Idaho National Engineering Laboratory

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Evaluation of South Texas Project Electric Generating Station Units 1 And 2 Offsite Dose Calculation Manual, Revision 6

Docket No. 50-498, Facility License No. NPF-76
Docket No. 50-499, Facility License No. NPF-80

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Lockheed
Idaho Technologies Company

ENCLOSURE

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Technical Evaluation Report For The Evaluation Of South Texas Units 1 And 2 ODCM

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ABSTRACT

The Offsite Dose Calculation Manual (ODCM) for the South Texas Electric Generating Station Units 1 and 2 contains current methodology and parameters used to calculate offsite doses, dose rates, effluent monitoring alarm setpoints, and conduct the radiological environmental monitoring program. The NRC transmitted Revision 6, effective January 1, 1994, to the Idaho National Engineering Laboratory for review by L. .heed Idaho Technologies

The licensee's ODCM generally uses documented and approved methods that are consistent with the methodology and guidance of NUREG-0133 and Regulatory Guide 1.109. However, due to several omissions and errors, including four items related to alarm/trip setpoints and tritium calculations, which should be addressed promptly, it is recommended that the licensee submit a revision of the ODCM to address and correct the most significant deficiencies identified in this review.

FOREWORD

This report is submitted as partial fulfillment of the "Review of Radiological Issues" project being conducted 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 E2084.

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ACRONYMS/SYMBOLS

D	Symbol used for radiation induced doses
$\dot{D}$	Symbol used for radiation dose rates
CFR	Code of Federal Regulations
FR	Federal Regulation
INEL	Idaho National Engineering Laboratory
NRC	Nuclear Regulatory Commission
ODCM	Offsite Dose Calculation Manual
RETS	Radiological Effluent Technical Specifications
STP	South Texas Nuclear Station Plant, Units 1 and 2
STPEGS	South Texas Project Electric Generating Station

Technical Evaluation Report For The Evaluation Of South Texas Units 1 And 2 ODCM

1. INTRODUCTION

1.1 Purpose Of Review

This document reports the review and evaluation of Revision 6 of the Offsite Dose Calculation Manual (ODCM) submitted by the Houston Lighting and Power Company, the Licensee for the South Texas Nuclear Station, Units 1 and 2 (STP). Revision 6 of the ODCM for STP was transmitted to the NRC by letter dated March 1, 1994. Personnel at Lockheed Idaho Technologies performed this review to assess conformity of the ODCM to the STP technical specifications and current NRC guidelines. The ODCM is a supplementary document for implementing the STP Technical Specifications in conformance with Section IV of Appendix I to 10 CFR 50.[1]

The ODCM consists of two parts. Part A of the ODCM is a description of the Radiological Effluent Monitoring Program including the controls, surveillance requirements, and bases. Part B contains the Radiological Calculational Methods and Parameters.

1.2 Plant Specific Background

STP is situated on a 19-square mile site. The site is relatively remote with the nearest resident over two miles from either unit and with the nearest community about four miles distant. The closest site boundary is nearly a mile from either unit.

The terrain is coastal plain with farm land and range predominating. The land rises slowly from sea level 10 miles south of the plant to an elevation of 45 ft, 10 miles to the north. The only topographical relief consists of plant associated structures and shallow gullies. The topographical details are used in calculating off-site doses due to atmospheric releases.

STP consists of two pressurized water reactors: each unit is rated at 3,800 MW(t). The units are similar in design and operate independently with a minimum of shared systems. Each unit consists of a reactor containment building, an attached fuel-handling and storage building, an attached mechanical electrical auxiliary building, and a detached turbine generator building. The most notable common system is the Cooling Reservoir into which liquid radioactive effluents are discharged from both units. Also, the systems which monitor radioactive releases for each unit report their results to a common computer for the purpose of report generation and off-site dose calculation.

Dose calculations for liquid effluent releases into the cooling reservoir within the site incorporate the effects of dilution and radioactive decay. Dose calculations are based on off-site discharges from the reservoir to the Colorado River and the Little Robbins Slough.

Table 1. Summary of the content of STP ODCM, Revision 6.

Implementation in ODCM Section	Procedural Details in ODCM	Tech. Spec. Programmatic Control Section	Brief Description of Contents
Part B	Part B-1.1	Part A	Purpose and scope of the ODCM
2	3.1.2	3.3.3.10	Liquid effluent monitoring instrumentation and surveillance
3.1	3.1.3 Table B3-1	3.3.3.10	Liquid setpoint determination
3.1	3.1.2	3.11.1.1	Liquid effluent concentration
Part A Table A3-1	Part A Table A3-1	3/4.11.1	Liquid sampling and analysis
4.1	4.1.2	3.11.1.2	Liquid effluent dose commitment
4.5	Eq. 4.5a	3.11.1.3	Liquid radwaste treatment and dose projection
Part A Table 4.3-9	3.2.3	3.3.3.11	Gaseous effluent monitoring instrumentation and surveillance
3.2.1	3.2.3	3.3.3.11	Gaseous setpoint determination
4.3.2.1	Eq. 4.4d-h	3.11.2.1.a	Gaseous effluent air dose rate (noble gases)
4.3.2.2	Eq. 4.3a	3.11.2.1.b	Gaseous organ dose rate (iodines, tritium, and particulates)
Part A Table A4-1	Part A Table A4-1	3/4.11.2.1	Gaseous sampling and analysis
4.3.3	Eq. 4.4f,h	3.11.2.2	Gaseous air dose commitment
4.3.4	Eq. 4.4i	3.11.2.3	Gaseous organ dose commitment
4.5	Eq. 4.5a	3.11.2.4	Gaseous radwaste treatment and dose projections
4.7	4.7	3.11.4	Uranium fuel cycle (total) dose
5	5.2	3.12.1	Radiological environmental monitoring, sampling, and analysis
4.4.1	Eq. 4.4a-c	None	χ/Q and D/Q methodology and data
Part A 6.9.1.3	5.1	3.12.2	Land use census
Part A 6.9.1.3	5.5	2.12.3	Interlaboratory Comparison Program
None	None	6.15.1	Major changes to liquid and gaseous radwaste treatment systems
None	5.8	6.9.1.3	Annual Radiological Environmental Operating Report
None	5.8	6.9.1.4	Semiannual Radioactive Effluent Release Report
Part A-9.9.1.4	None	T.S. 6.13, 6.14	Changes to the ODCM

2. REVIEW CRITERIA

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

1. NUREG-1302, Standard Operating Procedures for Radiological Effluent Controls for PWRs.[2]

2. NUREG-0133, Preparation of RETS for Nuclear Power Plants.[3]

The following NRC guidelines were also used in the ODCM review:

1. Regulatory Guide 1.109, Revision 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I."[4]

2. Branch Technical Position, "General Contents of the Dose Calculation manual (ODCM)"[5]

As specified in NUREG-1302, 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, consistent with systems being used at the station, define the treatment paths and the components of the liquid and gaseous management systems. A description and the location of samples in support of the environmental monitoring program are also needed in the ODCM. The NRC regulations require that the ODCM be a stand-alone document. That is, given the plant specific data and the methodology documented in the ODCM, all dose and dose rate calculations required by the NRC can be made.

3. RADIOACTIVE EFFLUENT RELEASE ROUTES

Liquid and gaseous effluent release routes from STP are discussed in this section, along with the monitoring methodology being used. The description in Revision 6 of the ODCM dated January 1, 1994, was reviewed. Comments on the clarity of the description and adequacy of the monitoring methodology in Section 2 of the ODCM are included in this section.

3.1 Liquid Effluent Release Routes

AT STP there are multiple liquid effluent sources that are routed to the liquid radwaste processing system or to the circulating water system. The radioactive liquid waste is routed to the liquid radwaste processing system of each unit for treatment and release. Releases are by batch from each unit and enter the Circulating Water System via the Open Loop Auxiliary Cooling System and hence the reservoir. Liquid radioactive releases from either unit leave STP from the reservoir to the Colorado River, the West Branch of the Colorado, or to the Little Robbins Slough area. Under normal circumstances all radioactive liquid effluents are treated and diluted into the 150,000 acre-foot (average fill height) reservoir prior to release from the site. Planned releases are made to the Colorado River through the blowdown facilities. However, some releases are uncontrollable such as flow from the hydraulic relief wells surrounding the reservoir or flow over the spillway following unusually heavy rains.

Control and Surveillance Requirement (CSR) 3.3.3.10 requires a radioactivity monitor with alarm setpoints and automatic termination of release on the liquid waste processing discharge monitor. However, Section 2.2 indicates that there are a number of monitors used for process control purposes and that these monitors are used to direct the radioactive waste to the liquid radwaste processing system. From the description in Section 2.2, it appears that other liquid wastes not identified as radioactive waste by the process monitors are released directly to the circulating water system and the reservoir. Further, it is indicated that some process lines are not monitored. The description of this entire system should be clarified, and other specific possible release points such as the steam generator blowdown and the condensate polishing systems should be addressed specifically. Also, Technical Specification limitations on releases from the site should be referenced in the ODCM to show that the ODCM is supporting document for the Technical Specifications.

The STP ODCM does not contain any diagrams of the liquid effluent release points, flow paths, and alarm locations. One or more simple figures should be included that illustrate the liquid effluent pathways. Also, it is recommended that diagrams of the liquid radwaste effluent system and other relevant systems be included in the ODCM. Detector locations should be included in these figures. The form of the suggested figures is shown in Figure 1 although sufficient detail is not shown in this figure.

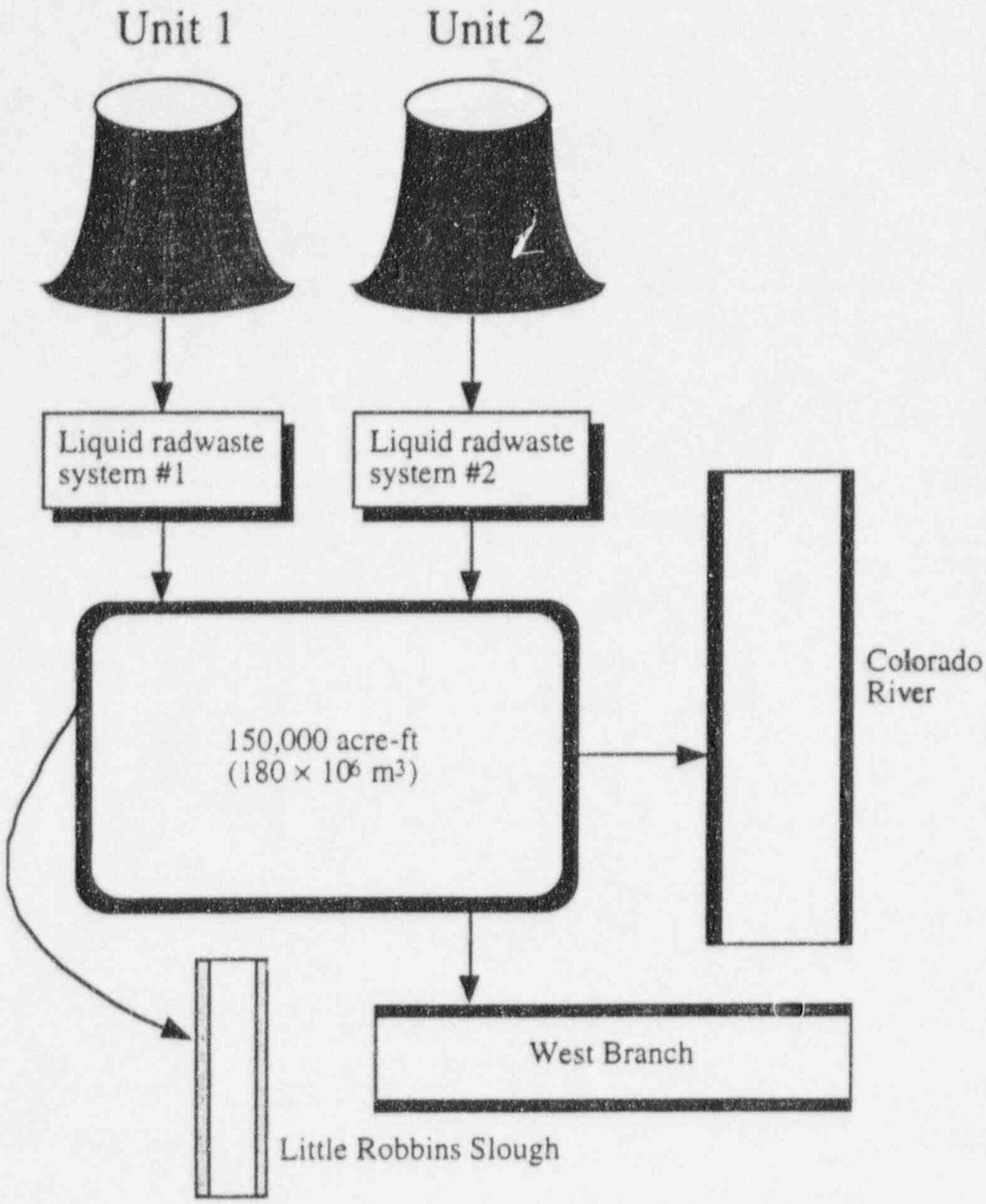

Figure 1. STP liquid radwaste pathways.

3.2 Gaseous Effluent Release Routes

From the Final Safety Analysis Report for STP, there are five routine release pathways:

1 Reactor Containment Building (RCB).

2 Mechanical-Electrical Auxiliary Building (MEAB).

3 Fuel-Handling Building (FHB).

4 Gaseous Waste Processing System (GWPS).

5 Turbine-Generator Building (TGB).

Only the first four sources contribute significantly to routine plant atmospheric releases. The effluents from the first four sources are routed to a common exhaust pipe located on the roof of each unit's MEAB. The Turbine-Generating Building has its own exhaust pipe located on its roof. Figure 2 illustrates the five radioactive gaseous discharge points, and Figure 3 illustrates the Turbine-Generator Building Exhaust. In Figure 2, the sum of the release rates is about 7,000 m^3/min; however, in Section 2, it states that the average flow rate is 5,600 m^3/min. Maximum flowrates for different operational modes should be defined in the ODCM.

In Table 3.3-13, a monitor for the vent is identified. The condenser evacuation system effluent, which was monitored, has been rerouted to the vent for one reactor and is in the process of being rerouted to the unit vent for the other reactor. It should be made clear in the ODCM that there is a unit vent monitor for each unit. Also, ODCM Figure B2-1, Unit Ventilation Systems, is missing the gaseous waste processing system and Turbine-Generation Building gaseous release pathways. This information should be included in one or more diagrams that illustrate the gaseous release pathways

For gaseous releases, the height of the release points should be specified in the ODCM. Additionally, vent sizes, exit velocities, and/or flowrates should be specified along with the height of surrounding buildings. Dose calculations are dependent on the height of the release point.

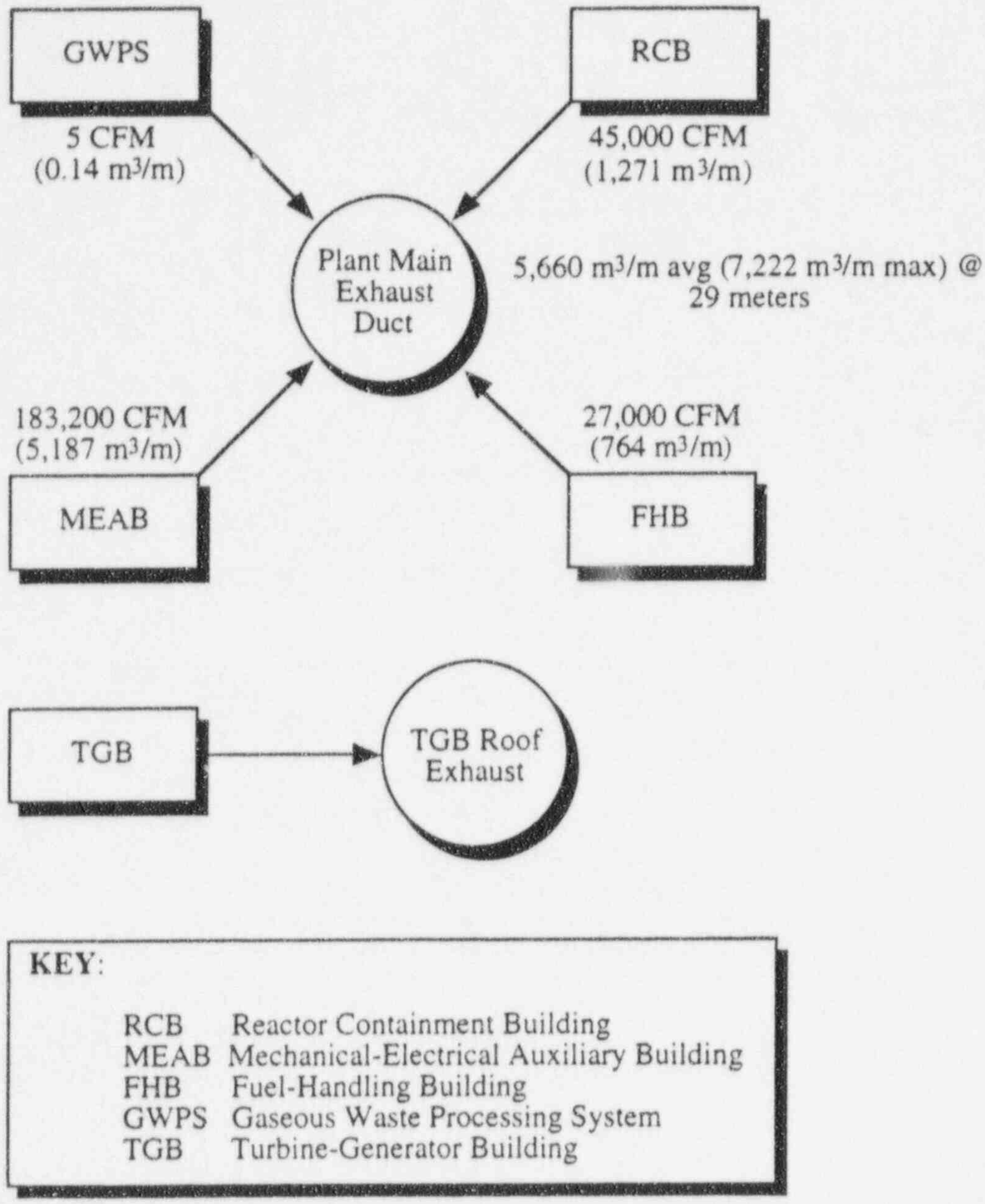

Figure 2. Primary gaseous effluent release routes at STP. (Based on Figure B2-1 of the STP ODCM Revision ~~5~~ 6.)

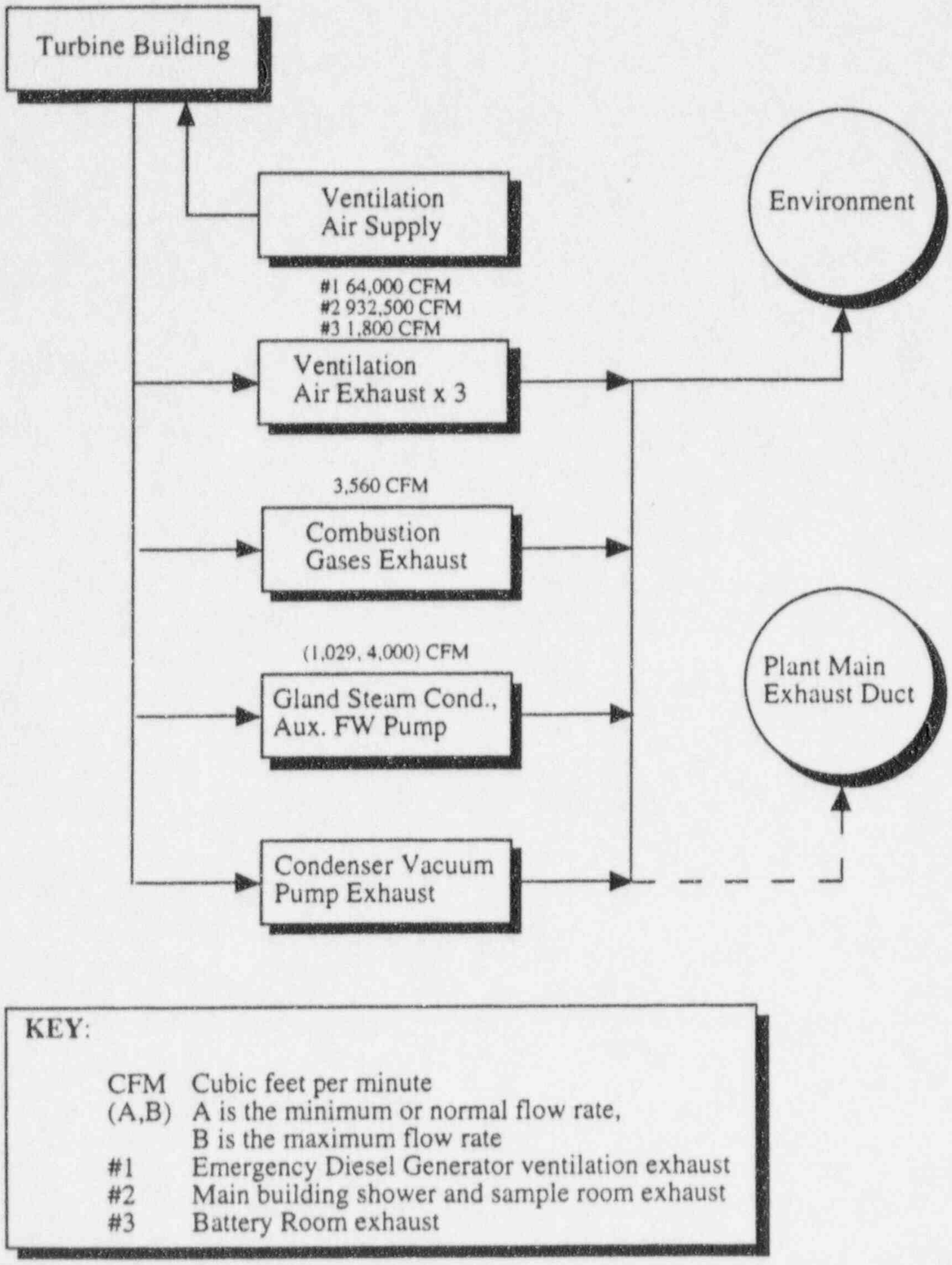

Figure 3. Turbine building ventilation system at STP. (Based on Figure B2-2 of the STP ODCM Revision 6.)

4. EVALUATION

This evaluation assesses conformity of the ODCM to the STP Technical Specification and current NRC guidelines. Summarized below is the detailed evaluation of the STP ODCM. A general comment is that because the ODCM is a supporting document for the Technical Specifications, the Technical Specifications that are being supported should be noted in Part A.

4.1 Liquid Effluent Monitor Setpoints

STP Control and Surveillance Requirements (CRS) 3.3.3.10 requires that the radioactive liquid effluent monitoring instrumentation channels shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of specification 3.11.1.1 are not exceeded. STP ODCM CSR 3/4.11.1.1 of Part A, requires the concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2[6] for radioactive material other than noble gases and to 2×10^{-4} µCi/ml total activity for dissolved or entrained noble gases.

The methodologies of STP ODCM Section 3.1, "Liquid Effluents," used to calculate setpoints are generally correct, and the ODCM contains example calculations using the actual measured liquid effluent releases. Inclusion of the safety factor, S_F, adds conservatism to the calculation of alarm setpoints, but it is not clear how conservative this safety factor is and whether it also applies to automatic termination of release for the monitors. Methodology for both alarm and trip setpoints should be included if they have different setpoints. Specific comments are listed below.

- Methodology to determine setpoints for the liquid effluent monitors to prevent simultaneous releases from more than one batch release tank should be included in Section 3. This would prevent the possibility of exceeding release limits due to simultaneous releases.
- It is not clear that the alarm trip setpoint calculational methods in Section 3.1 provide adequate definition of the setpoint calculation for the liquid radwaste monitor because Equation 3.1f divides the sum of the radionuclide concentrations by the sum of the fractions of the 10 CFR 20 limits. This equation should be clarified or revised to sum the fraction of the 10 CFR 20 limit for each radionuclide in the effluent.
- The NRC guidelines specify that the methods for calculating fixed and adjustable setpoints should be clearly illustrated. STP ODCM Section 3.1, "Liquid Effluents," does not indicate if the setpoints are fixed or adjustable and whether the setpoints are for continuous or batch releases. Also, the ODCM should specify whether the alarm and the automatic control trip are separate devices. If they are, the alarm/trip setpoint calculation in the ODCM should list the trip setpoint calculation setpoints separately. In either case, it should be specified how the calculations are performed, and the alarm setpoints should be lower than the automatic trip setpoints.

4.1.1 Liquid Detector System And Instrument Response

ODCM Section 2.3, "Detector System and Instrument Responses," contains a good description of the detectors, detection range and illustrations of the detector response in ODCM Figure B2-5. There are no comments for this section.

4.2 Gaseous Effluent Monitor Setpoints

According to STP CSR 3.3.3.11, it is required that the radioactive gaseous effluent monitoring instrumentation channels shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of CSR 3.11.2.1 are not exceeded. STP CSR 3.11.2.1 states that the dose rate due to noble gases from the site to areas at and beyond the site boundary shall be limited to less than or equal to 500 mrem/yr to the total body and less than or equal to 3,000 mrem/yr to the skin. Also, the CSR states that the dose rate for ^{131}I, ^{133}I, ^{3}H, and all radionuclides in particulate from with half-lives greater than 8 days shall be limited to less than or equal to 1,500 mrem/yr to any organ.

The methodologies described in ODCM Section 3.2 that are used to calculate setpoints, are correct. Example calculations and the actual measured gaseous effluent releases are included in the ODCM. The safety factor, S_F, adds conservatism to the calculation of the alarm setpoints. However, two changes should be made to the ODCM. The recommended changes are:

1. Inclusion of whole body gamma and skin dose rate Equations 4.4d and 4.4e in ODCM Section 3.2.3 would increase clarity. It helps the flow of the document to show equations in the sections in which they are being used.

2. The factor, S_F, shown in Section 3.2.3 is noted as a shielding factor in Equation 4.4d; however, the source of this factor is not clear. Also, it is not clear that the S_F factor is conservative as the factors is 1.0 for the alarm setpoint calculations.

4.2.1 Gaseous Detector System And Instrument Response

ODCM Section 2.3, "Detector System and Instrument Responses," contains a good description of the detectors, detection range and illustrations of the detector response in ODCM Figures B2-3 and B2-4. There are no comments for this section.

4.3 Concentrations In Liquid Effluents

According to CSR 3.11.1.1, concentrations of radioactive materials released in liquid effluents to <u>unrestricted areas</u> should be limited to 10 times the concentration specified in 10 CFR Part 20.1001-20.2401, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2×10^{-4} µCi/ml.

STP ODCM Section 3.1, "Liquid Effluents," contains an adequate description of methodology used to calculate concentrations in liquid effluents. Questions and comments are discussed in the following paragraphs.

- ODCM Sections 4.2.2.1, 4.2.2.2, and 4.2.2.3 should explain what is being calculated, and also in Section 4.2.2.2 and 4.2.2.3, the calculation being performed should be better defined. ODCM Section 4.2.2.1 should define which equations the assumptions are applicable to and whether they are conservative. Also, sample calculations should be shown where appropriate.

- ODCM Section 4.2.2.2 should explain that what is calculated is the total integrated radionuclide releases Q_c, Q_{wc}, Q_{lrs}, and Q_{elrs} into the Colorado River, West Branch of the Colorado River, Little Robbins Slough, and East Fork Little Robbins Slough, respectively. Furthermore, the equations that define the total integrated radionuclide releases for these sources come before the variable and parameter definitions.

- ODCM Section 4.2.2.3 should explain that what is calculated is the total integrated tritium offsite releases Q_c^{Tritium}, Q_{wc}^{Tritium}, Q_{lrs}^{Tritium}, and $Q_{elrs}^{\text{Tritium}}$ in liquid effluents into the Colorado River, West Branch of the Colorado River, Little Robbins Slough, and East Fork Little Robbins Slough, respectively. Furthermore, the equations that define the total integrated radionuclide releases for these sources should be listed before the variable and parameter definitions.

There does not seem to be any reference to ODCM "Appendix to part B Section 4" on the reservoir release model, in ODCM Section 4.1, "Liquid Releases." This should be corrected promptly. It is not clear why the reservoir models are in an appendix. It is recommended that the reservoir models be combined into several contiguous sections. This would greatly improve the description. The following paragraphs address comments on ODCM appendix entitled "Model of the Release of Radioactive Materials from the STP Reservoir for Use in Off-site Dose Calculations:"

- There is no introductory paragraph. The Appendix starts with a list of assumptions without any discussion of the application of these assumptions. The appendix on reservoir models should explain that the concentration of radioactive liquid effluents being discharged into STP reservoir is being calculated.

- The equations are un-labeled. These equations should be labeled to help in referencing.

- The first equation on page B4-246 of ODCM is supposed to sum individual radionuclide concentrations. This summation should be explicit to avoid confusion. This explicit radionuclide summation should be indicated by subscripting the variables Y_i and Y_r in the activity equation. This summation notation and variable scripting should be applied to all the following equations that are based on the initial integrated activity equation.

- The conclusion states that to be strictly correct mathematically, an additional radioactive decay term, $e^{-0.03833Y_r}$, should be applied. This should be clearly stated. Here in lies the problem with the notation when the summation over radionuclides is not explicit. It is strictly correct mathematically to multiply the modified integrated activity equation by the additional decay term under the summation not as the product of two summed terms. The solution to this problem is to use summation notation and the appropriate variable and parameter scripting. This may make the equations longer to write, but it should reduce confusion to the reader and potentially more serious errors in the calculation of dose. It is not clear why the small exponential decay factor $e^{-0.03833Y_r}$ is of concern when the approximation $a = 0$ and $b = \infty$ has been made. What is being calculated and why needs to be clarified.

- The total release equation is integrated from $t = a$ to $t = b$, which are the endpoints of the integration time interval. This is obvious, but the parameters a and b should be defined separately. It is suggested that a different notation be used instead of a and b for example, $a = T_i$ and $b = T_f$ would be more explicit and alert the reader that the parameters represent time. The use of a and b to represent time can be unclear and their meaning can easily be lost in a few pages.

- In Figure B4-1: Lower Colorado River, the mile key is incomplete. The mile marks should be included in the figure.

- It is suggested that a longitude and latitude marker (location of the reactors for example) be included along with a compass indicator in Figures B4-1 and B4-2. The compass indicator is normal for such geographic figures. Also, Figures B4-1 and B4-2 should indicate if the objects depicted are to scale and are in accurate positions. This information should be included in the figure key or figure caption, even if described elsewhere.

4.4 Dose Rates Due To Gaseous Effluents

The dose at any time beyond the site boundary from gaseous effluents from all units on the site should meet CSR 3.11.2.1. The release rate limits specified in CSR 3.11.2.1 and implemented in Section 4.3 are:

1. For noble gases, $\dot{D} \leq 500$ mrem/yr to the whole body and $\leq 3{,}000$ mrem/yr to the skin.

2. For ^{131}I for ^{133}I, for ^{3}H, and for all radionuclides in particulate form with half-lives greater than 8 days: $\dot{D} \leq 1{,}500$ mrem/yr to any organ.

The equations identified are generally correct; however, it is not clear that equations 4.4d and 4.4e specifically limit the instantaneous dose rates to those identified in CSR 3.11.2.1 as the limits are not identified in the equations. Also, it is not clear that the default χ/Q value of 5.3×10^{-6} is conservative as the S_F value noted appears to be 1.0.

4.4.1 Dose Rates Due To Noble Gases

The methodology for calculating whole body and skin dose rates due to noble gases is described in Section 4.4.2 of the ODCM. A specific comment is that Equations 4.4d and 4.4e include numerical values for a shielding factor. this shielding factor is identified in Regulatory Guide 1.109; however, the ODCM should include the methodology and justification for the shielding factor used.

4.4.2 Dose Rates Due To Iodine–131, Iodine–133, Tritium, and Radioactive Material In Particulate Form

The dose rate from ^{131}I, ^{133}I, ^{3}H, and radioactive materials in particulate from are specified in CSR 3.11.2.3 and are implemented in Section 4.3.4.3 and Equation 4.4i. However, Equation 4.4i does not specifically show the inhalation and ingestion rates and assumed factors that are included in the calculation. This is particularly true as it is indicated that a code similar to GASPAR was used for the dose factor calculations. The code used and the inhalation and ingestion rates should be described even if the values are included in the dose factor.

4.5 Dose Due To Liquid Effluents

ODCM Sections 4.1 and 4.2 implement CSR 3.11.1.2 for the calculation of cumulative dose contributions from liquid effluents for the current calendar quarter and current calendar year. The CSR requires that the dose to a member of the public from radioactive materials in liquid effluents released to unrestricted areas shall be limited:

During any calendar quarter	During any calendar year
$D \leq 1.5$ mrem to the total body	$D \leq 3$ mrem to the total body
$D \leq 5$ mrem to any organ	$D \leq 10$ mrem to any organ

The ODCM should include a detailed presentation of the calculational models and a complete tabulation of all values assigned to each parameter. The ODCM has numerous example calculations and detailed descriptions of assumptions and supporting data. However, it would be helpful if primary pathways that are not included in the dose calculations, such as potable water, are identified in the ODCM. Specific comments on the liquid dose calculations are noted below.

In ODCM Section 4.2.1.2, "Little Robbins Slough Environment," it is stated that there is no firm data regarding average annual consumption of meat. Without local data, the assumptions of meat consumption in NUREG-0133 should be used, and the ODCM should state the assumptions used.

Regulatory Guide 1.109 discusses tritium dose through consumption of food grown on contaminated soil and water. STP Section 4.3.4.1 and the complementary calculations of dose from liquid effluents do not discuss dose from ingestion or inhalation of tritium. This should be corrected promptly.

In ODCM Table B4-1, "Radionuclide Fractions Leaving STP via Liquid Routes," the column headings should contain enough information to identify the data. Also, it is indicated that the values were calculated according to the methods of Section B4.1. This should read Section 4.2. Identification of the data with associated variables and symbols would clarify the explanation.

In ODCM Table B4-7a, "Liquid Pathway Dose Factors," there are 25 radionuclides with all values set to zero. This fact should be explained in the notes attached to the table.

4.6 Dose Due To Gaseous Effluents

CSR 3.11 2.2 requires that the air dose due to noble gases released in gaseous effluents from each unit to areas at and beyond the site boundary shall be limited to the following: during any calendar quarter to less than or equal to 5 mrads for gamma radiation and less than or equal to 10 mrads for beta radiation. During any calendar year, the STP limits are 10 mrads for gamma radiation and less than or equal to 20 mrads for beta radiation. These limits are implemented in Section 4.3.3.

The dose calculations noted in Section 4.3.3 are incomplete and do not specify the requirements identified in the CSR. The base equations for gaseous doses are identified in NUREG/CR-0133 and Regulatory Guide 1.109. The source of equations used for dose rates and doses should be explicit. Be aware that there are differences between the calculations in NUREG-0133 and Regulatory Guide 1.109. The equations in NUREG-0133 are abbreviated versions of those in Regulatory Guide 1.109.

The STP Technical Specifications, NUREG-1334,[7] contained a requirement (3.11.2.6), which requires that the quantity of radioactivity in each storage tank be limited to less than 1×10^5 Ci. It should be explained why this requirement is not specified in the CSRs.

In ODCM Section 4.4.3, "Dose Due to Deposited and Inhaled Radionuclides," and Notes to Table B4-7, "Pathway Dose Factors," it is stated that the exposure pathway dependent dose factors, R_{aij} are generated using a code similar to NRC's GASPAR routine described in NUREG-0597. It is recommended that a short description of this code and its comparison with GASPAR II be included in the ODCM.

In ODCM Table B4-5, Particle Depletion and Deposition Factors for Ground Level Releases, the table headings Depletion and Deposition are unclear. It is suggested that this table include more explanation in the table heading or footnotes even if there is a description elsewhere. Also, it is helpful to the reader to indicate to indicate the variables or symbols that are associated with the data.

In ODCM Section 4.4.3, "Dose Due to Deposited and Inhaled Radionuclides," first paragraph, it is stated that dose is calculated according to Regulatory Guide 1.109. The equations in Regulatory Guide 1.109 use the dose commitment age. This is described on page 1 Section 1 of Regulatory Guide 1.109. It is not clear to the reader if this is the case for the STP ODCM. If the years of age are used instead of the dose commitment age, significant errors in the dose could result. It is recommended that use of the dose commitment age be clearly stated and that this data be summarized in tabular format as shown below in Table 2.

ODCM Section 4.4.3, Dose Due to Deposited and Inhaled Radionuclides, lists the pathways, organs, and age groups used to calculate dose factors. It is recommended that this information be placed in a numbered table, along with an explanation of the pathways. Suggested tabular formats for the organs and pathways are shown in Tables 3 and 4.

Table 2. Age group description.

Age group a	Years of age (yr)	Dose commitment age (yr)	Fraction of population [1], POP_a in each age group
Infant	0-1	Newborn = 0	0.015
Child	1-11	4	0.168
Teen	11-17	14	0.153
Adult	17 →	17	0.665

1 NUREG/CR-1004, Table 3.39

Table 3. Organ description.

Organ	Organ Model
Total body	
G. I. tract	
Bone	
Liver	
Kidney	
Thyroid	
Lung	
Skin	

Table 4. Effluent pathway description.

Pathways	Pathway Description
Inhalation	Inhalation of gases and particulate material
Meat ingestion	Etc.
Milk ingestion	
Vegetation ingestion	
Grown shine	

All equations and parameters that are used to calculate the dose and dose rate must be included in the ODCM. Thus, the following dose factor equations must be explicitly included in STP ODCM: Pasture Grass-cow/goat-milk Ingestion Dose Factors, Stored Feed-cow/goat-milk Ingestion Dose Factors, Pasture Grass-beef Ingestion Dose Factors, Stored Feed-beef Ingestion Dose Factors, Fresh Leafy Vegetable Ingestion Dose Factors, Stored Vegetable Ingestion Dose Factors, Tritium Pasture Grass-cow/goat-milk Dose Factors, Pasture Grass-beef Dose Factors, Fresh Leafy Vegetables Dose Factors, and Inhalation Dose Factors.

4.7 Dose Projections

CSRs 3.11.1.2 and 3.11.2.4 require that dose projections be performed every 31 days when the liquid and gaseous radwaste treatment systems are not being fully utilized. Dose projection calculations are implemented in Section 4.5.

4.7.1 Liquid Effluent Dose Projections

In Section 4.5, it is stated that a safety factor will be applied to the implementing procedures to assure that errors in a projected release are unlikely to result in exceeding the conditions of Control 3.11.1.3. These equations and a tabulation of the safety factors should be included in the ODCM.

4.7.2 Gaseous Effluent Dose Projections

In Section 4.6, it is stated that a safety factor will be applied to the implementing procedures to ensure that errors in a projected release are unlikely to result in exceeding the conditions of Control 3.11.2.4. These equations and a tabulation of the safety factors should be included in the ODCM.

4.8 Diagrams Of Effluent Release Routes

The STP ODCM contains two diagrams related to radioactive effluent treatment and release routes. Diagrams are included only for the gaseous effluent release points. It is recommended that graphical representations of the liquid effluent release points, paths and alarm locations be made. In addition, it is suggested that the gaseous effluent diagrams be revised as they are difficult to read, rely on unexplained abbreviations, and are not very detailed. The Branch Technical Position[8] states that the ODCM should contain "simplified flow diagrams defining the treatment paths and the components of the radioactive liquid and gaseous waste management systems." The licensee should replace the present figures with appropriate simplified flow diagrams.

4.9 Total Dose

CSR 3.11.4 requires that the total annual dose or dose commitment to any member of the puulic meets the dose limitations of 40 CFR Part 190.[9] The CSR requires the preparation and submittal of a special report whenever the calculated doses from plant generated radioactive effluents and direct radiation exceed 25 mrem to the total body or any organ, except the thyroid, which shall be limited to less than or equal to 75 mrem. Section 4.7 implements this requirement; however, equations that indicate how the total dose will be calculated are not shown.

There is no section that details the manner in which maximum individual doses should be calculated. Section 4.5 should include the mathematical description of the methodologies and sample calculations. This may mean some redundancy in the ODCM, but that is acceptable for completeness and clarity.

4.10 Environmental Monitoring Program

CSR 3.12.1 requires that the Radiological Environmental Monitoring Program (REMP) be conducted in accordance with the tables in that section, and the implementation of the program is shown in ODCM Section 5, which describes the licensee's REMP. The REMP measures radiation and radioactive exposure pathways that lead to the highest potential radiation exposure of members of the public resulting from plant operation.

The REMP is thorough and within NRC guidelines. However, it is suggested that on Figures B4-1 and B4-2, concentric radius rings which represent various distances from the plant, be included along with sector divisions as a guide to the location of monitoring equipment, populations, agriculture, and recreational activities.

4.11 Land Use Census

CSR 3.12.2 requires that a land use census be performed and that the census be performed at least once per 12 months. ~~An interlaboratory Comparison Program be performed.~~ The program is implemented in ODCM Section 5.1. The Land Use Census description is within NRC guidelines.

4.12 Interlaboratory Comparison Program

CSR 3.12.3 requires that an Interlaboratory Comparison Program be performed. This program is implemented in ODCM Section 5.5, Quality Control, and describes the licensee's Interlaboratory Comparison Program. The Interlaboratory Comparison Program is within NRC guidelines.

5. TECHNICAL FINDINGS

Deficiencies and suggestions are summarized below in four categories of decreasing importance. The items in Category A identify the most series deficiencies, including omissions that cause uncertainty whether the proper methodology is used in the ODCM. Category B contains deficiencies that are less series than Category A, and Category C contains minor deficiencies and editorial recommendations. Category D contains suggestions for changes the licensee may wish to make to simplify calculations, update data, or remove excess conservatism from the methodology.

Category A:

The items in this category should be addressed promptly. Some items identify errors or emissions that result in erroneous calculated doses and dose rates. Others identify omissions or inappropriate values that may result in release rate limits being exceeded or reported doses being insufficiently documented.

1. ODCM Section 3.3.3.10 requires a radioactivity monitor with alarm setpoints and automatic termination of release on the Liquid Waste Processing Discharge Monitor. However, Section 2.2 indicates that there are a number of monitors used for process control purposes and that these monitors are used to direct the radioactive waste to the liquid radwaste processing system. The description of this entire system should be clarified and other specific possible release points such as the steam generator blowdown, and the condensate polishing systems should be addressed specifically. Also, Technical Specification limitations on releases from the site should be referenced in the ODCM to show that the ODCM is a supporting document for the Technical Specifications.

2. It is not clear that the alarm/trip setpoint calculational methods in Section 3.1 provide adequate definition of the setpoint calculation for the liquid radwaste monitor because the calculations presented in Equation 3.1f do not provide assurance that the concentrations for individual radionuclides will not exceed the limits in the CSR. This calculation should be revised to sum the fraction of the 10 CFR 20 limits for each radionuclide.

3. The NRC guidelines state that methods for calculating fixed and adjustable setpoints shall be clearly illustrated. STP ODCM Section 3.1, Liquid Effluents, does not indicate if the setpoints are fixed or adjustable and whether the setpoints are for continuous or batch releases. Also, the ODCM should specify whether the alarm and the automatic control trip are separate devices. If they are, the alarm/trip setpoint calculations in the ODCM should list the trip setpoint calculations separately. In either case, it should be specified how the calculations are performed and the alarm setpoints should be lower than the automatic trip setpoints.

4. The source of equations used for dose rates and doses should be explicit. The STP ODCM includes the defining equations with good descriptions of the variables and values used, but does not include many of the secondary equations, such as food stuff dose factors. All the equations used in dose calculations must be present in the ODCM. There are differences between the calculations in NUREG 0133 and Regulatory Guide 1.109. The equations in NUREG 0133 are abbreviated from those in Regulatory Guide 1.109. Including all the equations and parameters for each calculation section may result in some redundancy in the ODCM but that is acceptable for completeness and clarity reasons.

5. The possibility of simultaneous batch release of radioactive liquid effluent is not discussed. This should be addressed. If simultaneous batch releases are possible, the appropriates equations and calculations should be included in the ODCM.

6. The factor, S_F, shown in Section 3.2.3, is noted as a shielding factor in Equation 4.4d; however, the source of this factor is not clear. Also, it is not clear that the S_F factor is conservative as the factor 1.0 for the alarm setpoint calculations. This should be addressed promptly.

7. It is not clear that Equations 4.4d and 4.4e specifically limit the instantaneous dose rates to those identified ion CSR 3.11.2.1 as the limits are not identified in the equations. Also, it is not clear that the default χ/Q value of 5.3×10^{-6} is conservative, as the S_F value noted is 1.0.

8. Regulatory Guide 1.109 explicitly discusses tritium exposure through the consumption of food grown on contaminated soil and water. STP Section 4.3.4.1 and the implementing calculations on dose from liquid effluents do not discuss doses from inhalation or ingestion of tritium.

9. The general conclusion of the review of Section 4.3.3 is that the equations are incomplete and that they do not specify the requirements identified in the CSR. The base equations for gaseous doses are identified in NUREG-0133 and Regulatory Guide 1.109. The source of equations used for doses rates and doses should be explicit.

10. The STP Technical Specifications, NUREG–1334, contained a requirement (3.11.2.6), which required that the quality of radioactivity in each storage tank be limited to less than 1×10^5. It should be explained why this requirement is not included in the CSR requirements.

Category B:

The items below concern information that should be added to make the ODCM complete, prevent erroneous interpretation of the methodology, or correct methodology that is erroneous.

1. In Table 3.3-13, a monitor for each unit vent is identified; however, it should be made clear that there is a unit vent monitor for each unit. Also, ODCM Figure B2-1, unit ventilation systems, is missing the gaseous waste processing system and Turbine-Generation Building gaseous release paths. This information should be included in one or more diagrams that illustrate the gaseous release paths.

2. The methodologies of STP ODCM Section 3.1, Liquid Effluents, used to calculate setpoints, are generally correct however, it is unclear how conservative the safety factor S_F is and whether it applies to the automatic termination of release. A table of liquid gaseous effluent setpoints in numerical or symbolic form should be included.

3. ODCM Sections 4.2.2.1, 4.2.2.2, and 4.2.2.3 should explain the equations and the application of the listed assumptions. Further, sample calculations should be provided.

4. There is no introductory paragraph in the Appendix to B4. The Appendix starts with a list of assumptions without any discussion of the application of these models. The appendix on reservoir models should explain that the concentration of radioactive liquid effluents discharged into the STP reservoir is being calculated. These equations should be labeled to help in referencing.

5. Equation 4.4i does not specifically state that the inhalation and ingestion rates are included in the calculation or what factors have been assumed. This is particularly true as it is indicated that a code similar to GASPAR was used to develop the dose factor calculations. The code used and the inhalation and ingestion rates should be described even if the value is included in the dose factor.

6. The ODCM in Sections 4.1 and 4.2 should include a detailed presentation of the calculational models and a complete tabulation of all values assigned to each parameter. The ODCM has numerous example calculations and detailed descriptions of assumptions and supporting data. However, it would be helpful is primary pathways that are not included in the dose calculations, such as potable water, are identified in the ODCM.

7. In ODCM Section 4.2.1.2, Little Robbins Slough Environment, it is stated that there is no firm data regarding average annual consumption of meat. Without local data, the assumptions for meat consumption in NUREG-011 should be used and stated in the ODCM.

8. In ODCM Section 4.4.3, Dose Due to Deposited and Inhaled Radionuclides, and Notes to Table B4-7, Pathway Dose Factors, it is stated that the exposure pathway dependent dose factors, R_{aij}, are generated using a code similar to NRC's GASPAR routine described in NUREG/CR-0595. How does this code compare with the NRC methods described in Regulatory Guide 1.109, Revision 1 and the NRC code, GASPAR I or II?

9. In ODCM Table B4-5, Particle Depletion and Deposition Factors for Ground Level Releases, the table headings Depletion and Deposition are unclear. It is suggested that this table include more explanation in the table heading or footnotes even if there is a description elsewhere.

10. In ODCM Section 4.4.3, "Dose Due to Deposited and Inhaled Radionuclides," first paragraph, it is stated that dose is calculated according to Regulatory Guide 1.109. The equation in Regulatory Guide 1.109 use dose commitment age. This is described on page 1 Section 1 of Regulatory Guide 1.109. It is not clear to the reader if this is the case for the STP ODCM. If the years of age is used instead of the dose commitment age, significant errors in the dose could result. It is recommended that use of the dose commitment age be clearly stated and that this data be summarized in tabular format (similar to that shown in Table 2 of this TER).

11. All equations and parameters that are used to calculate dose and dose rate must be included in the ODCM. Thus, the following dose factor equations should be explicitly included in the STP ODCM: Pasture Grass-Cow/Goat-Milk Ingestion Dose Factors, Stored Feed-Cow/Goat-Milk Ingestion Dose Factors, Pasture Grass-Beef Ingestion Dose Factors, Stored Feed-Beef Ingestion Dose Factors, Fresh Leafy Vegetable Ingestion Dose Factors, Stored Vegetable Ingestion Dose Factors, Tritium Pasture Grass-Cow/Goat-Milk Dose Factors, Pasture Grass-Beef Dose Factors, Fresh Leafy Vegetables Dose Factors, and Inhalation Dose Factors.

12. In Section 4.5 and 4.6, it is stated that a safety factor will be applied to the implementing procedures to ensure that errors in liquid and gaseous projected releases are unlikely to result in exceeding the conditions of Control 3.11.1.3 and 3.11.2.4. These equations and a tabulation of the safety factors should be included in the ODCM.

13. Per CSR 3.11.4, Section 4.5 should include the mathematical description of the methodologies and sample calculations used to calculate total dose. This may mean some redundancy in the ODCM, but that is acceptable for completeness and clarity.

14. ODCM Section 4.2.2.2 should explain that what is calculated is the total integrated radionuclide releases Q_c, Q_{wc}, Q_{lrs}, and Q_{elrs} for releases into the Colorado River, West Branch of the Colorado River, Little Robbins Slough, and East Fork Little Robbins Slough, respectively. Furthermore, the equations that define the total integrated radionuclide releases for these sources come before the variable and parameter definitions.

15. ODCM Section 4.2.2.3 should explain that what is calculated is the total integrated tritium off-site releases Q_c^{Tritium}, $Q_{wc}^{\mathrm{Tritium}}$, $Q_{lrs}^{\mathrm{Tritium}}$, and $Q_{elrs}^{\mathrm{Tritium}}$ in liquid effluents into the Colorado River, West Branch of the Colorado River, Little Robbins Slough, and East Fork Little Robbins Slough, respectively. Furthermore, the equations that define the total integrated radionuclide releases for these sources should be listed before the variable and parameter definitions.

Category C:

The items in this category indicate omissions and editorial deficiencies that are not likely to cause significant problems:

1. Understanding is improved if a list of acronyms and a list of symbols and notation conventions is included.

2. There are no figures for the liquid effluent release points, paths, and alarm locations. Simplified figures of the liquid effluent release points, paths, and alarm locations should be included. If more detail is desired by the licensee, use a separate figure for each major radioactive liquid release point.

3. Inclusion of whole body gamma and shin dose rate Equations 4.4d and 4.4e in ODCM Section 3.2.3 would increase clarity.

4. The ODCM contains four diagrams, Figures B2-1, B2-2, B4-1, and B4-2, related to radioactive effluent treatment and release routes. However, the Figures B2-1 and B2-2 are difficult to read and rely on un-keyed abbreviations. Simplified flow diagrams defining the treatment paths and the components of the radioactive liquid and gaseous waste management systems should be used.

5 There does not seem too be any reference to ODCM "Appendix to part B Section 4" on the reservoir release model, in ODCM Section 4.1, Liquid Releases. It is not clear why the reservoir models are in an appendix. It is recommended that the reservoir models be combined into several contiguous sections. This would greatly improve the description.

6. The first equation on page B4-246 should represent the sum of individual radionuclide concentrations. This summation should be explicit to avoid confusion. This explicit radionuclide summation should be indicated by subscripting the variables Y_i and Y_{r_i} in the activity equation. This summation notation and variable scripting should be applied to all the following equations that are based on the initial integrated activity equation.

7. In Appendix B4, the total release equation is integrated from $t = a$ to $t = b$, which are the endpoints of the integration time interval. This is obvious, but the parameters a and b should be defined separately. It is suggested that a different notation be used instead of a and b; for example, $a = T_i$ and $b = T_f$ would be more explicit and alert the reader that the parameters represent time. The use of a and b to represent time can be unclear and their meaning can easily be lost in a few pages.

8. In ODCM Appendix A, reservoir models, Figure B4-1: Lower Colorado River, the mile key is incomplete. The mile marks should be included in the figure. It is suggested that a longitude and latitude marker (location of the reactors for example) be included along with a compass indicator in Figures B4-1 and B4-2. Also, are the objects in Figures B4-1 and B4-2 to scale and position?

9. In ODCM Table B4-1, Radionuclide Fractions Leaving STP via Liquid Routes, the column headings should contain enough information to identify the data. Also, it is indicated that the values were calculated according to the methods of Section B4.1. This should read Section 4.2. Also, it is helpful to the reader to indicate what variable or symbol is associated with the data.

10. ODCM Section 4.4.3, Dose Due to Deposited and Inhaled Radionuclides, lists the pathways, organs, and age groups used to calculate dose factors. It is recommended that this information be placed in a numbered table, along with an explanation of the pathways. Suggested tabular formats for the organs and pathways are shown in Tables 3 and 4.

11. Specify the elevation of the site. This will complete the plant specific background on topographical details.

Category D:

The following items concern methodology and parameters that the licensee may wish to change because the change may simplify calculations, remove unnecessary conservatism in the calculations, or make use of recent data:

1. In ODCM Table B4-7a, "Liquid Pathway Dose Factors," there are 25 radionuclides with all entries for all pathways set to zero. It is recommended that the notes section of this table explain why there are no data for these radionuclides.

6. CONCLUSIONS

The licensee's ODCM, Revision 6, updated through January 1, 1994, consistently uses documented and approved methods that are consistent with the methodology and guidance of NUREG-0133 and Regulatory Guide 1.109. However, due to several omissions and errors, it is recommended that the NRC request another revision of the ODCM to address and correct the most significant deficiencies identified in the review.

The most important corrections and additions needed are summarized below:

- ODCM Section 3.3.3.10 requires a radioactivity monitor with alarm setpoints and automatic termination of release on the liquid waste processing discharge monitor. However, Section 2.2 indicates that there are a number of monitors used for process control purposes and that these monitors are used to direct the radioactive waste to the liquid radwaste processing system. The description of this direct system should be clarified, and other specific possible release points such as the steam generator blowdown and the condensate polishing systems should be addressed specifically.

- It is not clear that the alarm/trip setpoint calculation methods in Section 3.1 provide adequate definition of the setpoint calculation for the liquid radwaste monitor because the calculations presented in Equation 3.1f do not provide assurance that the concentration for individual radionuclides will not exceed the limits in the CSR.

- The possibility of simultaneous batch release of radioactive liquid effluent is not discussed. This should be addressed. If simultaneous batch releases are possible, the appropriates equations and calculations should be included in the ODCM.

- Regulatory Guide 1.109 explicitly discusses tritium exposure through the consumption of food grown on contaminated soil and water. STP Section 4.3.4.1 and the implementing calculations on dose liquid effluents do not discuss doses from inhalation or ingestion of tritium.

7. REFERENCES

1. Title 10, Code of Federal Regulations, Part 50, "Domestic Licensing of Production and Utilization Facilities"

2. NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors.", Generic Letter 89-01, Supplement No. 1, April 1991.

3. Standard Radiological Effluent Technical Specifications For Pressurized Water Reactors, NUREG-0133, Revision 3, 1988.

4. Regulatory Guide 1.109, Calculation Of Annual Doses To Man From Routine Releases Of Reactor Effluents For The Purpose Of Evaluating Compliance With 10 CFR Part 50, Appendix I.

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

6. Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation"

7. NUREG-1334, "Technical Specifications South Texas Project, Unit Nos. 1 and 2 Docket Nos. 50-498 and 50-499, Appendix A to License Nos. NPF-76 and NPF-78", NRC, Office of Nuclear Reactor Regulation, January 1989.

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

9. Title 40, Code of Federal Regulations, Part 190, "Environmental Radiation Protection Standards For Nuclear Power Operations"