rh-106	0.00050
Sr-91	0.17	Sn-125	0.000016
Y-90	0.053	Sb-125	0.0000077
Y-91m	0.12	Sb-127	0.00013
Y-91	0.18	Te-125m	0.000071
Y-93	0.22	Te-127m	0.00046
Zr-95	0.0028	Te-127	0.0013
Zr-97	0.0019	Te-129m	0.0045
Nb-95	0.0025	Te-129	0.0029
Nb-97m	0.0019	Te-131m	0.0059
Nb-97	0.0019	Te-131	0.0010
Mo-99	0.47	Te-132	0.060
Tc-99	0.44	I-130	0.0021
Ru-103	0.0017	I-131	0.36
Ru-106	0.00050	I-132	0.060

TABLE III-5 (cont'd)

Nuclides	Ci/yr	Nuclides	Ci/yr
I-133	0.74	Pm-149	0.00093
I-135	0.10	Sm-153	0.00042
Cs-134	0.20	Na-24	0.012
Cs-136	0.076	P-32	0.000076
Cs-137	0.19	Cr-51	0.017
Ba-137m	0.18	Mn-54	0.0031
Ba-140	0.43	Fe-55	0.075
La-140	0.23	Fe-59	0.024
Ce-141	0.0093	Co-58	0.17
Ce-143	0.0075	Co-60	0.017
Ce-144	0.0017	Cu-64	0.019
Pr-143	0.0029	Zn-65	0.00077
Pr-144	0.0017	Zn-69m	0.00016
Nd-147	0.00095	W-187	0.019
Pm-147	0.00023		

TOTAL ∿ 5 Ci

H-3 ∿ 20 Ci

equipment malfunction and downtime and expected operational occurrences, the values have been normalized to 5 curies. The calculated releases of tritium shown in Table III-5 are based on operating experience.

c. Operational Experience

During the course of operating the Monticello reactor under normal conditions and at an annual average full load factor of 80%, the amount of radioactivity released to the environment is anticipated to be greater than that shown for the first year of operation. The applicant expects the total annual release of radioactive materials in liquid effluents will be about 3 curies including tritium and that the annual average gaseous radioactivity release rate with the existing 30-minute offgas holdup system will be about 25,000 µCi/sec. The actual releases of radioactivity for the first year of operation (approximately 49% plant capacity factor) are shown in Tables III-6 and III-7.

d. Solid Wastes

Solid wastes are generated from the operation and maintenance of waste process systems, reactor systems, and plant support systems. The solid waste processing and handling operations are carried out remotely in ventilated areas.

Filter sludges from the reactor clean-up, fuel pool, condensate-filter/demineralizers, radwaste filters and spent resins from the mixed-bed demineralizer make up the largest volume of solid waste. The sludges and resins are dewatered by centrifugation after storage in phase separator tanks. The dewatered material is mixed with cement, and placed in a 55-gallon drum. The drum is sealed remotely, decontaminated, and placed in an appropriately shielded area.

Bulk wastes from the reactor system, such as control rod blades, fuel channels, and in-core-ion chambers are stored in the spent-fuel storage pool before being removed from the plant in approved shipping containers. Compactible dry wastes are collected in drums at the source locations, transferred to the radwaste building, and compressed by a hydraulic press-baling machine.

Certain chemical wastes that are not suitable for reuse are mixed with cement during drumming operations or are placed directly in 55-gallon drums previously filled with an absorbent and removed from the plant as solid waste.

Based on present operating conditions, it is estimated that approximately 33,000 ft^3 of solid waste per year containing

TABLE III-6

MONTICELLO NUCLEAR GENERATING PLANT
LIQUID RELEASES - 1971

1971	Ci/Month Gross Activity	Ci/Month Tritium	Vol. of Liquid (Liters)
January	3×10^{-7}	1×10^{-3}	2×10^{5}
February	6×10^{-7}	1.4×10^{-3}	9.2×10^{5}
March	4×10^{-6}	4×10^{-4}	7.8×10^{4}
April	1×10^{-5}	4×10^{-3}	4.9×10^{4}
May	4×10^{-4}	8×10^{-4}	8.6×10^{4}
June	6×10^{-4}	6×10^{-3}	1.4×10^{5}
July	7×10^{-3}	9×10^{-3}	7.9×10^{4}
August	1.5×10^{-4}	4×10^{-4}	1.9×10^{4}
September	6×10^{-3}	2.5×10^{-1}	1.4×10^{5}
October	1×10^{-5}	3.2×10^{-4}	1.6×10^{4}
November	2×10^{-4}	3.2×10^{-1}	2×10^{5}
December	8×10^{-5}	1×10^{-3}	8.8×10^{4}
TOTAL	0.014	0.6	1.2×10^{6}

TABLE III-7

MONTICELLO NUCLEAR GENERATING PLANT
GASEOUS RELEASES - 1971

1971	Ci/Month Noble Gases	Ci/Month Iodine	μCi/sec.
January	------	------	------
February	------	------	------
March	12	0.000006	150
April	58	0.000026	900
May	710	0.00032	1,875
June	550	0.00025	900
July	1,283	0.0017	11,250
August	16,700	0.0017	14,250
September	21,100	0.015	15,000
October	26,300	0.0082	14,250
November	9,140	0.0046	11,500
December	------	0.00044	11
TOTAL	76,000	0.032	

53 curies will be shipped offsite for disposal. In addition, approximately 80 barrels of compacted wastes will be shipped offsite annually. All solid waste will be packaged and shipped in accordance with AEC and DOT Regulations.