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TECHNICAL EVALUATION REPORT

TECHNICAL EVALUATION REPORT FOR THE EVALUATION
OF ODCM UPDATED THROUGH REVISION 9
PRAIRIE ISLAND NUCLEAR GENERATING PLANT
UNITS 1 AND 2

T. S. Bohn
W. Serrano
C. R. Amaro
M. R. Winberg

EG&G Idaho

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Prepared for the
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DISCLAIMER

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PRAIRIE ISLAND NUCLEAR GENERATING PLANT UNITS 1 AND 2

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T. S. Bohn
W. Serrano
C. R. Amaro
M. R. Winberg

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Idaho National Engineering Laboratory
EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

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ABSTRACT

The Offsite Dose Calculation Manual for the Prairie Island Nuclear Generating Plant (PNGP) Units 1 and 2 contains current methodology and parameters used in the calculation of offsite doses due to radioactive liquid and gaseous effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, and in the execution of the environmental radiological monitoring program. ODCM Revision 2, dated August 6, 1982 was submitted by the Licensee with letter dated August 13, 1982 to the NRC and received initial approval on October 21, 1982. Since then, Revisions 3 through 9 have been submitted to the NRC. The latest revision, Revision 9, dated June 29, 1987, was submitted on August 28, 1987 with the Semiannual Effluent Report for January-June 1987. The NRC transmitted the ODCM updated through Revision 9 to the Idaho National Engineering Laboratory (INEL) for review. The ODCM was reviewed in its entirety by EG&G Idaho at the INEL and the results of the review are presented in this report. It was determined that the ODCM updated through Revision 9 uses methods that are, in general, in agreement with the guidelines of NUREG-0133. However, it is recommended that another revision to the ODCM be submitted to address and correct the discrepancies identified in the review.

FOREWORD

This report is submitted as partial fulfillment of the "Review of Radiological Issues" project being contracted by the Idaho National Engineering Laboratory for the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation. The U. S. Nuclear Regulatory Commission funded the work under FIN D6034 and NRC B&R Number 20 19 05 03.

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1. INTRODUCTION

Purpose of Review

This document reports the review and evaluation of the Offsite Dose Calculation Manual (ODCM) updated through Revision 9, submitted by the Northern States Power Company (NSP), the Licensee for the Prairie Island Nuclear Generating Plant (PNGP), Units 1 and 2. The ODCM is a supplementary document for implementing the Radiological Effluent Technical Specifications (RETS) in compliance with 10 CFR 50, Appendix I requirements.[1]

Plant-Specific Background

The NSP submitted Revision 2 of the ODCM, dated August 6, 1982, for PNGP to the Nuclear Regulatory Commission (NRC). The NRC reviewed the ODCM and found it, in general acceptable as stated in letter dated October 21, 1982.[2] Since then, Revisions 3 through 9 have been made with changes indicated in the RECORD OF REVISIONS on page 5 of Revision 9 of the ODCM and changes submitted to the NRC with subsequent semiannual reports. The latest revision, Revision 9, dated June 29, 1987, was submitted to the NRC on August 28, 1987 with the Semiannual Effluent Report for January-June 1987.[3] The NRC transmitted the ODCM updated through Revision 9, to an independent review team at the Idaho National Engineering Laboratory (INEL). The INEL team reviewed the ODCM in its entirety and the results and conclusions are presented in this report.

2. REVIEW CRITERIA

Review criteria for the ODCM were provided by the NRC in two documents:

NUREG-0472, RETS for PWRs[4]
NUREG-0133, Preparation of RETS for Nuclear Power Plants.[5]

The following NRC guidelines were also used in the ODCM review: "General Contents of the Offsite Dose Calculation Manual," Revision 1[6], and Regulatory Guide 1.109, Revision 1.[7]

As specified in NUREG-0472, the ODCM is to be developed by the Licensee to document the methodology and approaches used to calculate offsite doses and maintain the operability of the radioactive effluent systems. As a minimum, the ODCM should provide equations and methodology for the following:

- Alarm and trip setpoints on effluent instrumentation
- Liquid effluent concentrations in unrestricted areas
- Gaseous effluent dose rates at or beyond the site boundary
- Liquid and gaseous effluent dose contributions
- Liquid and gaseous effluent dose projections.

In addition, the ODCM should contain flow diagrams that define the treatment paths and the components of the radioactive liquid, gaseous, and solid waste management systems. These flow diagrams should be consistent with the systems being used at the plant. A description and the location of samples in support of the environmental monitoring program are also needed in the ODCM.

3. EVALUATION

There are two operating PWRs (Unit 1 and Unit 2) at the Prairie Island Nuclear Generating Station. The ODCM is for both units and contains the methodology and parameters to be used in the calculation of offsite doses due to radioactive liquid and gaseous effluents, in the calculation of liquid and gaseous effluent monitoring instrumentation alarm and/or trip setpoints, and in the conduct of environmental radiological environmental monitoring. The ODCM provides information and methodologies to be used to assure compliance with PNGP's Operating Technical Specifications relating to liquid and gaseous radiological effluents discharged from Units 1 and 2.

Liquid Effluent Pathways

PNGP is located on the southeastern border of Minnesota. The site is situated on the west bank of the Mississippi River, approximately 6 miles northwest of the city of Red Wing, Minnesota.

Water for the main condenser cooling system is taken from the Mississippi River, with any discharges from the system returned to the river via a discharge canal and discharge structure. The cooling water discharge rate can vary from 75 cfs/unit in the cooling tower mode to 680 cfs/unit in the once-through mode. The system normally operates in the cooling tower mode.

The two units share common radwaste treatment systems as well as major release points for liquid effluents. The design objective for the liquid radwaste system is to process the waste so that the radioactivity discharged will approach essentially zero under normal operating conditions and will be a small fraction of the 10 CFR 20 limits.

The liquid radwaste system collects, processes, stores and disposes of all radioactive liquid wastes. There are three liquid processing systems: the Chemical and Volume Control System (CVCS), the Aerated Drain Treatment System (ADT), and the Steam Generator Blowdown Treatment System (SGBD).

Once the wastes are processed they are collected in the following waste tanks and discharged.

Aerated Drains Monitor Tanks (2)
Chemical and Volume Control System Monitor Tanks (2)
Steam Generator Blowdown Monitor Tanks (2)

The discharged liquid effluent is diluted by water from the cooling tower blowdown in the discharge canal and released to the Mississippi River.

Simplified diagrams for the liquid effluent treatment system and pathways and the solid radwaste treatment system are not included in this ODCM. Figure 1 in this report is a copy of a simplified diagram of the liquid effluent treatment system obtained from NUREG/CR-4397[8] which may or may not reflect the as-built systems at the plant.

Liquid Effluent Monitor Setpoints

Section 2.1 of the ODCM contains the methodology used to determine the isolation setpoints for the radiation monitors for the liquid radwaste effluent line, steam generator blowdown lines for Units 1 and 2, and for the alarm setpoint for the discharge canal monitor in compliance with Technical Specification 3.9.E.a.

It appears from the write-up in the ODCM that there are three monitored lines that feed a common header before release to the discharge canal or the blowdown line. However, since no simplified diagram of the liquid radwaste release pathways is included in the ODCM it is not clear if this is the correct interpretation. The setpoint calculation for each monitor

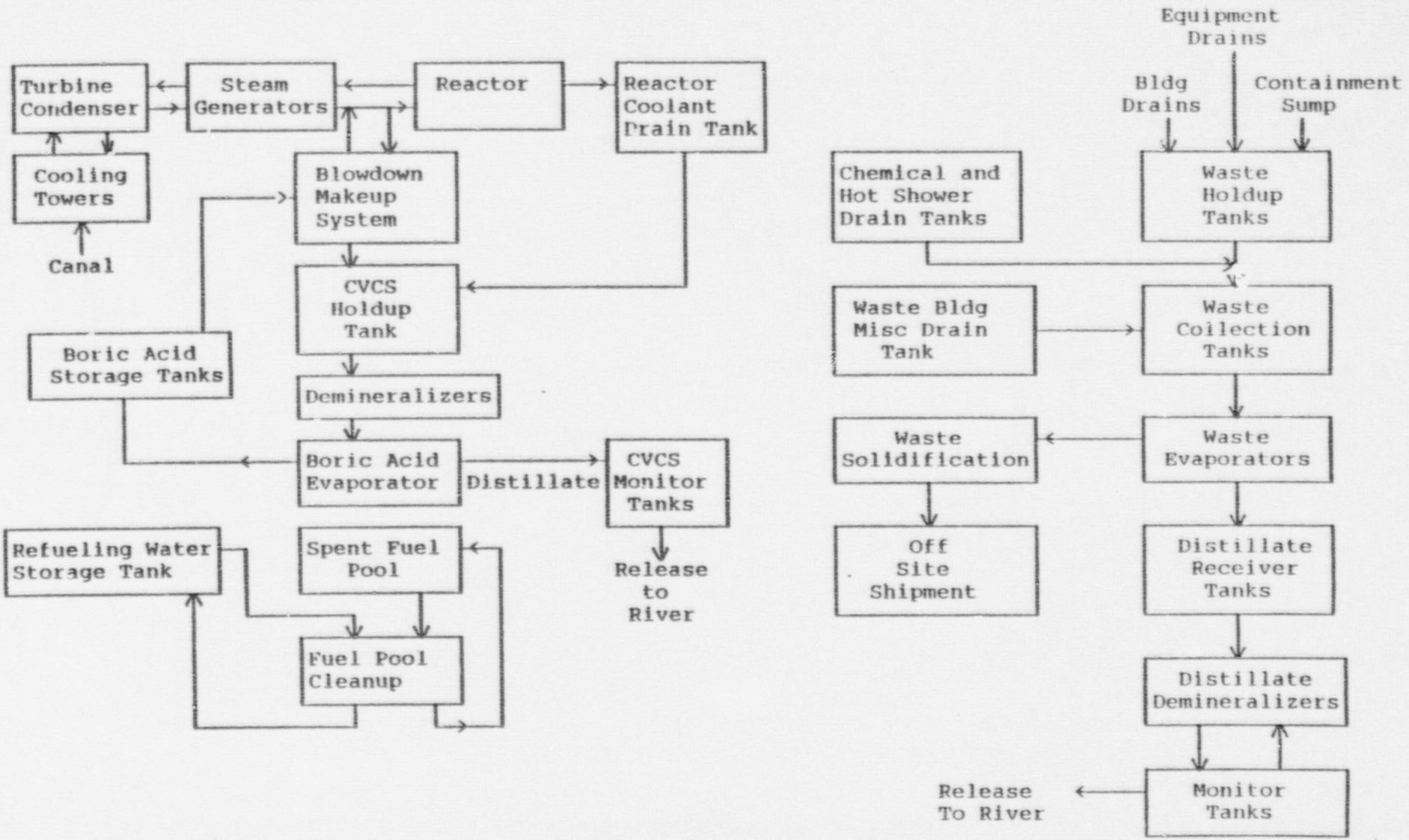

Figure 1. Prairie Island Nuclear Generating Plant liquid radwaste system. (Taken from In-Plant Source Term Measurements at Prairie Island Nuclear Generating Station, NUREG/CR-4397, September 1985).

includes an assigned T_m fraction of allowed release to ensure meeting the concentration limits in the event of simultaneous releases from the three lines. In Sections 2.1.1.5 and 2.1.2.1 of the ODCM, the parameter T_m is defined as a fraction of radioactivity that may be discharged from each release point to ensure that the site boundary dose rate limit is not exceeded due to simultaneous releases. It is not clear how this methodology will ensure compliance with a "dose rate" limit as part of the setpoint calculation since the setpoint calculation is based on the concentration limits. Also, the technical specifications do not require compliance to a dose rate limit at the site boundary due to radioactive liquids released. In Section 2.1.2.1, F is incorrectly defined as 67,3000 gpm instead of 67,300 gpm.

The methodologies described in Section 2.1 to determine the setpoints for the radioactivity monitors in the liquid radwaste system are, in general, in agreement with the guidelines of NUREG-0133 and are considered acceptable.

Gaseous Effluent Pathways

According to Technical Specification Table TS.3.9-2, PNGP has six release points for gaseous effluents:

Unit No. 1 Reactor Building Vent
Unit No. 1 Auxiliary Building Vent
Unit NO. 2 Reactor Building Vent
Unit No. 2 Auxiliary Building Vent
Spent Fuel Pool Vent
Radwaste Building Vent

This list is consistent with Table 3.1-1 of the ODCM which identifies six release points and is inconsistent with Section 3.3.1 of the ODCM which states that noble gases are released from up to nine vents. Also, Table 3.1-1 of the ODCM identifies the Shield Building Vents for Units 1 and 2 as release points whereas Technical Specification Table TS.3.9-2

identifies the Reactor Building Vents for Units 1 and 2. All processed effluent gases released to the atmosphere from the release points are considered ground releases.

The technical specifications identify noble gas activity monitors, iodine sampler cartridges, particulate sampler filters and sampler flow monitors at each release point to monitor gaseous effluent releases. Each vent is continuously surveyed during release of noble gases and the noble gas monitors provide automatic termination of release (except for the radwaste building which has no automatic isolation function). The iodine and particulate samplers are analyzed routinely in accordance with Technical Specification Table TS.4.17-4.

The Technical Specification TS.3.9.B.4.f identifies a limit of 78,000 curies of noble gas in each waste gas decay tank (2) considered as dose equivalent Xe-133. Surveillance to determine the gas storage inventory is made on a monthly basis. If the tank's contents exceed 10,000 curies, the surveillance will be increased to daily.

A simplified diagram of the gaseous effluent treatment system and pathways is not included in this ODCM. Figure 2 in this report is a copy of a simplified diagram of the gaseous effluent treatment system obtained from NUREG/CR-4397[8] which may or may not reflect the as-built systems at the plant.

Gaseous Effluent Monitor Setpoints

Section 3.1 of the ODCM contains the methodology used to determine the setpoints for the gaseous radwaste radiation monitors as required by Technical Specification 3.9.F.a. Methodology for calculating the setpoints based on both the skin and whole body dose rates are included with the more conservative setpoint being used. Simultaneous releases from each of the release points are considered in the equations for determining the setpoints.

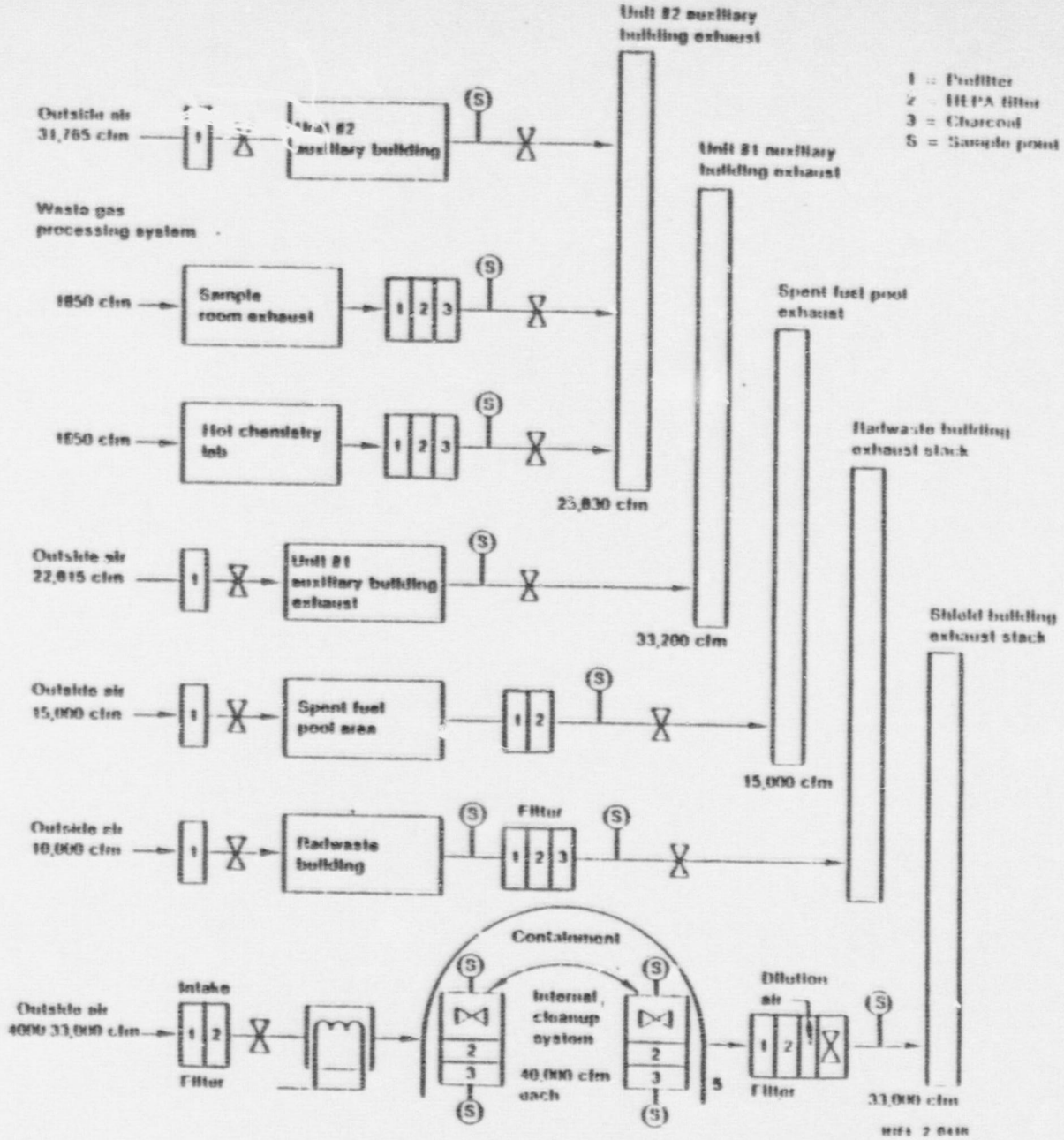

Figure 2 Prairie Island Nuclear Generating Plant gaseous radwaste treatment system. (Taken from In-Plant Source Term Measurements at Prairie Island Nuclear Generating Station, NUREG/CR-4397, September 1985.)

The methodology for determining the setpoints for the noble gas effluent monitors is in agreement with the guidelines of NUREG-0133 and is considered acceptable.

Concentrations in Liquid Effluents

Section 2.2 of the ODCM contains the methodology for determining the radioactivity concentrations in the released liquid effluents as required by Surveillance Technical Specification 4.17.A.1.c.

The radioactivity concentration for continuous radioactive liquid releases from the steam generator blowdown is regulated by the alarm/trip setpoints determined according to the methodology in the ODCM. Additional surveillance is provided by the analysis of weekly grab samples as required in Technical Specification Table TS.4.17-3.

The radioactivity concentrations for a liquid radwaste batch release is determined by analysis of a grab sample from the liquid waste batch tank prior to release. The summation of ratios of diluted liquid effluent radionuclide concentrations to the corresponding MPC values for each radionuclide for batch tank releases is set to less than or equal to 0.9 instead of less than or equal to 1.0 to allow for simultaneous releases from the steam generator blowdown for each unit.

The methodology for determining radioactivity concentrations in the released liquid effluents is within the guidelines of NUREG-0133 and is considered acceptable.

Dose Rates in Gaseous Effluents

Section 3.2.1 contains the methods for determining the noble gas dose rates as required by Surveillance Technical Specification 4.17.B.1.b. The total body and skin dose rates due to the release of noble gases are assured to be within the dose rate limits by correctly setting the setpoints for the noble gas monitors.

Section 3.2.2 of the ODCM contains the methods for determining the dose rate to any organ due to the release of I-131, tritium, and all radionuclides in particulate form with half lives greater than 8 days to areas at or beyond the unrestricted area as required by Surveillance Technical Specification 4.17.B.1.

The dose rate calculation is made prior to a radioactive gas batch release and weekly for all releases. The analysis source terms for the calculation are determined from the results of weekly analyses of the vent particulate filters and charcoal canisters and vent flow rate. The critical receptor location for the dose rate calculation is the site boundary with the highest X/Q.

The definition for P_i in Section 3.2.2 incorrectly identifies the infant as the critical age group whereas the data in Table 3.2-1 correctly lists the dose factors for the child age group which is the limiting age group for the thyroid dose rate via the inhalation pathway. The data in Table 3.2-1 are not specific to the thyroid but are composed of the largest dose factors for each of the organs for the child age group which are more conservative.

It is not clear why the term $(D_v - D_p)$ in Equation (3.2-2) should not be written as $(D_v + D_p)$.

With the exception of the above concerns, the methodology in Section 3.2.2, for determining the dose rate to any organ due to the release of I-131, tritium, and radionuclides in particulate form is, in general, in agreement with the guidelines of NUREG-0133 and is considered acceptable.

Dose Due to Liquid Effluents

Section 2.3 of the ODCM contains the methodology for determining the dose or dose commitment to a Member of the Public due to radioactive

material released in liquid effluents as required by Surveillance Technical Specification 4.17.A.2.a.

Doses to the members of the public due to radionuclides identified in the liquid effluents will be calculated monthly to show compliance with 10 CFR 50, Appendix I. Mississippi River water is not used as a potable water supply within 300 miles downstream of the PNGP. Therefore, PNGP identifies only the fish consumption pathway for the dose calculations assuming that the adult is the maximum exposed individual. The methodology includes near-field dilution factors specific to the plant.

In Section 2.3.1, the dilution flow, ADF_k, is supposed to be the average flow during the reporting period (e.g., one month, one quarter, or one year) and not the "actual dilution flow during the time period of release" as defined in Sections 2.3.1. If operating in a cooling tower mode, the value would be 1000 cfs for the reporting period. However, if operating in the once-through mode, the dilution flow would be the average dilution flow (discharge canal flow) during the reporting period. Additionally, ADF_k is defined as flow but the units are in gallons.

In Section 2.3.2, the Licensee should be aware that the latest value for the bioaccumulation factor for phosphorus is 3.0E+03 (pCi/kg)/(pCi/liter) instead of the value in Table A-1 of Regulatory Guide 1.109, Rev. 1.

The methodology for determining the projected dose due to the release of radioactivity in liquid effluents is, in general, in agreement with the guidelines of NUREG-0133. However, without a different definition for the dilution flow it is uncertain if the method is acceptable for use in the dose calculations.

Dose Due to Gaseous Effluents

Section 3.3.1 of the ODCM contains the methodology for calculating the cumulative gamma and beta air doses due to the release of radioactive

noble gases as required by Surveillance Technical Specification 4.17.B.2.a.

The methodology for calculating the air dose due to the release of radioactive noble gases is in agreement with NUREG-0133 and is considered acceptable.

Section 3.3.2 of the ODCM contains the methodology for calculating the cumulative dose due to the release of I-131, tritium, and radionuclides in particulate form with half-lives greater than eight days as required by Surveillance Technical Specification 4.17.B.2.a.

With the exception of the dose factors for tritium, the reviewer was unable to reproduce the dose factors contained in Tables 3.3-6 through 3.3-18. The tables contain the dose factors for the meat, cow-milk, and goat-milk pathways. In some cases the values obtained by the reviewer were 30% higher than those of the Licensee.

Section C.1 of Appendix C should be modified to address the child's thyroid instead of the infant's thyroid as follows:

a. "child" should replace "infant."
b. breathing rate is 3700 m^3/yr instead of 1400 m^3/yr.
c. $P_{i1} = 3.7 \times 10^9 \ DFA_i$ instead of $1.4 \times 10^9 \ DFA_i$
d. Table E-9 values from Regulatory Guide 1.109 Revision 1 should be used instead of Table E-10.

The methodology for calculating the cumulative dose due to the release of I-131, tritium, and radionuclides in particulates form with half-lives greater than eight days is, in general, in agreement with the guidelines of Regulatory Guide 1.109, Revision 1 and NUREG-0133. However, because of the uncertainty in the dose factors in Tables 3.3-6 through 3.3-18, it is uncertain if the dose calculations will result in values that can be used to compare with the dose limits of Technical Specification TS.3.9.B.3.a.

Dose Projections

Section 2.3.4 of the ODCM describes the method used to project doses due to the expected release of radioactive liquids to determine when additional components of the liquid radwaste treatment system will be used to process waste as required by Surveillance Technical Specification 4.17.A.3.a. The methodology for determining the dose projection due to liquid radwaste effluents is in agreement with NUREG-0133 and is considered acceptable.

Section 3.3.3 of the ODCM describes the method used to project doses due to the expected release of radioactive gaseous effluents to determine when the waste gas treatment system shall be operated as required by Surveillance Technical Specification 4.17.B.4.a. The methodology for determining the dose projection due to gaseous effluents is in agreement with NUREG-0133 and is considered acceptable.

Total Dose

Section 4.0 of the ODCM, contains the methodology for calculating the total dose including direct radiation as required by Surveillance Technical Specification 4.17.D.a. The methodology described in Section 4.0 for calculating the total dose was determined to be acceptable.

Environmental Monitoring Program

Section 5.0 of the ODCM identifies specific parameters of distance and the direction sector from the site and additional information for each and every sample identified in Table TS.4.10-1 of the technical specifications for PNGP.

The location for the control sample, identified as Code P-25 in Table 5.1-1, for the well water, milk, cultivated crops, and corn samples is located in the NNW sector. However, the largest D/Q value is in the NW sector and the smallest D/Q value is in the NE sector. It is not clear why the location of the control sample is not in the sector of smallest D/Q. Figures 5.1-1 and 5.1-3 are illegible and should be replaced.

Summary

In summary, the Licensee's ODCM uses documented and approved methods that are, in general, consistent with the methodology and guidance in Regulatory Guide 1.109, Revision 1 and NUREG-0133. However, because of the discrepancies identified in this review, it is recommended that the NRC request another revision to address the discrepancies.

4. CONCLUSIONS

The Licensee's ODCM, updated through Revision 9, for the Prairie Island Nuclear Generating Plant, Units 1 and 2 was reviewed. It was determined that the ODCM uses methods that are, in general, consistent with the guidelines of Regulatory Guide 1.109, Revision 1 and NUREG-0133. The methodology in most sections of the ODCM are acceptable for use in demonstrating compliance to the radiological effluent technical specifications. However, it is recommended that another revision to the ODCM be submitted to address the following discrepancies identified in the review:

- In Section 3.2.2, the definition for P_i incorrectly identifies the infant as the critical age group whereas the data in Table 3.2-1 correctly lists the dose factors for the child age group which is the limiting age group for the thyroid dose rate via the inhalation pathway.

- In Section 3.3.1, it states there are up to nine noble gas release vents, whereas Table 3.1-1 in the ODCM identifies six release vents and the Technical Specification Table TS3.9-2 also identifies six release vents.

- Table 3.1-1 of the ODCM identifies the Shield Building Vents for Units 1 and 2 as release vents instead of the Reactor Building Vents for Units 1 and 2 as identified in Technical Specification Table TS.3.9-2.

- Simplified flow diagrams illustrating the treatment paths and components of the radioactive liquid, gaseous, and solid waste management systems are omitted and should be included in the ODCM.

- In Section 2.1.2.1, F is incorrectly defined as 67,3000 gpm instead of 67,300 gpm.

- In Section 2.3.1, the dilution flow, ADF_k, is supposed to be the average flow during the reporting period (e.g., one month, one quarter, or one year) and not the "actual dilution flow during the time period of release" as defined in Sections 2.3.1.

- In Section 2.3.2, the Licensee should be aware that the latest value for the bioaccumulation factor for phosphorus is 3.0E+03 (pCi/kg)/(pCi/liter) instead of the value in Table A-1 of Regulatory Guide 1.109, Rev. 1.

- In Section 3.2.2, it is not clear why the term $(D_v - D_p)$ in Equation (3.2-2) should not be written as $(D_v + D_p)$.

- Section C.1 of Appendix C should be modified to address the child's thyroid:
    a. "child" should replace "infant."
    b. breathing rate is 3700 m^3/yr instead of 1400 m^3/yr.
    c. $P_{ij} = 3.7 \times 10^9 DFA_i$ instead of $1.4 \times 10^9 DFA_i$
    d. Table E-9 of Regulatory Guide 1.109 Revision 1 should be used instead of Table E-10.

- In Tables 3.3-6 through 3.3-18, with the exception of the dose factors for tritium, the reviewer was unable to reproduce the dose factors. In some cases the values obtained by the reviewer were 30% higher than those of the Licensee.

- The location for the control sample, identified as Code P-25 in Table 5.1-1, is located in the NNW sector. However, the largest D/Q value is in the NW sector and the smallest D/Q value is in the NE sector. It is not clear why the location of the control sample is not in the sector of smallest D/Q.

- In Section 5.0 of the ODCM, Figures 5.1-1 and 5.1-3 are illegible and should be replaced.

- In Section 2.1.1.5, it is not clear how this methodology will ensure compliance with a liquid dose rate limit as part of the setpoint calculation since the setpoint calculation is based on the concentration limits. Also the technical specifications do not require compliance to a liquid dose rate limit at the site boundary.

5. REFERENCES

1. Title 10, Code of Federal Regulations, Part 50, 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."

2. Letter from D. C. Dilanni (NRC) to D. M. Musolf (NSP), Subject: Prairie Island Off-Site Dose Calculation Manual (ODCM) Approval Letter, October 21, 1982.

3. Letter from F. L. Fey, Jr. (NSP) to Nuclear Regulatory Commission, Subject: Prairie Island Nuclear Generating Plant Effluent and Waste Disposal Semi-Annual Report for January 1, 1987 through June 30, 1987, August 28, 1987.

4. "Standard Radiological Effluent Technical Specifications for Pressurized Water Reactors," Rev. 3, Draft 7", intended for contractor guidance in reviewing RETS proposals for operating reactors, NUREG-0472, September 1982.

5. "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, A Guidance Manual for Users of Standard Technical Specifications," NUREG-0133, October 1978.

6. "General Contents of the Offsite Dose Calculation Manual," Revision 1 Branch Technical Position, Radiological Assessment Brarch, NRC, February 8, 1979.

7. "Calculation of Annual Doses of Evaluating Compliance with 10 CFR 50, Appendix I," Regulatory Guide 1.109, Rev. 1, October 1977.

8. "In-Plant Source Term Measurements at Prairie Island Nuclear Generating Station," NUREG/CR-4397, September 1985.

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The Offsite Dose Calculation Manual for the Prairie Island Nuclear Generating Plant (PNGP) Units 1 and 2 contains current methodology and parameters used in the calculation of offsite doses due to radioactive liquid and gaseous effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, and in the execution of the environmental radiological monitoring program. ODCM Revision 2, dated August 6, 1982 was submitted by the Licensee with letter dated August 13, 1982 to the NRC and received initial approval on October 21, 1982. Since then, Revisions 3 through 9 have been submitted to the NRC. The latest revision, Revision 9, dated June 29, 1987, was submitted on August 28, 1987 with the Semiannual Effluent Report for January-June 1987. The NRC transmitted the ODCM updated through Revision 9 to the Idaho National Engineering Laboratory (INEL) for review. The ODCM was reviewed in its entirety by EG&G Idaho at the INEL and the results of the review are presented in this report. It was determined that the ODCM updated through Revision 9 uses methods that are, in general, in agreement with the guidelines of NUREG-0133. However, it is recommended that another revision to the ODCM be submitted to address and correct the discrepancies identified in the review.

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