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Evaluation of Sequoyah Nuclear Plant Offsite Dose Calculation Manual, Revision 28

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ABSTRACT

The Offsite Dose Calculation Manual (ODCM) for the Sequoyah Nuclear Plant (SQN) OCDM contains (1) current methodology and parameters used to calculate offsite doses, dose rates, effluent monitoring alarm setpoints, (2) the radioactive effluent/radiological environmental monitoring controls and surveillance requirements, and their bases, and (3) the radiological environmental monitoring program. The NRC transmitted the most recent complete SQN ODCM, Revision 28 effective December 1, 1992, to the Idaho National Engineering Laboratory for review by EG&G Idaho, Inc. The ODCM was reviewed by EG&G, and the results are presented in this report.

The SQN ODCM generally uses documented and approved methods that are consistent with the methodology and guidance of NUREG-0133 and Regulatory Guide 1.109. The ODCM contains at least a verbal description of all the required methodology. Four primary comments on monitoring methodology, calculational methods for liquid effluent releases, and total dose calculation methods were identified and should be addressed promptly. Due to several omissions and errors found in the ODCM, it is recommended that the ODCM be revised to address and correct the most significant deficiencies identified in the 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 this 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
CSR	Control and Surveillance Requirements
FR	Federal Regulation
INEL	Idaho National Engineering Laboratory
NRC	Nuclear Regulatory Commission
ODCM	Offsite Dose Calculation Manual
RETS	Radiological Effluent Technical Specifications
SQN	Sequoyah Nuclear Plant
TRM	Tennessee River Mile

Evaluation Of Sequoyah Nuclear Plant (SQN) Offsite Dose Calculation Manual, Revision 28

1. INTRODUCTION

1.1 Purpose Of Review

This document reports the review and evaluation of the most recent version of the Offsite Dose Calculation Manual (ODCM) submitted by the Tennessee Valley Authority, the Licensee for the Sequoyah Nuclear Plant (SQN). Revision 28 of the ODCM, effective December 1, 1992, was transmitted to EG&G Idaho for review. The ODCM is a supplementary document used to implement the Radiological Effluent Technical Specifications (RETS) for compliance with 10 CFR 50, Appendix I.[1] This review of this document was performed to assess conformance of the ODCM to the SQN technical specification and NRC guidelines. The ODCM is divided into two major parts.

The first part of the ODCM contains the control and surveillance requirements (CSRs) required by the SQN Technical Specifications, including:

1. Radioactive Effluent Controls required by Section 6.8.5.f of the SQN Technical Specification.

2. Radiological Environmental Monitoring Controls required by in Section 6.8.5.g of the SQN Technical Specifications.

3. Description of the information that should be included in the Annual Radiological Environmental and Semiannual Radioactive Effluent Release Reports required by SQN Technical Specification 6.9.1.6 and 6.9.1.8.

4. Administrative Controls for the ODCM requirements.

The second part of the ODCM contains the methodologies used to:

1. Calculate offsite doses resulting from radioactive gaseous and liquid effluents.

2. Calculate gaseous and liquid effluent monitor Alarm/Trip setpoints.

3. Conduct the Environmental Radiological monitoring Program.

The SQN ODCM will be maintained for use as a reference guide on accepted methodologies and calculations. Changes in the calculation methods or parameters are incorporated into the ODCM to assure that the ODCM represents the current methodology in all applicable areas. Any licensee initiated ODCM change will be implemented in accordance with SQN technical Specification 6.1.4 and ODCM Administrative Control 5.3. A summary of SQN ODCM, Revision 28 is listed in Table 1.

Table 1. Summary of SQN ODCM, Revision 28.

Implementation in ODCM Section	Procedural Details in ODCM	Tech. Spec. Programmatic Control Section	Brief Description of Contents
1.0, 2.0	None	None	Purpose and scope of the ODCM
1.1.1	Section 6.2	6.8.5.f.1	Liquid effluent monitoring instrumentation and surveillance
1.1.1	Section 6.2	6.8.5.f.1	Liquid setpoint determination
1.2.1.1	Section 6.1	6.8.5.f.2,	Liquid effluent concentration
None	None	6.8.5.f.3	
2.2.1.1.1	None	None	Liquid sampling and analysis
1.2.1.2	Section 6.3	6.8.5.f.4, 6.8.5.f.4	Liquid effluent dose commitment
2.2.1.3	Section 6.5	6.8.5.f.6	Liquid radwaste treatment and dose projection
1.1.2	Section 7.1	6.8.5.f.1	Gaseous effluent monitoring instrumentation and surveillance
None	Section 7.1	6.8.5.f.1	Gaseous setpoint determination
1.2.2.1	Section 7.2.3	6.8.5.f.7	Gaseous effluent air dose rate (noble gases)
1.2.2.1	Section 7.2.4	6.8.5.f.7	Gaseous organ dose rate (iodines, tritium, and particulates)
2.2.2.1.2	None	6.8.5.f.9	Gaseous sampling and analysis
1.2.2.2	Section 7.6	6.8.5.f.4	Gaseous air dose commitment
1.2.2.3	Section 7.6.3	6.8.5.f.4	Gaseous organ dose commitment
1.2.2.4	Section 7.5	6.8.5.f.8	Gaseous radwaste treatment and dose projections
1.2.3	Section 6.3, 7.3, 7.4	6.8.5.f.10	Uranium fuel cycle (total) dose
1.3.1	Section 9.0	6.8.5.g.1	Radiological environmental monitoring, sampling, and analysis
None	Section 7.8	None	χ/Q and D/Q methodology and data
1.3.2	Section 5.1	6.8.5.g.2	Land use census
1.3.3	Section 5.1	6.8.5.g.3	Interlaboratory Comparison Program
6.9.1.8	Section 5.2	6.15.1.1	Major changes to liquid and gaseous radwaste treatment systems
None	Section 5.1	6.9.1.6	Annual Radiological Environmental Operating Report
None	Section 5.2	6.9.1.8	Semiannual Radioactive Effluent Release Report
None	Section 5.3	6.14	Changes to the ODCM

1.2 Plant Specific Background

The plant site, consisting of approximately 525 acres, is located in Southeastern Tennessee on the West shore of Chickamauga Lake, approximately 9.5 miles Northeast of Chattanooga.

The population density of the area surrounding the site is relatively low with only three cities within 30 miles of the plant having populations exceeding 10,000 people. The minimum exclusion and low population distances are 1,824 ft and 3 mile, respectively.

SQN consists of two Westinghouse pressurized water reactors rated at 1148 MW(e) SQN Unit 1 started commercial operation July 1, 1981 and SQN Unit 2 started commercial operation June 1, 1982.

A complete site description with identifications of bodies of water, rivers, agriculture, population, and recreational activities that are within the vicinity of SQN, has not been included in the ODCM. For review purposes, this information was obtained from the Final Safety Analysis Report. A description of geographical features that would affect gaseous effluent distributions and the corresponding shielding factors should be included in the ODCM.

A brief site description should be included in the ODCM even if one is available in other SQN documents. This site description should include, as a minimum, the nearest population locations that may be affected by effluent releases, rivers and bodies of water that may receive liquid effluents, agriculture activities, and recreational activities.

2. REVIEW CRITERIA

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

1. NUREG-1302, Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Reactors.[2],

2. NUREG-0133, Preparation of Radiological Effluent Technical Specifications 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 Offsite 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

The NRC regulations require that the ODCM be a stand alone document.

3. RADIOACTIVE EFFLUENT RELEASE ROUTES

Liquid and gaseous effluent release routes from SQN are discussed in this section, along with the monitoring methodology currently being used. The description in Revision 28 of the ODCM dated September 25, 1992, was reviewed. Comments on the clarity of the description of the monitoring methodology and the adequacy of the monitored release routes are included in this section.

3.1 Liquid Effluent Release Routes

There are five liquid effluent release sources at SQN. They are the liquid radwaste system, the condensate demineralizer system, the turbine building sump, the steam generator blowdown for Units 1 and 2, and essential raw cooling water effluent header. A simplified diagram of the five sources is shown in Figure 1. Figure 2 provides additional details on the Liquid Radwaste System while Figure 3 provides additional details on the condensate demineralizer system and the steam generator blowdown. Radioactive liquid effluents from all liquid effluent sources except the turbine building pump are discharged into the cooling tower blowdown line. From the blowdown line this is discharged to the diffuser pond for ultimate discharge to the Tennessee river. The turbine building pumps are discharged directly to the diffusion pond. The cooling tower blowdown provides dilution for liquid effluents at a minimum flow rate of 15,000 gpm. The circulating water intake and outlet are both in the Tennessee River. SQN CSR 1.1.1 requires radioactivity monitors with alarm setpoints on the following effluent lines:

- Liquid Radwaste Effluent Line.
- Steam Generator Blowdown Effluent Line.
- Condensate Demineralizer Regenerant.
- Essential Raw Water Cooling Water Effluent Header.
- Turbine Building Sump Effluent Line.

It is important to note that a complete listing of monitors are samplers is not included in Table 1.1-1. O-RM-90-211, which monitors the inlet to the diffuser pond, is not listed in Table 1.1-1 or ODCM Figure 6.1 and there is no required operability requirement. This monitor should monitor the cooling tower blowdown discharge. Further, there is no evidence of a monitor on the diffuser pond outlet, which would monitor possible concentration factors in the diffuser pond. Also, it is recommended that the flow rates for each liquid discharge point be included in a figure or tablular form. Table 2 lists the flow rates and storage capacity of tanks for five effluent liquid pathways. In ODCM Figure 6.1, a reference is made to ODCM Figure 2.2; it should refer to ODCM Figure 6.2

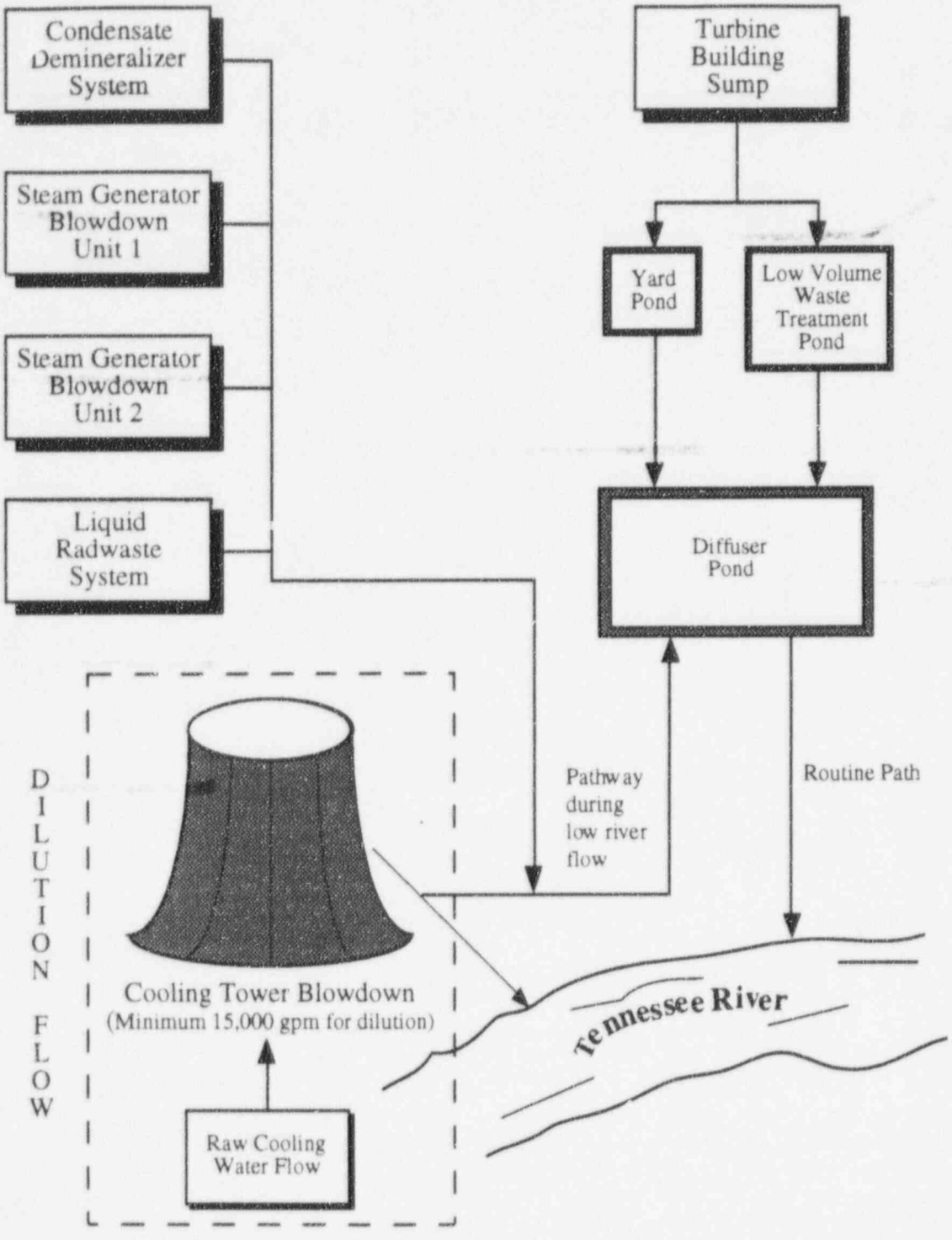

Figure 1. Liquid effluent release routes at SQN. (Based on Figure 6.1 of the SQN ODCM Revision 28.)

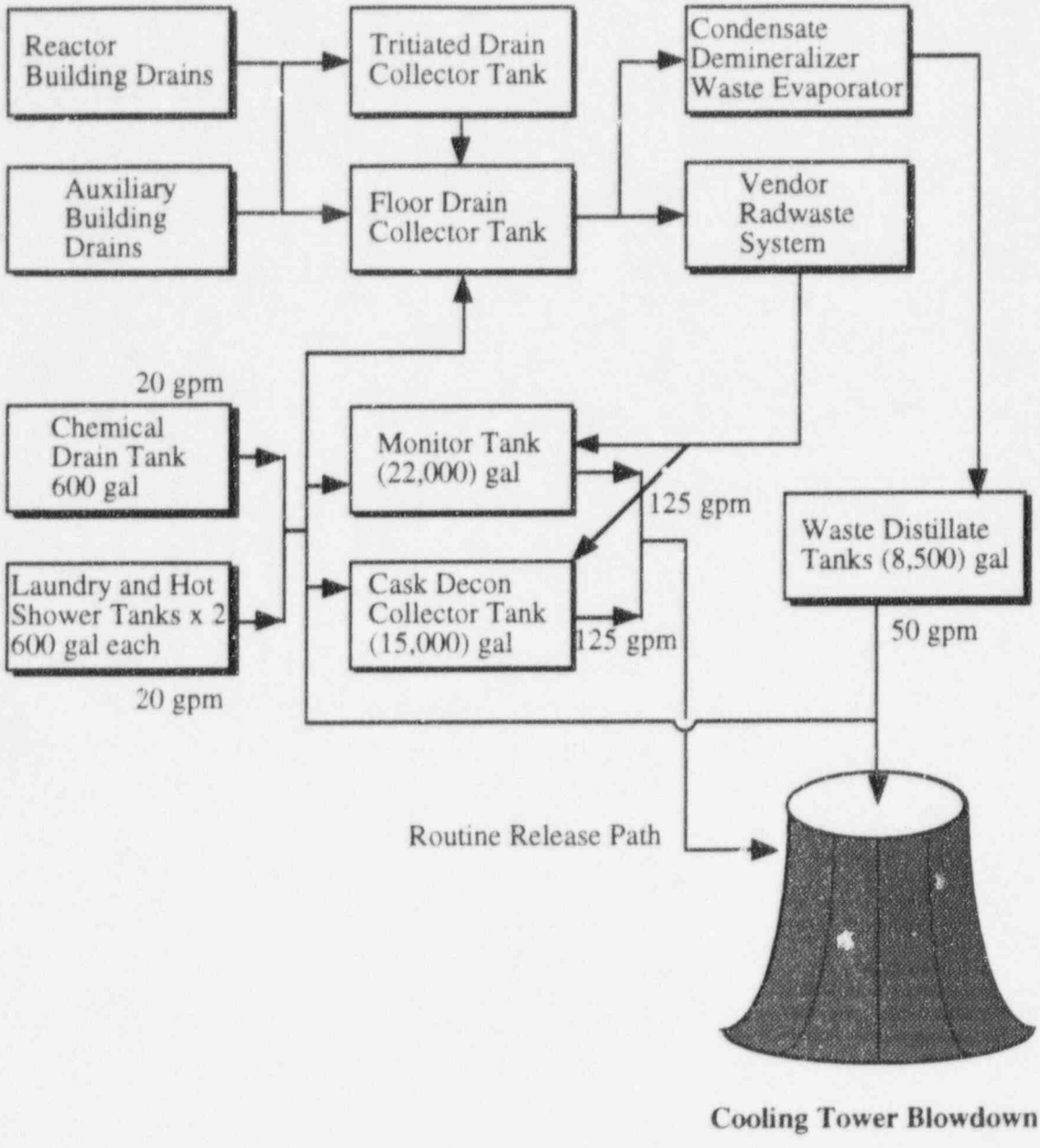

Figure 2. Liquid radwaste system at SQN. (Based on Figure 6.2 of the SQN ODCM Revision 28.)

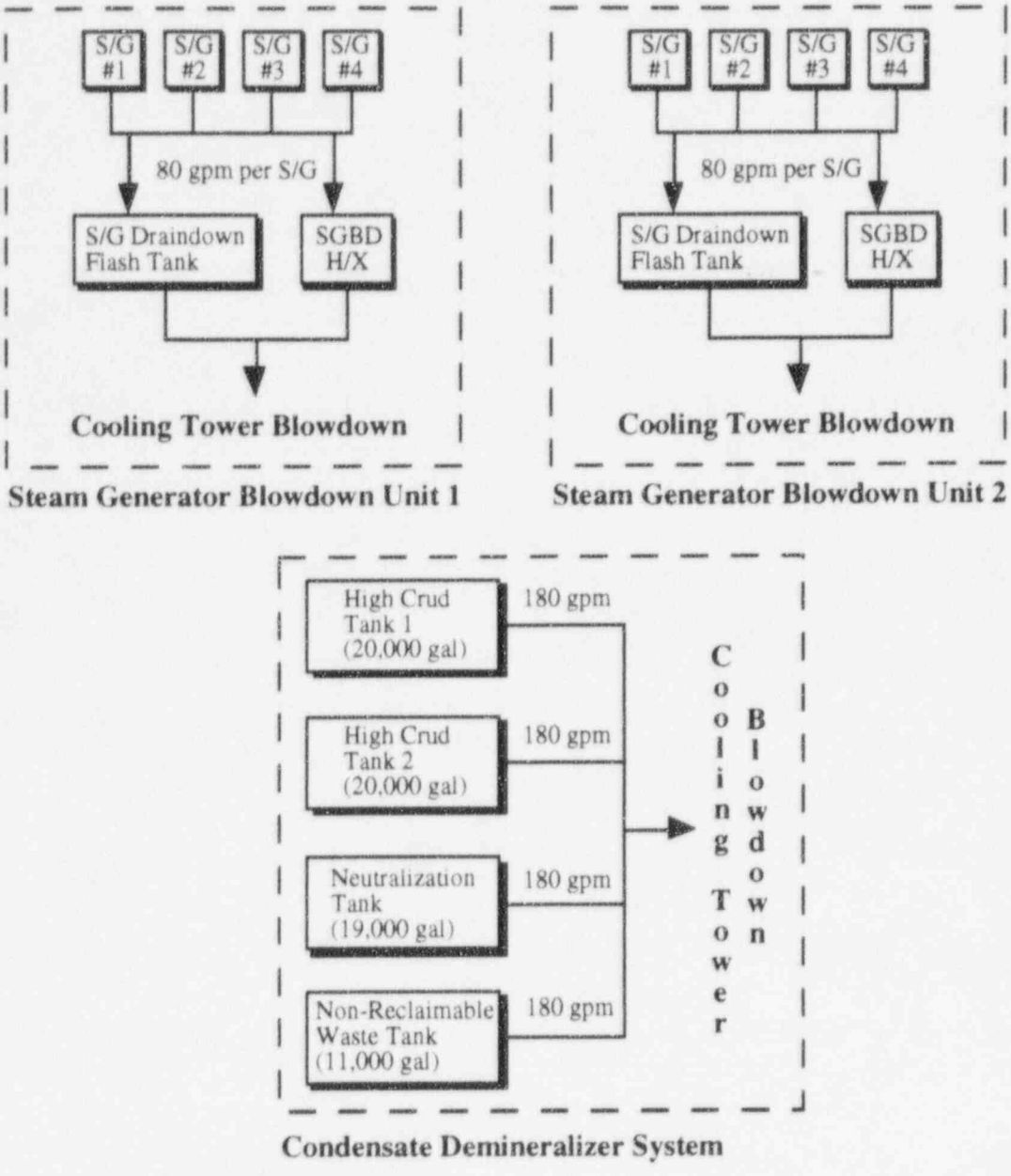

Figure 3. Steam Generator Blowdown Units 1 & 2 and the Condensate Demineralizer System at SQN. (Based on Figure 6.1 of the SQN ODCM Revision 28.)

Table 2. Liquid effluent flow rates and storage capacity at SQN.

Release Point	Flow Rate (gpm)	Storage Capacity/Tank (gal)
Liquid Radwaste System		
Chemical drain tank	20	600
Laundry and hot shower tanks (2)	20	600
Monitor tank	125	22,000
Cask decon collector tank	125	15,000
Waste distillate tanks	50	8,500
	360	47,300
Condensate demineralizer system		
High crud tank (2)	180	20,000
Neutralization tank	180	19,000
Non-reclaimable waste tank	180	11,000
	720	70,000
Turbine building sump	1,500	30,000
Steam generator blowdown (2)	N/A	N/A
Essential raw water cooling header	N/A	N/A

3.2 Gaseous Effluent Release Routes

There are six vents at SQN that are monitored for airborne effluents as required by CSR 1.1.2. They are:

- Condenser vacuum exhaust for each unit (2).
- Service building exhaust.
- Auxiliary building exhaust.
- Shield building exhaust for each unit (2).

A simplified diagram of the six exhaust points is shown in Figure 4. Figure 5 shows the gaseous radwaste treatment system, which is also monitored as noted in CSR 1.1.2.

Regulatory Guide 1.109, Revision 1, Section c.2 specifies that for elevated gaseous releases, the height of the release points should be specified in making estimates of average effluent concentrations downwind from the release points. Vent sizes, exit velocities, and/or flow rates should be specified in the ODCM along with height of surrounding buildings. If gaseous release is at ground level , Regulatory Guide 1.111[6] specified that building wake correction terms be used. Shape factors and building cross sections should be specified. in the ODCM.

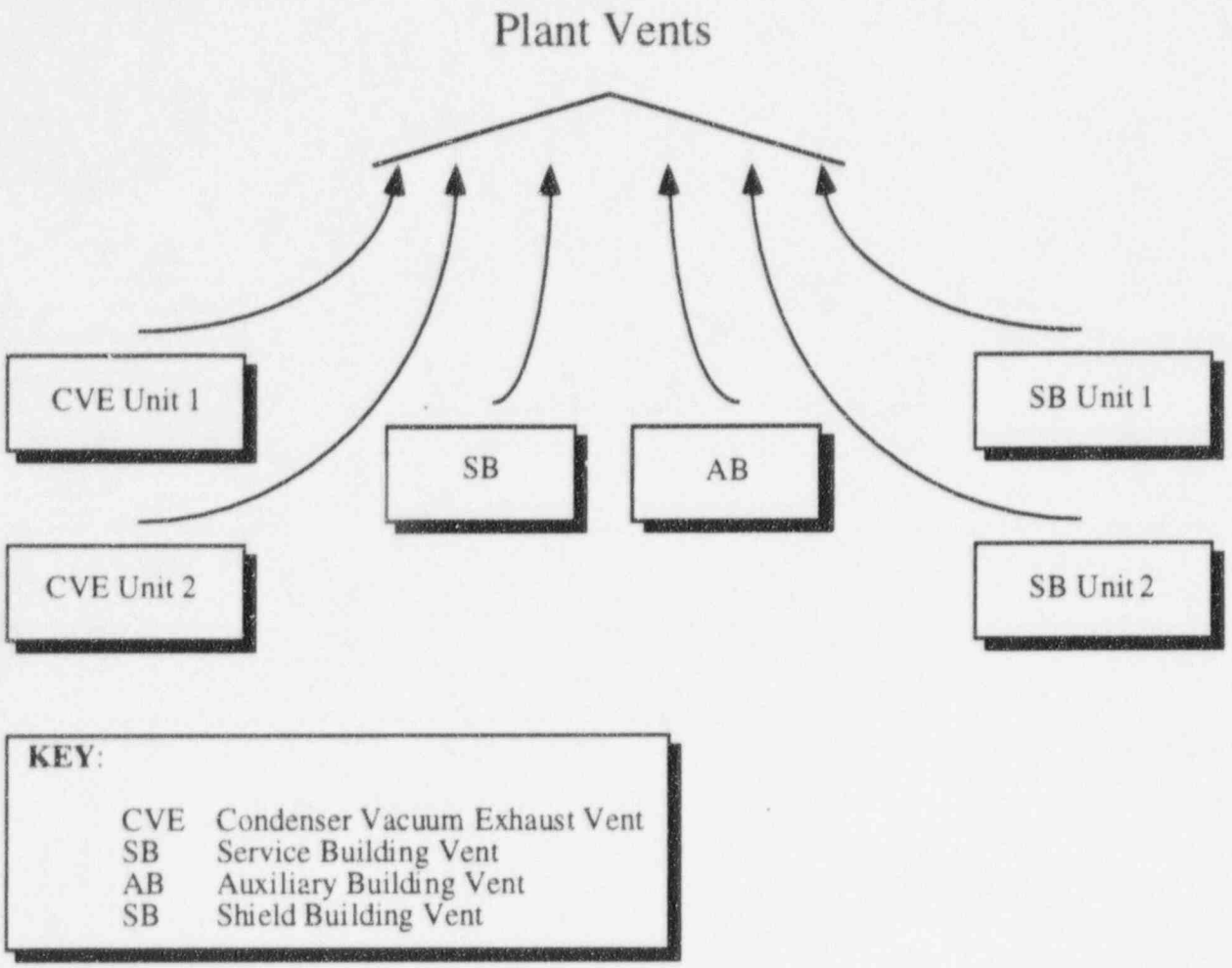

Figure 4. Gaseous effluent release routes at SQN (based on Figure 7.1 of the SQN ODCM Revision 28.)

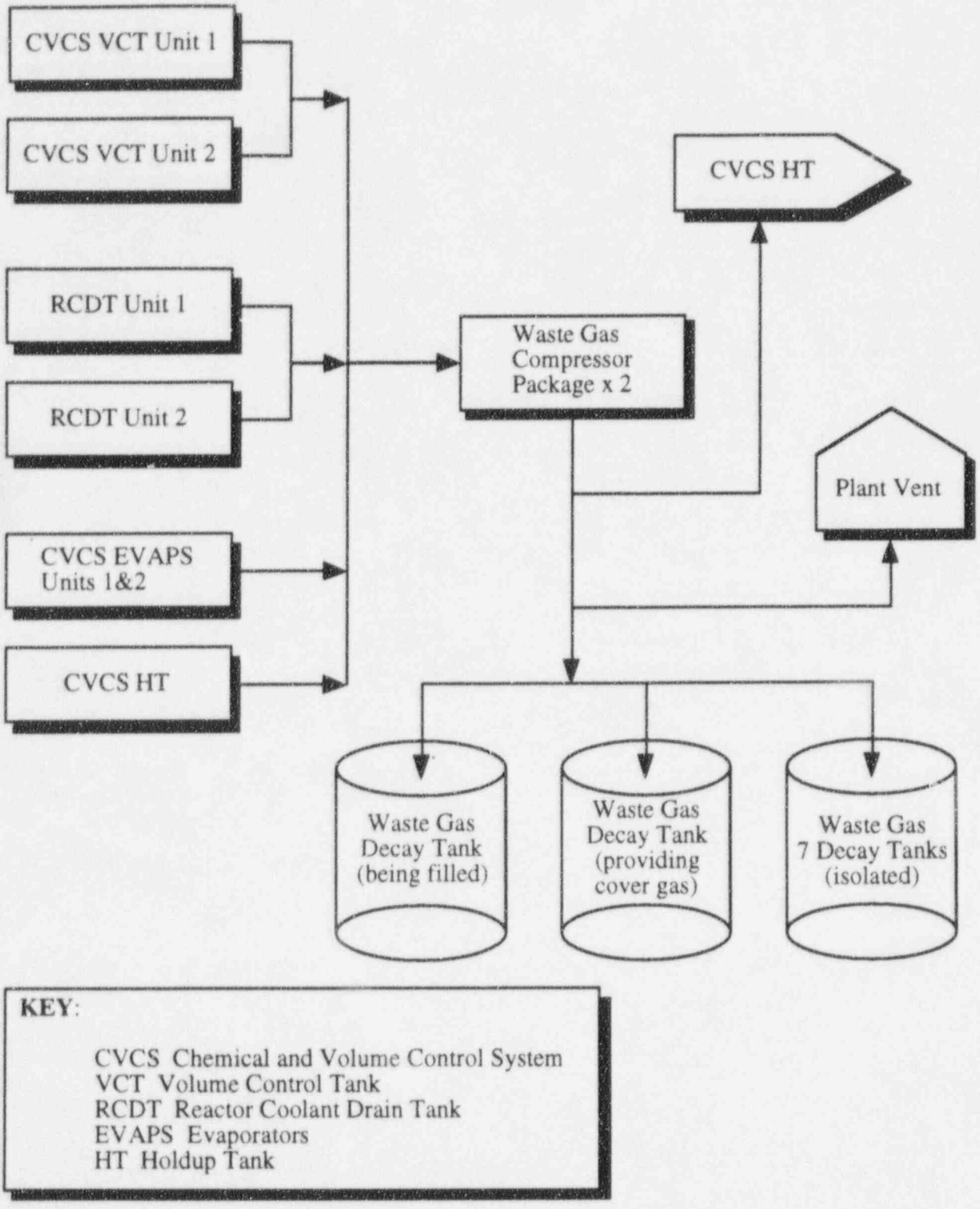

Figure 5. Gaseous radwaste and off-gas treatment system at SQN. (Based on Figure 7.3 of the SQN ODCM Revision 28.)

As noted, there are six monitored exhausts at SQN; however, the ODCM suggests that there are unmonitored release points. This should be clarified and a description of the unmonitored release points should be made if they exists along with their flowrates. Each release path should be identified with actual flowrates and simplified diagrams. In addition to simplified diagrams showing the gaseous effluent release points, it is recommended that the flow rates for each gaseous discharge point be included in a figure or tabular form. Table 3 lists the flow rates for the six monitored gaseous effluent points.

Table 3. Gaseous effluent flow rates.

Release Point	Flow Rate (cfm)
(2) Condenser vacuum exhaust	45
Service building vent	14,950
General building exhaust	228,000
(2) Shield building vent	>28,000

4. EVALUATION

The SQN ODCM is a supporting document for the SQN Technical Specifications. The ODCM should be a stand-alone document and it should include a detailed presentation of the calculational models used, including a complete tabulation of all values assigned to each parameter used in the calculations. Two changes to the ODCM which would facilitate referencing and discussion would be the use of standard notation for mathematical symbols, and use of a consistent equation numbering system.

4.1 Liquid Effluent Monitor Setpoints

CSR 1.1.1 requires that the radioactive liquid effluent monitoring instrumentation channels shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of CSR 1.2.1.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the methodology and parameters in ODCM Section 6.2.

The methodologies listed in ODCM Section 6, Liquid Releases, to calculate setpoints are generally correct. However, it should be noted that the flowrates on page 64 for the tanks in the condensate demineralizer system are different than those specified in Figure 6.1. This discrepancy should be addressed. Specific comments are stated below:

- In Section 6.2.1, the discharge monitor setpoints for monitor O-RE-90-211 are discussed; however, this monitor is not included in Table 1.1-1. Also, no monitoring appears to be performed at the outlet of the diffuser pond. Justification should be provided for not providing appropriate monitoring, control, and surveillance requirements for the outlet of the diffuser pond.

- The last paragraph of ODCM Section 6.2.2, "Release Point Monitor Setpoints," states that continuous release monitors are set in the same fashion as the batch release monitors. It is not clear that this technique, when calculated over a one-week period provides conservative monitor setpoints for continuous releases because the sum of the fractions method used in Section 6.2.3 does not identify these release pathways and no specific dilution flow is allocated to these pathways. These equations should be clarified.

- In ODCM Section 6.1.2, "MPC-Sum of the Ratios," the term MPC, maximum permissible concentration is not defined. The term MPC should be defined when used even though it may be common terminology.

- In ODCM Section 6.2.3, "Batch Release Point Monitor Setpoint," Equation 6.4 lists a safety factor, S_F, for the monitor. The ODCM does not contain any numerical values for the safety factor. The safety factor presumably is a conservative factor that is less than one. If the safety factor is greater than one, then the potential exist for larger effluent releases. The ODCM should include the definition and numerical examples of the safety factor. The NRC requires that the ODCM contain sample calculations. The ODCM should include sample setpoint calculations.

- In ODCM Section 6.2.3, "Batch Release Point Monitor Setpoint," an administrative factor, X", is discussed. This administrative factor , which may be the safety factor, S_F, is designed to account for expected variations in monitor response. It is not obvious what this administrative factor is. The logic of using the administrative factor would be better stated as follows:

  $S = X \times S_E$

  where

  S = actual setpoint

S_E = expected monitor response setpoint

X = administrative factor

The ODCM states that the administrative will be defined in approved plant instructions. The administrative factor should be defined in the ODCM with example values for completeness.

- In Equation 6.4 of ODCM Section 6.2.3, "Batch Release Point Monitor Setpoint," the fraction of dilution flow allocated to a release point, A, is defined. It is recommended that the fraction of dilution flow allocated to a release point, A, be tabulated. An example is listed in Table 4. Also, releases from the liquid radwaste , and/or condensate demineralizer system should be addressed.

Table 4. Liquid release point dilution flow and fraction of dilution flow, A_w.

Release Point	Minimum Flow Rate (gpm)	Dilution Factor[a]
Radwaste	9,000	0.6
Condensate Demineralizer	3,000	0.2
Steam Generator Blowdown (Unit 1)	1,500	0.1
Steam Generator Blowdown (Unit 2)	1,500	0.1

a Based on a total flow rate of 15,000 gpm.

It is also recommended that the dilution fraction be subscripted, i.e., A_w. Where w is the release point.

To be within NRC guidelines, the methodology to determine setpoints for the liquid effluent monitors should include the method used to prevent simultaneous releases from more than one batch release tank. This section would be better illustrated if a table of liquid effluent setpoint locations, setpoint identification and setpoint limits in numerical or symbolic form is included. The SQN ODCM does not indicate if the liquid alarm and the automatic control trip are separate devices. If they are, the alarm/trip setpoint in the ODCM should list the separate trip setpoints. The alarm setpoints should be lower than the automatic control setpoints. Separate calculations for both should be included in the ODCM.

4.2 Gaseous Effluent Monitor Setpoints

In accordance with CSR 1.1.2, the radioactive gaseous effluent monitoring instrumentation channels shown in ODCM Table 1.1-2 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of ODCM Control 1.2.2.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with the methodology and parameters in ODCM Section 7.1.

The methodologies listed in ODCM Section 7 are generally correct; however, there are some items that require further clarification. As noted previously, it is not clear from page 102 that all potential gaseous release points are monitored. This should be clarified, or the lack of monitors should be justified. Other changes or subjects for which clarification is required are discussed below.

- ODCM Section 7.1.1.1, "Containment Purge Effluent Monitors," states that the monitor setpoint is set at a percentage of an SQN Technical Specification limit. The percentage used and its basis should be stated.

- In ODCM Section 7.1.1.2, "Waste Gas Decay Tank Effluent Monitor," the monitor setpoint for the release is set equal to X times the expected monitor response. The administrative factor, X, is designed to account for expected variations in the monitor response. This section states that the administrative factor, X, is defined in approved plant instruction. The administrative factor also needs to be defined in the ODCM. The values used for the administrative factor and its justification need to be included in the ODCM.

- In ODCM section 7.1.1.2, "Waste Gas Decay Tank Effluent Monitor," Equation 7.2 identifies a dose rate allocation factor A and a safety factor S_F. To properly evaluate the methodology, these factors should be listed and sample calculations presented.

- ODCM Section 7.1.2, "Discharge Point Monitor Setpoints," describes in words the mathematical determination of setpoints. This can be clearly illustrated in the following manner:

  If $(XS_E < S_D)$ & $(S_D < S_{max})$ then $S = S_D$
  If $(XS_E > S_D)$ || $(S_D > S_{max})$ then $S = XS_E$

  The following notation is used to describe this logic.

Symbol	Description
S_{max}	Calculated maximum setpoint
S	Actual setpoint determined in logic diagram
S_D	Normal default setpoint
S_E	Expected monitor response
X	Administrative factor
&	Logical AND
|	Logical OR

SQN ODCM does not indicate if the gaseous alarm and the automatic control trip are separate devices. If they are, the alarm/trip setpoint in the ODCM should list the alarm and trip setpoints separately.

4.3 Concentrations In Liquid Effluents

In accordance with SQN Technical Specification 6.8.5.f.2 and 3 and CSR 2.2.1.2, the concentration of radioactive material released to UNRESTRICTED AREAS shall be limited to the concentrations specified in 10 CFR Part 20, 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} mircocuries/ml total activity.

There is no ODCM section which describes the calculation of concentrations of liquid effluents that may be released into water ways. This calculation should include as a minimum, what bodies of water receive liquid effluents, the range of the total dilution flow and the maximum dilution flow rate for the Cooling Tower Blowdown. ODCM Section 6.3, "Cumulative Liquid Effluent Dose Calculations," covers some of the required liquid concentration calculations. This section defines a near field average dilution factor, D. The calculation of D uses a mixing factor defined as the percentage of the river flow that is available for dilution of the release. The method used to develop this factor, D, should be presented. In addition, the general methods used to calculate liquid effluent doses should be better defined, and examples and/or references to other relevant sections used to calculate dose should be included in the ODCM.

In ODCM Section 6.2, "Instrument Setpoints," no maximum dilution flow rate for the cooling tower blowdown is defined. Based upon NUREG-0133 cooling tower blowdown times an applicable factor is limited to 1000 cfs. The range of the total dilution flow, TDF, should be identified. It is recommended

that the following statement be made; "The very large dilution factors afforded by the circulating coolant will not be used to allow high concentrations of liquid radioactive waste to be discharged from the plant."

4.4 Dose Rates Due To Gaseous Effluents

In accordance with SQN Technical Specification 6.8.5.f.7, the dose rate due to radioactive materials released in gaseous effluents to areas at or beyond the SITE BOUNDARY shall be limited to the following:

- For noble gases: $\dot{D} \leq$ 500 mrem/yr to the total body and $\dot{D} \leq$ 3,000 mrem/yr to the skin.
- For ^{131}I, ^{133}I, ^{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.

Example calculations of the expected dose rates that a member of the public at or beyond the site boundary may receive should be shown in Section 7.2 with all factors defined.

4.4.1 Dose Rates Due To Noble Gases

Pursuant to SQN Technical Specification 6.8.5.f.7, Control 1.2.2.1 requires that dose rates due to radioactive noble gases released in gaseous effluents be limited to less than or equal to 500 mrem/yr to the whole body and to less than or equal to 3000 mrem/yr to the skin. ODCM Section 7.2, "Gaseous Effluents - Dose Rates," contains methodology to determine that dose rates at or beyond the site boundary due to releases of radioactive noble gases in gaseous effluents are within the limits of ODCM Section 1/2.2.2, "Gaseous Effluents."

The licensee's methodology to determine dose rates due to radioactive noble gases is within NRC guidelines. However, in order to clarify how the equations are used, the licensee should include example calculations of the expected dose rates due to noble gases that a member of the public at or beyond the site boundary may receive.

4.4.2 Radionuclides Other Than Noble Gases

Pursuant to SQN Technical Specification 6.8.5.f.7 and CSR 1.2.2.1 requires that dose rates due to radioactive other than noble gases released in gaseous effluents be limited to less than or equal to 1,500 mrem/yr to any organ for all radionuclides in particulate form with half-lives greater than 8 days. ODCM Section 7.2, "Gaseous Effluents - Dose Rates," contains methodology to determine that dose rates at or beyond the site boundary due to releases of ^{131}I, ^{133}I, ^{3}H, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents are within the limits of ODCM Section 1/2.2.2 "Gaseous Effluents."

The licensee's methodology to determine dose rates due to radioactive other than noble gases is within NRC guidelines. However, the licensee should include example calculations.

4.5 Dose Due To Liquid Effluents

In accordance with SQN Technical Specification 6.8.5.f.4 and 5, and CSR 1.2.1.2, the dose or dose commitment to a member of the public from radioactive materials in liquid effluents released to unrestricted areas shall be limited from each reactor unit to:

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

ODCM Sections 6.6 and 6.7 contain the methodology used to determine the cumulative dose contributions from liquid effluents for the current calendar quarter and current calendar year.

ODCM Section 6.3, "Cumulative Liquid Effluent Dose Calculations," lists the age groups and organs that are used in dose and dose rate calculations. The age groups should specify the age ranges or whether the dose commitment age is used. 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 recommended that this data be summarized in tabular form as shown in Table 5.

Table 5. Age group description.

Age group a	Years of age (yr)	Dose commitment age (yr)	Fraction of population [a], 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

a NUREG/CR-1004, Table 3.39

The ODCM description of dose factor equations should start with the defining equation and with all terms defined. Then a description of the special cases for water ingestion, aquatic food ingestion, and shoreline recreation should be included. This would make the description more clear.

The equations in Section 6.7, "Liquid Dose Factor Equations," should be labeled.

4.6 Dose Due To Gaseous Effluents

In accordance with SQN Technical Specification 6.8.5.f.8 and CSR 1.2.1.2, the air dose due to noble gases released in gaseous effluents from each reactor unit to area at or beyond the site boundary shall be limited top the following:

During any calendar quarter	During any calendar year
$D \leq$ 5 mrem for gamma radiation	$D \leq$ 10 mrem for gamma radiation
$D \leq$ 10 mrem for beta radiation	$D \leq$ 20 mrem for beta radiation

It is recommended that the data related to the variables in ODCM Section 7.6.4, Population Doses, be summarized in tabular form. This would improve the appearance of the document.

The following paragraphs pertain to the gaseous dose pathway factors $R_i^p[\chi/Q]$ or $R_i^p[D/Q]$.

- ODCM Section 7.7.1, "Pasture Grass-cow/goat-milk Ingestion Dose Factors," the equation for the milk dose factor is not labeled and should be numbered.

- ODCM Section 7.7.2, "Stored Feed-cow/goat-milk Ingestion Dose Factors," the equation for the feed dose factor should be labeled. Also, the reference to this equation is unclear. It should be shown where this equation is referenced in the document.

- ODCM Section 7.7.3, "Pasture Grass-beef Ingestion Dose Factors," the equation for the beef dose factor should be labeled and numbered.

- ODCM Section 7.7.4, "Stored Feed-beef Ingestion Dose Factors," the equation for the stored beef dose factor should be referenced and numbered.

- ODCM Section 7.7.5, "Fresh Leafy Vegetable Ingestion Dose Factors," the equation for the fresh vegetable dose factor should be labeled and numbered.

- ODCM Section 7.7.6, "Stored Vegetable Ingestion Dose Factors," the equation for the stored vegetable dose factor should be labeled and numbered.

- ODCM Section 7.7.7, "Tritium Pasture Grass-cow/goat-milk Dose Factors," the equation for the tritium dose factor should be labeled and numbered. This equation is modified from the equation in NUREG-0133. These modifications should be modified.

- ODCM Section 7.7.8, "Tritium Stored Feed-cow/milk Dose Factors," the equation for the tritium dose factor should be labeled and numbered.

- ODCM Section 7.7.9, "Pasture Grass-beef Dose Factors," the equation for the tritium dose factor should be labeled and numbered. This equation appears to be a modification of the equation in NUREG-0133, Section 5.3.1.4. The modification should be justified.

- ODCM Section 7.7.10, "Tritium Stored Feed-beef Dose Factors," the equation for the tritium dose factor should be labeled and numbered.

- ODCM Section 7.7.11, "Fresh Leafy Vegetables Dose Factors," the equation for the tritium dose factor should be labeled and numbered. This equation appears to be a modification of the equation in NUREG-0133, Section 5.3.1.5. The modification should be justified.

- ODCM Section 7.7.12, "Tritium-Stored Vegetables Dose Factors," the equation for the tritium dose factor should be labeled and numbered. This equation appears to be a modification of the equation in NUREG-0133, Section 5.3.1.5. The modification should be justified.

- ODCM Section 7.7.14, "Ground Plane Dose Factors," the equation for the ground dose factor should be labeled and numbered. Also, the equation leaves out the shielding factor, S_F, compared to NUREG-0133, Section 5.3.1.2. This modification should be justified.

- ODCM Table 7.5, "Population Within Each Sector Element," does not indicate the time period that the population data was taken. The year that this data was determined should be specified in the table or table caption.

- ODCM Figure 7.4, "Plume Depletion Effect For Ground Level Releases," the vertical axis label "Fraction Remaining in Plume" should read "p Fraction Of Radionuclide Remaining In plume."

- ODCM Figure 7.5, "Vertical Standard Deviation Of Material In A Plume," has the following undefined labels, A-G. Figures should have all labels described. Define the vertical axis symbol σ_z. This definition can be included in the figure caption. For example, σ_z is the vertical dispersion coefficient.

4.7 Dose Projections

In accordance with CSR 2.2.1.2 and 2.2.2.4, dose projections will be performed. This will be done by maintaining running 31-day totals for the gamma , beta, and maximum organ dose.

4.7.1 Liquid Effluent Dose Projections

ODCM Section 6.5, "Dose Projections," indicates that the average of the previous two months doses will be used to project doses for the next 31 days. It is clear that this is a conservative estimate that would prevent the limits in ODCM Control 1.2.1.2 from being exceeded. The dose projection calculations need to be explicit and example calculations need to be presented along with a table of the radwaste dilution factors noted on the equations.

4.7.2 Gaseous Effluent Dose Projections

Section 7.5 of the ODCM indicates that 31-day running totals will be used to project doses from the off-gas systems; however, no method is indicated for projected the doses as was done for the liquid dose projections. This should be clarified and methods should be presented for projecting the doses from gaseous effluents along with example calculations.

4.8 Diagrams Of Effluent Release Routes

The ODCM contains five diagrams related to radioactive effluent treatment and release routes. However, the diagrams are difficult to read, rely on un-keyed abbreviations. This does not meet the NRC recommendation that the ODCM contain "simplified flow diagrams defining the treatment paths and the components of the radioactive liquid and gaseous waste management systems."

To be consistent with NRC guidelines, the licensee should replace the present figures with appropriate simplified flow diagrams. Detailed comment of each figure follows.

- ODCM Figure 6.1, Liquid Effluent Release Points, should be simplified. An example of the possible simplification is illustrated in Figure 1 of this report of Sequoyah 1/2 ODCM. If more detail is desired by the licensee, use a separate figure for each major radioactive gaseous release point. Figures 2 and 3 of the Technical Review of Sequoyah 1/2 ODCM illustrate breaking up ODCM Figure 6.1 into several simpler illustrations.

- ODCM Figure 7.1, "Gaseous Effluent Release Points," should be simplified. Add a symbol/term key. An example of the possible simplification is illustrated in Figure 4 of the Technical Review of Sequoyah 1/2 ODCM. If more detail is desired by the licensee, use a separate figure for each major radioactive gaseous release point.

- ODCM Figure 7.2, "Auxiliary And Shield Building Vents," should be simplified. Add a symbol/term key. An example of the possible simplification is illustrated in Figure 6 of the Technical Review of Sequoyah 1/2 ODCM. If more detail is desired by the licensee, use a separate figure for each major radioactive gaseous release point.

- ODCM Figure 7.3, "Gaseous Radwaste Treatment System," should be simplified. Add a symbol/term key. An example of the possible simplification is illustrated in Figure 5 of the Technical Review of Sequoyah 1/2 ODCM. If more detail is desired by the licensee, use a separate figure for each major radioactive gaseous release point.

4.9 Total Dose

In accordance with SQN Technical Specification 6.8.5.f.10, the annual (calendar year) dose or dose commitment to any member of the public, due to releases of radioactivity from uranium fuel cycle sources, shall be limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which shall be limited to less than or equal to 75 mrem).

- ODCM Section 8.1, "Annual Maximum Individual Doses-Total Reported Dose," contains a verbal description of annual dose methodology. NRC guidelines require that the total dose methodology include the mathematical formulation of the total dose components, for example see Regulatory Guide 1.109, the final total dose expressions, and examples of the expected total dose under expected plant operation. The mathematical description of the total dose methodology should be included in the ODCM.

- ODCM Section 6.6.4, "Total Maximum Individual Dose," contains a verbal description of the total maximum individual dose from liquid effluents. This verbal description should be augmented with an mathematical description of the methodologies. This section could be included in the Total Dose Section.

4.10 Environmental Monitoring Program

In accordance with SQN Technical Specification 6.8.5.g.1 and CSR 9.0,the radiological environmental monitoring program shall be conducted as specified in ODCM Table 2.3-1. The Radiological Environmental Monitoring Program measures radiation and radioactive material exposure pathways that lead to the highest potential radiation exposure of members of the public resulting from plant operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50. The Radiological Environmental Monitoring Program is within NRC guidelines.

It is recommended that Figure 9.1, "Environmental Monitoring Locations Within One Mile Of The Plant," indicate that the numbers represent labeled environmental monitoring locations. It is recommended that Figure 9.2, "Environmental Monitoring Locations From One To Five Miles From The Plant," indicate that the numbers represent labeled environmental monitoring locations and that the concentric rings have a distance marker. It is recommended that Figure 9.3, "Environmental Monitoring Locations Greater Than Five Miles From The Plant," have a key that states that the numbers represent labeled environmental monitoring locations and that the concentric rings have a distance marker.

It is recommended that Table 9.1, "Environmental Radiological Monitoring Program Sampling Locations," and Table 9.2, "Thermoluminescent Dosimetry Locations," specify the center location from which the radial distance is measured.

4.11 Interlaboratory Comparison Program

In accordance with SQN Technical Specification 6.8.5.g.3 and CSR 1.3.2, analysis shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program which has been approved by the Commission.

ODCM Section 9.4, "Interlaboratory Comparison Program," describes the licensee's Interlaboratory Comparison Program. The Interlaboratory Comparison Program is within NRC guidelines.

5. SUMMARY

Primary 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 about 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. The justification for not including the RM-90-211 monitor for the inlet to the diffuser in the operability requirements should be discussed along with the reason for not monitoring the outlet of the diffuser pond where some radionuclide concentration mat occur. RM-90-211 should be in the table and at the diffuser pond outlet.

2. The ODCM is outside the NRC guidelines, because it does not include a section on the calculation of concentrations in liquid effluents. This section should include as a minimum, what bodies of water receive liquid effluents, the range of the total dilution flow and the maximum dilution flow rate for the Cooling Tower Blowdown. Methods that are referenced in NRC Regulatory Guide 1.109, Revision 1 or other sources should be included in the ODCM.

3. The possibility of simultaneously having batch and continuous releases of radioactive liquid effluent is not discussed. If simultaneous batch releases are possible, the appropriate equations and calculations should be included in the ODCM.

4. ODCM Section 8.1, "Annual Maximum Individual Doses-Total Reported Dose," contains a verbal description of annual dose methodology. The total dose methodology should include the mathematical formulation of the total dose components, for example see Regulatory Guide 1.109, the final total dose expressions, and examples of the expected total dose under expected plant operation.

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. It is recommended that each major section (for example, liquid and gaseous setpoints, gaseous dose rates, liquid and gaseous doses, and dose projections) include an example calculation. These examples should illustrate plant specific values.

2. There is no site or plant description concerning bodies of water, river, agriculture, population, and recreational activities are within the vicinity of SQN. It recommended that a brief description of the nuclear unit along with geographical features that would effect gaseous effluent distributions and the corresponding shielding factors. The site description should include one or more diagrams.

3. For gaseous releases from stacks, the height of the stack should be specified in the ODCM. Are the stacks greater than 80 meters or at ground level (meaning less than 80 m, see Regulatory

Guide 1.109). The atmospheric dispersion factors are dependent on the height of the release point. This should be clearly stated in the appropriate section in the ODCM. In addition, the height of surrounding buildings should be listed.

4. The ODCM should specify how liquid release setpoint calculations are affected by the release type.

5. SQN ODCM does not indicate if the alarm and the automatic control trip are separate devices. If they are, the alarm/trip setpoint in the ODCM should list the separate trip setpoints.

6. ODCM Section 7.1.1.1, "Containment Purge Effluent Monitors," states that the monitor setpoint is set at a percentage of a Technical Specification limit. This methodology should be described and tabulated.

7. In ODCM Section 7.1.1.2, "Waste Gas Decay Tank Effluent Monitor," the monitor setpoint for the release is set equal to X times the expected monitor response. The administrative factor, X, is designed to account for expected variations in the monitor response. This section states that the administrative factor, X, is defined in approved plant instruction. The administrative factor should be defined in the ODCM along with a justification of the values listed.

8. In ODCM Section 6.2, "Instrument Setpoints," no maximum dilution flow rate for the cooling tower blowdown is defined. The range of the total dilution flow, TDF, should be identified. It is recommended that the following statement be made; "The very large dilution factors afforded by the circulating coolant will not be used to allow high concentrations of liquid radioactive waste to be discharged from the plant."

9. ODCM Section 6.5, "Dose Projections," second paragraph states that if the projected doses exceed monthly limits, the liquid radwaste treatment system will be used to reduce the radioactive materials in liquid wastes prior to their discharge. The dose projection calculation should be explicit. The dilution factor and the maximum rate or dilution and discharge should be clarified.

10. The ODCM should contain flow diagrams that represent plant systems and that 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.

11. There are six monitored exhausts at SQN; however, the ODCM suggests that there are unmonitored release points. This should be clarified and a description of the unmonitored release points should be made if they exists along with their flowrates. Each release path should be identified with actual flowrates and simplified diagrams. In addition to simplified diagrams showing the gaseous effluent release points, it is recommended that the flow rates for each gaseous discharge point be included in a figure or tabular form.

12. In ODCM Section 6.2.3, "Batch Release Point Monitor Setpoint," Equation 6.4 lists a safety factor, S_F, for the monitor. The ODCM does not contain any numerical values for the safety factor. The safety factor presumably is a conservative factor that is less than one. If the safety factor is greater than one, then the potential exist for larger effluent releases. The ODCM should include the definition and numerical examples of the safety factor. The NRC requires that the ODCM contain sample calculations. The ODCM should include sample setpoint calculations.

13. In ODCM Section 6.2.3, "Batch Release Point Monitor Setpoint," an administrative factor, X", is discussed. This administrative factor , which may be the safety factor, S_F, is designed to account for expected variations in monitor response. It is not obvious what this administrative factor is.

The ODCM states that the administrative will be defined in approved plant instructions. The administrative factor should be defined in the ODCM with example values for completeness.

14. In Equation 6.4 of ODCM Section 6.2.3, "Batch Release Point Monitor Setpoint," the fraction of dilution flow allocated to a release point, A, is defined. It is recommended that the fraction of dilution flow allocated to a release point, A, be tabulated.

15. In ODCM section 7.1.1.2, "Waste Gas Decay Tank Effluent Monitor," Equation 7.2 identifies a dose rate allocation factor A and a safety factor S_F. To properly evaluate the methodology, these factors should be listed and sample calculations presented.

16. ODCM Section 7.1.2, "Discharge Point Monitor Setpoints," describes in words the mathematical determination of setpoints.

17. The calculation of D uses a mixing factor defined as the percentage of the river flow that is available for dilution of the release. The method used to develop this factor, D, should be presented. In addition, the general methods used to calculate liquid effluent doses should be better defined, and examples and/or references to other relevant sections used to calculate dose should be included in the ODCM.

18. Example calculations of the expected dose rates that a member of the public at or beyond the site boundary may receive should be shown in Section 7.2 with all factors defined.

19. ODCM Section 6.3, "Cumulative Liquid Effluent Dose Calculations," lists the age groups and organs that are used in dose and dose rate calculations. The age groups should specify the age ranges or whether the dose commitment age is used. 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 recommended that this data be summarized in tabular form as shown in Table 5.

20. The ODCM description of dose factor equations should start with the defining equation and with all terms defined. Then a description of the special cases for water ingestion, aquatic food ingestion, and shoreline recreation should be included. This would make the description more clear.

21. Section 7.5 of the ODCM indicates that 31-day running totals will be used to project doses from the off-gas systems; however, no method is indicated for projected the doses as was done for the liquid dose projections. This should be clarified and methods should be presented for projecting the doses from gaseous effluents along with example calculations.

Category C:

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

To improve readability, a consistent numbering system should be used for the equations.

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:

ODCM Section 7.1.2, Discharge Point Monitor Setpoints, describes in words the mathematical determination of setpoints. This can be clearly illustrated in a symbolic manner.

6. CONCLUSIONS

The licensee's ODCM, Revision 28 December 1992 generally uses documented and approved methods that are consistent with the methodology and guidance of NUREG-0133 and Regulatory Guide 1.109. The ODCM contains at least a verbal description of all the required methodology. However, the SQN ODCM should have a complete mathematical description of the methodologies, and example calculations for each calculational method should be in the ODCM.

Due to several omissions and errors, it is recommended that the ODCM be revised to address and correct the most significant deficiencies identified in the review.

Primary areas in which additional clarification is needed are:

1. Justification for not including the RM-90-211 monitor for the inlet to the diffuser pond in the operability requirements should be discussed along with the reason for not monitoring the outlet of the diffuser pond where some radionuclide concentration may occur.

2. To be within NRC guidelines, the ODCM should include a section on the calculation of concentrations in liquid effluent. This calculation should include, as a minimum, the bodies of water that receive liquid effluent, the range of the total dilution flow, and the maximum dilution flow rate for the cooling tower blowdown. Methods that are referenced in NRC Regulatory Guide 1.109, Revision 1, or other sources should be included in the ODCM.

3. The possibility of simultaneous batch releases of radioactive liquid effluent is not discussed. This should be clarified. If simultaneous batch releases are possible, the appropriate equations and calculations should be included in the ODCM.

4. ODCM Section 8.1, Annual Maximum Individual Doses-Total Reported Dose, contains a verbal description of annual dose methodology. The total dose methodology should include the mathematical formulation of the total dose components; for example, see Regulatory Guide 1.109, the final total dose expressions, and examples of the expected total dose under expected plant operation.

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. Regulatory Guide 1.111, "Methods For Estimating Atmospheric Transport And Dispersion Of Gaseous Effluents In Routine Releases From Light-Water-Coolder Reactors," Revision 1, July 1997.

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