CONNECTICUT YANKEE ATOMIC POWER COMPANY

BERLIN, CONNECTICUT
P. O. BOX 270 HARTFORD, CONNECTICUT 06101

TELEPHONE
203-666-6911

August 1, 1979

Docket No. 50-213

Director of Nuclear Reactor Regulation
Attn: Mr. Brian K. Grimes, Assistant Director
for Engineering and Projects
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

References: (1) W. G. Counsil letter to B. K. Grimes dated January 18, 1979.
(2) W. G. Counsil letter to B. K. Grimes dated February 28, 1979.
(3) Meeting Notes, Docket No. 50-213, dated July 5, 1979.

Gentlemen:

Haddam Neck Plant
Proposed Radiological Effluent Technical Specifications
and Offsite Dose Calculation Manual

A meeting was held on May 22, 1979 between representatives of Connecticut Yankee Atomic Power Company (CYAPCO) and the NRC Staff to review the Haddam Neck Plant's proposed Radiological Effluent Technical Specifications and Offsite Dose Calculation Manual (ODCM) which had been submitted on January 18, 1979 and revised on February 28, 1979, References (1) and (2), respectively.

As a result of that meeting, revisions, as requested by the Staff, have been made to both the Technical Specifications and the ODCM and are included herewith as Enclosures 2 and 3. Supplemental data has been added to the ODCM as requested. A number of technical, administrative, and clarity changes have been made to the proposed Technical Specifications based on discussions and comments during the meeting.

It should be noted that revisions to the Technical Specifications and ODCM, since the previous submittals, have been identified by double margin bars. Also, since both documents are still in draft status, all pages including those submitted as Rev. 1, on February 28, 1979, have been retyped as Rev. 0 and dated October, 1979, the date which CYAPCO feels would be the earliest implementation date achievable.

523 196

Additionally, the NRC Staff requested specific information concerning the Technical Specifications and ODCM as indicated in Reference (3). Responses to those comments are included herewith as Enclosure 1.

542 P

7908070

Two additional items remain outstanding; (1) Submission of a Process Control Program (PCP) for solid waste, and (2) a value impact appraisal of alternate spent resin disposal methods. These two items will be submitted on or before August 17, 1979. While this date is beyond the date for submission of all information of August 1, 1979, their non-availability for NRC Staff review should not impede review of the Technical Specifications and ODCM.

Because the documents being submitted herewith update information provided in References (1) and (2), the fee forwarded with Reference (1), pursuant to 10CFR170, is applicable to this submittal. Accordingly, no fee payment is enclosed.

Very truly yours,

CONNECTICUT YANKEE ATOMIC POWER COMPANY

W. G. Counsil

W. G. Counsil
Vice President

Enclosures

523 197

ENCLOSURE 1

RESPONSES TO SPECIFIC COMMENTS

Question 1

CYAPCO shall verify whether there is automatic isolation of the steam generator blowdown lines and what actuates the isolation.

Response

Presently, automatic isolation of the steam generator blowdown lines is actuated by high containment pressure (5 psig). A high radiation signal from the blowdown radiation monitor will alarm in the control room, but will not provide automatic isolation.

CYAPCO has initiated a plant design change request to incorporate automatic isolation of the steam generator blowdown upon a high radiation alarm from the steam generator blowdown monitor. This has been incorporated into the proposed Technical Specifications. It is expected that this modification will be completed by July, 1980.

Question 2

CYAPCO shall determine if, 1) the overflow lines from the waste test tanks are piped back to the radioactive waste system or overflow to diked areas, and 2) diked areas have drains and, if so, where do they drain and how are they controlled?

Response

The overflow lines from the Waste Test Tanks are piped to the diked areas around the Boron Waste Storage Tanks. This diked area drains to the Aerated Drain Tank. Control for this operation is under the administrative control of the Shift Supervisor.

Question 3 523 198

The ODCM must include descriptions of the real time X/Q models.

Response

Appendix G has been added to the ODCM describing the meteorological models used.

Question 4

CYAPCO shall resolve the difference between their X/Q of 1.32×10^{-5} sec/m^3 for the maximum annual average and the value calculated by the NRC of 2.3×10^{-5} sec/m .

Response

The X/Q value of 2.3×10^{-5} calculated by the NRC was calculated prior to 1975. Thus, it was calculated with data from the old meteorological tower. The old tower had temperature instrumentation at 5 ft. and 100 ft. and wind instrumentation at 100 ft., above grade elevation. The wind data may not have been representative of the 175 foot stack and the temperature sensor separation did not conform to Regulatory Guide 1.23 requirements. It was for these reasons that a new meteorological tower was constructed in 1975 at a different location with instrumentation levels at 33 ft. and 196 ft. The X/Q value of 1.3×10^{-5} was calculated using two years (1976 and 1977) of data from the new tower.

Also, the NRC value was calculated prior to the development of Regulatory Guide 1.111; whereas, the value calculated by CYAPCO was calculated in 1978, using the Reg. Guide models.

It is for these reasons that CYAPCO feels that the value of 1.3×10^{-5} is the more up-to-date and realistic X/Q value and should be used instead of the old NRC value.

Question 5

CYAPCO shall provide specific references in the ODCM to identify which codes, models, and options are used.

Response

Appendices C and E of the ODCM have been modified to indicate the models and options used when computer codes are used to calculate the doses due to liquid and gaseous effluents.

Question 6

CYAPCO shall show all gaseous release points on the flow diagrams and justify not monitoring any unmonitored releases.

Response

Station radiological area ventilation, except for insignificant levels from the turbine building and service building, is exhausted through the main stack, and, thus, is monitored.

There exists a separate roof vent over the boric acid storage area in the Primary Auxiliary Building (PAB). However, this vent has been tagged closed and the power leads to the fan and louver mechanism disconnected to prevent operation. Thus, the ventilation from this area is directed with the remainder of the PAB ventilation to the main stack.

Question 7

CYAPCO shall verify how oxygen is excluded from the Waste Gas Tank or that the system is designed for explosion.

Response

Oxygen is normally excluded from the Waste Gas System by maintaining the entire system at a positive pressure, at least 1/2 lb., above atmospheric. The waste gas is periodically tested for oxygen content. The system is not designed to withstand an explosion.

CYAPCO will initiate a plant design change request to install an oxygen monitor in the waste gas system. The requirements for oxygen monitoring have been added to the proposed Technical Specifications and will become effective upon completion of the design change.

The expected completion date for the design change depends mostly on the availability and delivery date of an oxygen monitor, which at the present time, is unknown. The modification will be completed, however, as soon as practicable.

Question 8

CYAPCO shall justify the charcoal cartridge change frequency for the stack sample and also justify the lower level of detection (LLD) for the stack sample noble gas monitor.

Response

The charcoal cartridge change frequency for the stack sampler and the stack noble gas activity monitor LLD as given in the NRC draft standard have been incorporated into the proposed technical specifications. Thus, no justifications are necessary.

Question 9

CYAPCO shall justify the use of grab samples vs. continuous sampling of the steam generator blowdown.

Response

CYAPCO has initiated a modification to install a continuous composite sampler on the steam generator blowdown line. This modification should be completed by March, 1980. Thus, justification for the use of grab samples is not required.

523 201

ENCLOSURE 2

REVISIONS TO THE

HADDAM NECK

RADIOLOGICAL EFFLUENT

TECHNICAL SPECIFICATIONS

523 202

INDEX

DEFINITIONS

SECTION 1.0 DEFINITIONS

523 203

INDEX
(Continued)

523 204

SECTION 2.0 SAFETY LIMITS AND MAXIMUM SAFETY SETTINGS

PAGE NO.

SECTION 3.0 LIMITING CONDITIONS FOR OPERATION

SECTION 4.0 SURVEILLANCE REQUIREMENTS

523 205

SECTION 4.0 SURVEILLANCE REQUIREMENTS (Cont'd) PAGE NO.

SECTION 5.0 DESIGN FEATURES

523 206

ADMINISTRATIVE CONTROLS

523 207

SOURCE CHECK

1.26
A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to radiation.

OFFSITE DOSE CALCULATION MANUAL (ODCM)

1.27
An OFFSITE DOSE CALCULATION MANUAL (ODCM) shall be a manual containing the methodology and parameters to be used in the calculation of offsite doses due to radioactive gaseous and liquid effluents and in the calculation of gaseous and liquid effluent monitoring instrumentation alarm/trip setpoints. Requirements of the ODCM are provided in Specification 6.15.

GASEOUS RADWASTE TREATMENT SYSTEM

1.28
A GASEOUS RADWASTE TREATMENT SYSTEM is any system designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system offgases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

VENTILATION EXHAUST TREATMENT SYSTEM

1.29
A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters for the purpose of removing iodines or particulates from the gaseous exhaust stream prior to the release to the environment. Such a system is not considered to have any effect on noble gas effluents. Engineered Safety Feature (ESF) atmospheric cleanup systems are not considered to be VENTILATION EXHAUST TREATMENT SYSTEM components.

523 208

MAJOR CHANGES TO RADIOACTIVE WASTE SYSTEMS

1.30 The RADIOACTIVE WASTE SYSTEMS are those liquid, gaseous and solid waste systems which are required to maintain control over radioactive material in order to meet the LCO's set forth in these specifications.

MAJOR CHANGES to these systems shall include the following:

1) Major changes in process equipment, components, structures and effluent monitoring instrumentation from those described in the Facility Description and Safety Analysis and evaluated in the staff's Safety Evaluation Report (SER) (e.g., deletion of evaporators and installation of demineralizers; use of fluidized bed calciner/incineration in place of cement solidification systems);

2) Major changes in the design of radwaste treatment systems (liquid, gaseous and solid) that could significantly alter the characteristics and/or quantities of effluents released or volumes of solid waste stored or shipped offsite from those previously considered in the FDSA and SER (e.g., use of asphalt system in place of cement);

3) Changes in system design which may invalidate the accident analysis as described in the SER (e.g., changes in tank capacity that would alter the curies released); and

4) Changes in system design that could potentially result in a significant increase in occupational exposure of operating personnel.

523 209

PROCESS CONTROL PROGRAM (PCP)

1.31 A PROCESS CONTROL PROGRAM shall contain sampling, analysis, and formulation determination by which SOLIDIFICATION of radioactive wastes from liquid systems is accomplished.

SOLIDIFICATION

1.32 SOLIDIFICATION shall be the conversion of radioactive wastes from liquid systems to an immobilized solid with definite volume and shape, bounded by a stable surface of distinct outline on all sides.

PURGE - PURGING

1.33 PURGE or PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

VENTING

1.34 VENTING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required during venting. Vent, used in system names, does not imply a VENTING process.

523 210

TABLE 1.2

FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At least once per 8 hours.
D	At least once per 24 hours.
W	At least once per 7 days.
B/W	At least once per 14 days.
M	At least once per month.
6/W	At least once per 42 days.
Q	At least once per quarter.
SA	At least once per 6 months.
A	At least once per 12 months.
R	At least once per 18 months.
S/U	Prior to each reactor startup.
P	Prior to each release.
N/A	Not applicable.

523 211

3.23 RADIOACTIVE LIQUID EFFLUENT INSTRUMENTATION - Limiting Condition for Operation

3.23.1 The radioactive liquid effluent monitoring instrumentation channels shown in Table 3.23-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Specification 3.25.1.1 are not exceeded. The setpoints shall be determined in accordance with procedures as described in the ODCM and shall be recorded.

Applicability: As shown in Table 3.23-1.

Action:

1. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than a value which will ensure that the limits of 3.25.1.1 are met, immediately suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel inoperable.

2. With the number of channels less than the minimum channels operable requirement, take the action shown in Table 3.23-1.

3. In the event a limiting condition for operation and/or associated action requirement cannot be satisfied, this shall not require plant shutdown or prevent a change in operational modes.

4. Inoperable monitors shall not require a report to the NRC. Failure to satisfy the corresponding action requirement shall require a 30 day report to the NRC.

4.23 RADIOACTIVE LIQUID EFFLUENT INSTRUMENTATION - Surveillance

4.23.1.1 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.23-1.

4.23.1.2 Records - Auditable records shall be maintained of all radioactive liquid effluent monitoring instrumentation alarm/trip setpoints. Setpoints and setpoint calculations shall be available for review to ensure that the limits of Specification 3.25.1.1 are met.

523 212

TABLE 3.23-1

Radioactive Liquid Effluent Monitoring Instrumentation

Instrument	Minimum # Operable	Applicability	Action
1. Gross radioactivity monitors providing automatic termination of release			
a. Waste and Recycle Test Tank Discharge Line	(1)	*	a
b. Steam Generator Blowdown Line[t]	(1)	*	b
2. Gross radioactivity monitors not providing automatic termination of release			
a. Service Water Effluent Line	(1)	*	c
3. Flow Rate Measurement			
a. Waste and Recycle Test Tank Discharge Line	(1)	*	d
b. Steam Generator Blowdown Line	**	*	NA
c. Discharge Canal	***	*	NA

* - At all times - which means that channels shall be OPERABLE and in service on a continuous, uninterrupted basis, except that outages are permitted, within the time frame of the specified action statement, for the purpose of maintenance and performance of required tests, checks, and calibrations.

t - Automatic termination of blowdown requirement will become effective upon completion of proposed modification to provide automatic termination.

** - Flow is determined by the use of valve curves. The steam generator blowdown is a gravity system.

*** - Discharge canal flow is determined by the use of pump curves.

NA - Not Applicable.

523 213

TABLE 3.23-1
(Continued)

ACTION STATEMENTS

Action a: With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases may be resumed for up to 14 days, provided that prior to initiating a release:

1. At least two independent samples are analyzed in accordance with Specification 4.23.1.3, and;

2. At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge valving;

Otherwise, suspend release of radioactive effluents via this pathway.

Action b: With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided grab samples are analyzed for gross radioactivity (beta or gamma) at a limit of detection of at least 10^{-7} uCi/ml;

1. At least once per 8 hours when the specific activity of the secondary coolant is > 0.01 uCi/ml DOSE EQUIVALENT I-131.

2. At least once per 24 hours when the specific activity of the secondary coolant is ≤ 0.01 uCi/ml DOSE EQUIVALENT I-131.

Action c: With the numbers of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided that at least once per 8 hours grab samples are collected and analyzed for gross radioactivity (beta or gamma) at a lower limit of detection of at least 10^{-7} uCi/ml.

Action d: With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours during actual releases

523 214

TABLE 4.23-1

Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements

Instrument	Channel Check	Source Check	Channel Calibration	Channel Functional
1. Gross radioactivity monitors providing automatic termination of release				
a. Waste and Recycle Test Tank Discharge Line	D(1)	P	R(2)	Q(3)
b. Steam Generator Blowdown Line*	D(1)	M	R(2)	Q(3)
2. Gross radioactivity monitors not providing automatic termination of release				
a. Service Water Effluent Line	D(1)	M	R(2)	Q(3)
3. Flow Rate Measurement				
a. Waste and Recycle Test Tank Discharge Line	D(1)	NA	R	Q
b. Steam Generator Blowdown Line	D(5)	NA	NA	NA
c. Discharge Canal	D(4)	NA	NA	NA

* - Automatic termination of blowdown requirement will become effective upon completion of a proposed modification to provide automatic termination.

523 215

TABLE 4.23-1
(Continued)

TABLE NOTATION

(1) Channel check need only be performed daily when discharges are made from this pathway. The channel check should be done when the discharge is in process.

(2) Calibration shall be performed using a radioactive liquid source, the activity of which is determined using a gamma spectrometer calibrated to an NBS traceable source. The radioactive source shall be in a known reproducible geometry.

(3) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:

1. Instrument indicates measured levels above the alarm/trip setpoint*.

2. Instrument indicates a downscale failure or circuit failure.

3. Instrument controls not set in operate mode.

* Automatic isolation shall also be demonstrated for the test tank discharge monitor line and steam generator blowdown line.

(4) Pump status should be checked at least daily.

(5) Valve position should be checked daily when discharges are being made via this pathway.

523 216

3.23 & 4.23 - Radioactive Liquid Effluent Instrumentation

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases. The alarm/trip setpoints for these instruments shall be calculated in accordance with NRC approved methods in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

523 217

3.24 Radioactive Gaseous Effluent Monitoring Instrumentation - Limiting Condition for Operation

3.24.1 The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.24-1 shall be OPERABLE with their alarm/trip setpoints set to ensure that the limits of Specification 3.26.1.1 are not exceeded. The setpoints shall be determined in accordance with procedures as described in the ODCM and shall be recorded.

Applicability: As shown in Table 3.24-1.

Action:

1. With a radioactive gaseous effluent monitoring instrumentation channel alarm/trip setpoint less conservative than a value which will ensure that the limits of 3.26.1.1 are met, immediately suspend the release of radioactive gaseous effluents monitored by the affected channel or declare the channel inoperable.

2. With the number of channels less than the minimum channels operable requirement, take the action shown in Table 3.24-1.

3. In the event a limiting condition for operation and/or associated action requirement cannot be satisfied, this shall not require plant shutdown or prevent a change in operational modes.

4. Inoperable monitors shall not require a report to the NRC. Failure to satisfy the corresponding action requirement shall require a 30 day report to the NRC.

4.24 Radioactive Gaseous Effluent Instrumentation - Surveillance

4.24.1.1 Each radioactive gaseous process or effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION, and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4.24-1.

4.24.1.2 Auditable records shall be maintained of the calculations made, of all radioactive process and effluent monitoring instrumentation alarm/ trip setpoints. Setpoints and setpoint calculations shall be available for review to ensure that the limits of Specification 3.26.1.1 are met.

523 218

TABLE 3.24-1

Radioactive Gaseous Effluent Monitoring Instrumentation

Instrument	Minimum # Operable	Applicability	Action
1. Main Stack			
a. Noble Gas Activity Monitor	(1)	*	a
b. Iodine Sampler	(1)	*	b
c. Particulate Sampler	(1)	*	b
d. Stack Flow Rate Monitor	(1)	*	c
e. Sampler Flow Rate Meter	(1)	*	c
2. a. Waste Gas System Oxygen Monitor**	(1)	*	d

* - At all times - which means that channels shall be OPERABLE and in service on a continuous, uninterrupted basis, except that outages are permitted, within the time frame of the specified action statement, for the purpose of maintenance and performance of required tests, checks and calibrations.

Action a: With the number of channels OPERABLE less than required by the minimum channels OPERABLE requirement:

1. Releases from the waste gas holdup system may continue for up to 14 days provided that prior to initiating the release:

   (a) At least two independent samples of the tank's contents are analyzed; and,

   (b) At least two technically qualified members of the facility staff independently verify the release rate calculations and discharge valve lineup; otherwise, suspend releases from the waste gas holdup system.

2. Releases from all pathways other than the waste gas holdup system may continue for up to 30 days provided grab samples are taken at least once per 8 hours and these samples are analyzed for gross radioactivity within 24 hours.

523 219

TABLE 3.24-1
(Continued)

Action b: With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days, provided samples are continuously collected with auxiliary sampling equipment, and analyzed at least once every 7 days.

Action c: With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue for up to 30 days provided the flow rate is estimated at least once per 4 hours.

Action d**: With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, operation of the system may continue for 30 days provided grab samples are obtained once every 24 hours and analyzed for oxygen.

** - These requirements will become effective upon completion of the proposed modification to install an oxygen monitor.

523 220

TABLE 4.24-1

Radioactive Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

Instrument	Channel Check	Source Check	Channel Calibration	Channel Functional
1. Main Stack				
a. Noble Gas Activity Monitor	D(1)	M	R(2)	Q(3)
b. Iodine Sampler	W	NA	NA	NA
c. Particulate Sampler	W	NA	NA	NA
d. Stack Flow Rate Monitor	D(1)	NA	R	Q
e. Sampler Flow Rate Meter	D	NA	R	NA
2. a. Waste Gas System Oxygen Monitor**	D(4)	NA	Q(5)	M

(1) Channel check daily when there exists releases via this pathway.

(2) Calibration shall be performed using a radioactive gaseous source which is traceable to the NBS and is in a known, reproducible geometry.

(3) The CHANNEL FUNCTIONAL TEST shall also demonstrate that control room alarm annunciation occurs if any of the following conditions exist:

a. Instrument indicates measured levels above the alarm/trip setpoint*.

b. Instrument indicates a downscale failure or circuit failure.

c. Instrument controls not set in operate mode.

* Automatic isolation of the waste gas holdup system releases by the noble gas monitor should also be demonstrated.

(4)** During Waste Gas System Operation.

523 221

(5)** The CHANNEL CALIBRATION shall include the use of standard gas samples containing a nominal:

a. One volume percent oxygen, balance nitrogen; and

b. Four volume percent oxygen, balance nitrogen.

** - These requirements will become effective upon completion of the proposed modification to install an oxygen monitor.

BASES

3.24 & 4.24 - Radioactive Gaseous Effluent Instrumentation

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases. The alarm/trip setpoints for these instruments shall be calculated in accordance with NRC approved methods in the ODCM to ensure that the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

523 222

3.25 Radioactive Liquid Effluents - Limiting Conditions for Operations

3.25.1 Liquid Effluents Concentration

3.25.1.1 The concentration of radioactive material released at any time from the site (see Figure 3.25-1) 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} uCi/ml total activity.

APPLICABILITY: At all times.

ACTION:

With the concentration of radioactive material released from the site exceeding the above limits, immediately restore concentration within the above limits and provide prompt notification to the Commission pursuant to Specification 6.9.2.a.

4.25 Radioactive Liquid Effluents - Surveillance Requirements

4.25.1 Liquid Effluents Concentration

4.25.1.1 The instantaneous concentration of radioactive material in liquid effluents released from the site shall be monitored in accordance with Table 3.23-1.

4.25.1.2 The liquid effluent continuous monitors having provisions for automatic termination of liquid releases, as listed in Table 3.23-1 shall be used to limit the concentration of radioactive material released at any time from the site to the values given in Specification 3.25.1.1.

4.25.1.3 Sampling and analysis shall be performed in accordance with Table 4.25-1 to assure that the limits of Specification 3.25.1.1 are met.

4.25.1.4 Reports - A summary of the releases of radioactive liquid effluents shall be reported in the semiannual report per Section 6.9.1.g.

523 223

TABLE 4.25-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (uCi/ml)[a]
A. Waste Test Tanks and Recycle Test Tanks	P Each Batch	P Each Batch	Principal Gamma Emitters[f]	5×10^{-7}
			I-131	1×10^{-6}
Turbine Building Sumps[i] (Waste Neut Tank)[i]	P[e], j One Batch/M	M	Dissolved and Entrained Gases	1×10^{-5}
	P Each Batch	M Composite[c]	H-3 P-32[k] Gross alpha[k]	1×10^{-5} 1×10^{-6} 1×10^{-7}
	P Each Batch	Q Composite[c]	Sr-89[k], Sr-90[k] Fe-55[k]	5×10^{-8} 1×10^{-6}
B. Steam Generator Blowdown and Service Water Effluent	D[g] Grab Sample[l] Continuous[m]	W Composite[d]	Principal Gamma Emitters[f] 5 I-131	5×10^{-7} 1×10^{-6}
	M Grab Sample	M	Dissolved and Entrained Gases[h]	1×10^{-5}
	W Grab Sample[l] Continuous[m]	M Composite[d]	H-3 P-32[h] Gross alpha[h]	1×10^{-5} 1×10^{-6} 1×10^{-7}
	W Grab Sample[l] Continuous[m]	Q Composite[d]	Sr-89[h], Sr-90[h] Fe-55[h]	5×10^{-8} 1×10^{-6}

523 224

TABLE 4.25-1
(Continued)

TABLE NOTATIONS

a. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 90% probability with 10% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$\text{LLD} = \frac{4.66\ s_b}{E\ .\ V\ .\ 2.22\ .\ Y\ .\ \exp(-\lambda\Delta t)}$$

where

LLD is the lower limit of detection as defined above (as pCi per unit mass or volume)

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per transformation)

V is the sample size (in units of mass or volume)

2.22 is the number of transformation per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between midpoint of sample collection and time of counting

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as a posteriori (after the fact) limit for a particular measurement.

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interferring nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Semiannual Radioactive Effluent Release Report.

523 225

TABLE 4.25-1
(Continued)

TABLE NOTATIONS

b. Deleted.

c. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

d. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluents release.

e. One batch per month means one batch from a waste test tank and one from a recycle test tank if they are discharged that month.

f. The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Mn-54, Fe-59, Co 58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level. When unusual circumstances result in LLD's higher than required, the reasons shall be documented in the semiannual radioactive effluent release report.

g. At least 5 days per week.

h. For the Service Water, these analyses are only required if a weekly gamma analysis indicates a gamma activity greater than 5×10^{-7} uCi/ml.

i. Turbine buildings sumps are pumped to the waste neut tank and then discharged on a batch basis. Each batch should be sampled and analyzed for principal gamma emitters only if the steam generator gamma activity is greater than 5×10^{-7} uCi/ml.

j. Not required for turbine building sumps - waste neut tank.

k. Only required for the turbine building sumps - waste neut tank if the gamma activity of the batch is greater than 5×10^{-7} uCi/ml.

l. Grab sample requirement is for Service Water only.

m. Continuous composite sample is for Steam Generator Blowdown only. This will become effective upon completion of a proposed modification to install a continuous sampler for Steam Generator Blowdown sampler. Until that time, the grab sample requirements as given for the Service Water will also apply to the Steam Generator Blowdown.

523 226

3.25.2 Liquid Effluents - Dose

3.25.2.1 The dose or dose commitment to an individual from radioactive materials in liquid effluents released from the site (see Figure 3.25-1) shall be limited:

a. During any calendar quarter to ≤ 1.5 mrem to the total body and to ≤ 5 mrem to any organ; and,

b. During any calendar year to ≤ 3 mrem to the total body and to ≤ 10 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Specification 6.9.2, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive materials in liquid effluents during the remainder of the current calendar quarter and during the subsequent three calendar quarters so that the average dose or dose commitment to an individual from such releases during these four calendar quarters is within 3 mrem to the total body and 10 mrem to any organ.

4.25.2 Liquid Effluent - Dose

4.25.2.1.1 Dose Calculations. Cumulative dose contributions from liquid effluents shall be determined in accordance with the Offsite Dose Calculation Manual (ODCM) at least once per 31 days.

4.25.2.1.1 Reports. Calculated quarterly doses shall be reported in the semiannual Radioactive Release Report per Section 6.9.1.g.

523 227

3.25.3 Liquid Effluents - Waste Treatment

3.25.3.1 The following subsystems of the liquid radwaste treatment system shall be OPERABLE: Aerated drain system mixed bed demineralizer, evaporator, and mixed bed polishing demineralizer, the degasifier, letdown system mixed bed demineralizer, first stage evaporator, second stage evaporator and mixed bed polishing demineralizer. The appropriate portions of the system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge when the projected dose due to liquid effluent releases from the site (see Figure 3.25-1) when averaged over 31 days would exceed 0.06 mrem to the total body or 0.2 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the liquid radwaste system inoperable for more than 31 consecutive days or, with radioactive liquid waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Specification 6.9.2, a Special Report which includes the following information:

   1. Identification of the appropriate equipment or subsystems not OPERABLE and the reason for inoperability.

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status.

   3. Summary description of action(s) taken to prevent a recurrence.

4.2.5.3 Liquid Effluents - Waste Treatment

4.25.3.1.1 Doses due to liquid releases from the site shall be projected at least once per 31 days.

4.25.3.1.2 The appropriate liquid radwaste subsystems as identified above shall be demonstrated OPERABLE at least once per 92 days unless the appropriate liquid radwaste subsystem has been utilized to process radioactive liquid effluents during the previous 92 days.

523 228

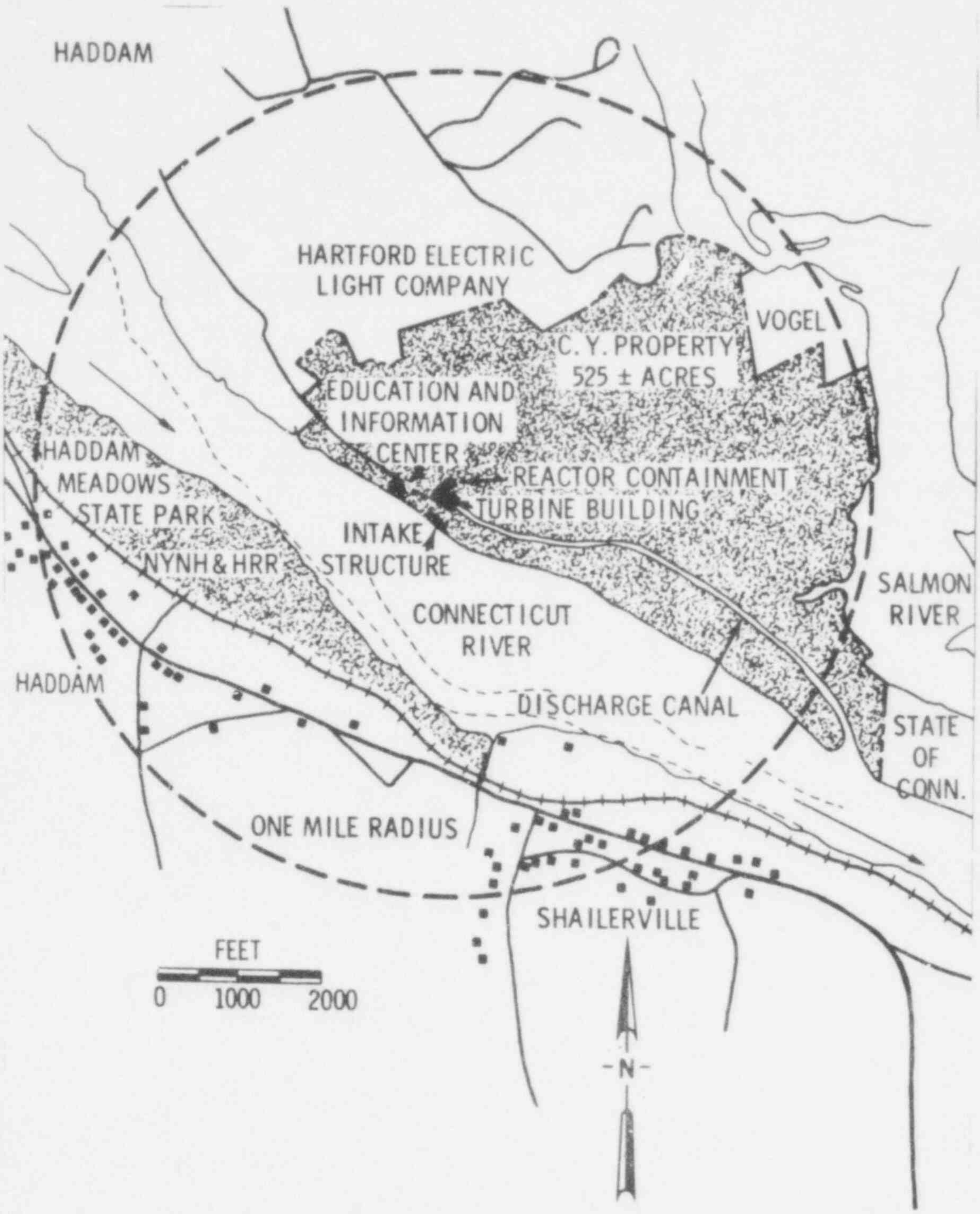
3.25.4 Liquid Holdup Tanks

This section is not applicable to Haddam Neck as there are no potable or surface water supplies downstream of the discharge.

4.25.4 Liquid Holdup Tanks

This section is not applicable to Haddam Neck as there are no potable or surface water supplies downstream of the discharge.

523 229



Site = Shaded area on northeast side of Connecticut River

FIG. 3.25-1

523 230

BASES

3.25 & 4.25 - Radioactive Liquid Effluents

3/4.25.1 CONCENTRATION

This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table II. This instantaneous limitation provides additional assurance that the levels of radioactive materials in bodies of water outside the site will not result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR Part 50, to an individual and (2) the limits of 10 CFR Part 20.106(e) to the population. The concentration limit for noble gases is based upon the assumption that Xe-135 is the controlling radioisotope and its MPC in air (submersion) was converted to an equivalent concentration in water using the methods described in International Commission on Radiological Protection (ICRP) Publication 2.

3/4.25.2 DOSE

This specification is provided to implement the requirements of Sections II.A, III.A and IV.A of Appendix 1, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.A of Appendix 1. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable." The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I is to be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents will be consistent with the methodology provided in 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, "Revision 1, October 1977, and Regulatory Guide 1,113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

523 231

3/4.25.3 LIQUID WASTE TREATMENT

The OPERABILITY of the liquid radwaste treatment system ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirements that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable." This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and design objective Section II.D of Appendix A to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the guide set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

3/4.25.4 LIQUID HOLDUP TANKS

Not Applicable

523 232

3.26 Radioactive Gaseous Effluents - Limiting Conditions for Operation

3.26.1 Gaseous Effluents - Dose Rate

3.26.1.1 The instantaneous dose rate offsite (see Figure 3.25-1) due to radioactive materials released in gaseous effluents from the site shall be limited to the following values:

a. The dose rate limit for noble gases shall be < 500 mrem/yr to the total body and < 3000 mrem/yr to the skin; and,

b. The dose rate limit for I-131 and I-133 and for all radioactive materials in particulate form with half lives greater than 8 days and radionuclides other than noble gases with half lives greater than 8 days shall be < 1500 mrem/yr to any organ.

APPLICABILITY: At all times.

ACTION:

With the dose rate(s) exceeding the above limits, immediately decrease the release rate to comply with the limit(s) given in Specification 3.26.1.1 and provide prompt notification to the Commission pursuant to Specification 6.9.2.a.

4.26 Radioactive Gaseous Effluents - Surveillance Requirements

4.26.1 Gaseous Effluents - Dose Rate

4.26.1.1.1 The instantaneous release rate corresponding to the above dose rate shall be determined in accordance with the methodology in the ODCM.

4.26.1.1.2 The instantaneous release rates shall be monitored in accordance with the requirements of Table 3.24-1.

4.26.1.1.3 The noble gas effluent monitor having provisions for automatic termination of gaseous releases, as given in Table 3.24-1, shall be used to limit releases to the specification given in 3.26.1.1.

4.26.1.1.4 Sampling and analysis shall be performed in accordance with Table 4.26-1 to assure that the limits of specification 3.26.1.1 are met.

4.26.1.1.5 Reports - A summary of the releases of radioactive gaseous effluents shall be reported in the semiannual report per section 6.9.1.g.

523 233

TABLE 4.26-1

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (uCi/ml)[a]
A. Waste Gas Storage Tank	P Each Tank Grab Sample	P Each Tank	Principal Gamma Emitters[e]	1×10^{-4}
			H-3	1×10^{-6}
B. Containment Purge	P Each Purge Grab Sample	P Each Purge	Principal Gamma Emitters[e]	1×10^{-4}
			H-3	1×10^{-6}
C. Main Stack	M[c] Grab Samples -Gases	M[c]	Principal Gamma Emitters[e]	1×10^{-4}
			H-3[f]	1×10^{-6}
	Continuous[d]	W[b] Charcoal Sample	I-131	1×10^{-12}
			I-133	1×10^{-10}
	Continuous[d]	W[b] Particulate Sample	Principal Gamma Emitters[e] (I-131, Others)	1×10^{-11}
	Continuous[d]	M Composite Particulate Sample	Gross α	1×10^{-11}
	Continuous[d]	Q Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
	Continuous[d]	Noble Gas Monitor	Gross Noble Gases	1×10^{-6}

POOR ORIGINAL

523 234

TABLE 4.26-1 (Continued)

TABLE NOTATION

a. The lower limit of detection (LLD) is defined in Table Notation a. of Table 4.25-1.

b. Samples shall be changed at least once per [illegible] days and analyses shall be completed within 48 hours after changing. Sampling and analyses shall also be performed at least once per 24 hours for at least 7 days following each thermal power level change exceeding 25% of RATED THERMAL POWER in one hour (power increases or decreases). When samples collected for approximately 24 hours are analyzed, the corresponding LLD's may be increased by a factor of 10.

c. Analyses shall also be performed following startup or similar operational occurrence which could significantly alter the mixture of radionuclides.

d. The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Specifications 3.26.1, 3.26.2, and 3.26.3.

e. The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135, and Xe-138 for gaseous emissions and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level for that nuclide. When unusual circumstances result in LLD's higher than required, the reasons shall be documented in the semi-annual effluent report.

f. When the refueling canal is flooded, samples shall be taken at least once every 24 hours from the charging floor (refueling floor) and analyzed for tritium. The results shall be used along with containment purge flow rates to determine tritium releases.

523 235

3.26.2 Gaseous Effluents Dose, Noble Gases

3.26.2.1 The offsite air dose (see Figure 3.25-1) due to noble gases released in gaseous effluents shall be limited to the following:

a. During any calendar quarter, to ≤ 5 mrad for gamma radiation and ≤ 10 mrad for beta radiation;

b. During any calendar year, to ≤ 10 mrad for gamma radiation and ≤ 20 mrad for beta radiation;

APPLICABILITY: At all times.

ACTION:

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Specification 6.9.3, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions to be taken to reduce the releases of radioactive noble gases in gaseous effluents during the remainder of the current calendar quarter and during the subsequent three calendar quarters so that the average dose during these four calendar quarters is within 10 mrad for gamma radiation and 20 mrad for beta radiation.

4.26.2 Gaseous Effluents - Dose, Noble Gases

4.26.2.1.1 Dose Calculations - Cumulative dose contributions for the total time period shall be determined in accordance with the Offsite Dose Calculation Manual (ODCM) at least once every 31 days.

4.26.2.1.2 Reports - Calculated quarterly doses shall be reported in the semiannual radioactive release report per Section 6.9.1.g.

523 236

3.26.3 Gaseous Effluents - Dose, Radioiodines, Radioactive Material In Particulate Form, and Radionuclides Other Than Noble Gases

3.26.3.1 The dose to an individual from I-131 and I-133, radioactive materials in particulate form with half lives greater than 8 days, and radionuclides other than noble gases with half-lives greater than 8 days in gaseous effluents released offsite (see Figure 3.25.1) shall be limited to the following:

a. During any calendar quarter to $\leq$ 7.5 mrem;

b. During any calendar year to $\leq$ 15 mrem;

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of the above radionuclides in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to Specification 6.9.3, a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions to be taken to reduce the releases of the above radionuclides in gaseous effluents during the remainder of the current calendar quarter and during the subsequent three calendar quarters so that the average dose or dose commitment to an individual from such releases during these four calendar quarters is within 15 mrem to any organ.

4.26.3 Gaseous Effluents - Dose, Radioiodines, Radioactive Material In Particulate Form, and Radionuclides Other Than Noble Gases

4.26.3.1.1 Dose Calculations - Cumulative dose contributions for the total time period shall be determined in accordance with the ODCM at least once every 31 days.

4.26.3.1.2 Reports - Calculated quarterly doses shall be reported in the semiannual radioactive release report for Section 6.9.1.g.

523 237

3.2?.4 Gaseous Effluents - Waste Treatment

3.26.4.1 The following subsystems of the GASEOUS RADWASTE TREATMENT SYSTEM shall be OPERABLE:

Waste Gas Surge Tank, Waste Gas Compressor A or B, and at least one Waste Gas Decay Tank.

The following subsystems of the ventilation exhaust treatment system shall be operable:

Ventilation System HEPA Filter and Charcoal Filter.

The gaseous radwaste treatment system shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the projected gaseous effluent doses due to gaseous effluent releases from the site (see Figure 3.25-1) when averaged over 31 days exceeds 0.2 mrad for gamma radiation and 0.4 mrad for beta radiation. The ventilation exhaust treatment system shall be used to reduce radioactive materials in gaseous waste prior to their discharge when the projected gaseous effluent doses due to gaseous effluent releases from the site (see Figure 3.25-1) when averaged over 31 days exceeds 0.3 mrem to any organ.

APPLICABILITY: At all times.

ACTION:

a. With the gaseous radwaste treatment system and/or the ventilation exhaust treatment system not OPERABLE for more than 31 consecutive days or with gaseous waste being discharged for more than 31 days without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, pursuant to Specification 6.9.3, a Special Report which includes the following information:

   1. Identification of the appropriate equipment of subsystems not OPERABLE and the reason for inoperability.

   2. Action(s) taken to restore the inoperable equipment to OPERABLE STATUS.

   3. Summary description of action(s) taken to prevent a recurrence.

4.26.4 Gaseous Effluents - Waste Treatment

4.26.4.1.1 Doses due to gaseous releases to unrestricted areas shall be projected at least once per 31 days.

4.26.4.1.2 The appropriate systems as identified above shall be demonstrated OPERABLE at least once per 92 days unless the appropriate system has been utilized to process radioactive gaseous effluents during the previous 92 days.

523 238

3.26.5 Radioactive Effluents - Total Dose

3.26.5.1 The dose or dose commitment to a real individual from all uranium fuel cycle sources is limited to < 25 mrem to the total body or any organ (except the thyroid, which is limited to < 75 mrem) over a period of 12 consecutive months.

APPLICABILITY: At all times.

ACTION:

a. With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Specifications 3.25.2.1, 3.26.2.1, or 3.26.3.1, prepare and submit a Special Report to the Commission pursuant to Specification 6.9.3 and limit the subsequent releases such that the dose or dose commitment to a real individual from all uranium fuel cycle sources is limited to < 25 mrem to the total body or any organ (except thyroid, which is limited to < 75 mrem) over 12 consecutive months. This Special Report shall include an analysis which demonstrates that radiation exposures to all real individuals from all uranium fuel cycle sources (including all effluent pathways and direct radiation) are less than the 40 CFR Part 190 Standard. Otherwise, obtain a variance from the Commission to permit releases which exceeds the 40 CFR Part 190 Standard.

4.26.5 Radioactive Effluents - Total Dose

4.26.5.1.1 Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with the ODCM.

523 239

3.26.6 Radioactive Effluents - Waste Gas System Oxygen Monitoring*

3.26.6.1 The concentration of oxygen in the waste gas system shall be limited to $\leq$ 4% by volume.

APPLICABILITY: At all times.

ACTION:

a. With the concentration of oxygen in the waste gas holdup system $>$ 4% by volume, immediately take appropriate action to reduce the concentration to within the limit. If not within the limit within 48 hours, suspend all additions of waste gases to the system until the limit is reached.

4.26.6 Radioactive Effluents - Waste Gas System Oxygen Monitoring*

4.26.6.1.1 The concentration of oxygen in the waste gas system shall be determined to be within the above limits by monitoring the waste gases with the oxygen monitor required OPERABLE by Table 3.24-1.

* - This specification will become effective upon completion of the proposed modification to install an oxygen monitor.

523 240

3.26 & 4.26 Radioactive Gaseous Effluents

3/4.26.1 Dose Rate

This specification is provided to ensure that the dose rate at any time from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 for all site boundaries. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of an individual offsite to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 (10 CFR Part 20.106(b)). The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual at or beyond the site boundary to $\leq$ 500 mrem/year to the total body or to $\leq$ 3000 mrem/year to the skin. These release rate limits also restrict, at all times, the corresponding thyroid dose rate above background to an infant via the cow-milk-infant pathway to $\leq$ 1500 mrem/year for the nearest cow to the plant.

3/4.26.2 Dose, Noble Gases

This specification is provided to implement the requirements of Sections II.B, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.B of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable". The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I is to be shown by calculational procedures based on models and data such that the actual exposure of an individual through the appropriate pathways is unlikely to be substantially underestimated. The dose calculations established in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents will be consistent with the methodology provided in 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", Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric, Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", Revision 1, July 1977.

523 241

3/4.26.3 Dose, Radioiodines, Radioactive Material in Particulate Form and Radionuclides Other Than Noble Gases

This specification is provided to implement the requirements of Sections II.C, III.A and IV.A of Appendix I, 10 CFR Part 50. The Limiting Conditions for Operation are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable". The ODCM calculational methods specified in the surveillance requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methods approved by NRC for calculating the doses due to the actual release rates of the subject materials are required to be consistent with the methodology provided in Regulatory Guide 1.109, "Calculating of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, "Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", Revision 1, July 1977. The release rate specifications for radioiodines, radioactive material in particulate form and radionuclides other than noble gases are dependent on the existing radionuclide pathways to man. The pathways which are examined in the development of these calculations are: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

3/4.26.4 Gaseous Waste Treatment

The OPERABILITY of the gaseous radwaste treatment system and the ventilation exhaust treatment system ensures that the systems will be available for use whenever gaseous effluents require treatment prior to release to the environment. The requirement that the appropriate portions of these sytems be used when specified provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable". This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50, and design objective Section IID of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the systems were specified as a suitable fraction of the guide set forth in Sections II.B and II.C of Appendix I, 10 CFR Part 50, for gaseous effluents.

523 242

3/4.26.5 Total Dose

This specification is provided to meet the reporting requirements of 40 CFR 190.

3/4.26.6 Waste Gas System Oxygen Monitoring

This specification is provided to ensure that the concentration of potentially explosive gas mixtures contained in the waste gas system is maintained below the flammability limits of hydrogen and oxygen, and thus provides assurance that the releases of radioactive materials will be controlled in conformance with the requirements of General Design Criterion 60 of Appendix A to 10 CFR Part 50.

523 243

3.27 RADIOACTIVE SOLID WASTE - Limiting Condition for Operation

3.27.1 The solid radwaste system shall be OPERABLE and used, as applicable in accordance with a PROCESS CONTROL PROGRAM, for the SOLIDIFICATION and packaging of radioactive wastes to ensure meeting the requirements of 10 CFR Part 20 and of 10 CFR Part 71 prior to shipment of radioactive wastes from the site.

APPLICABILITY: At all times.

ACTION:

a. With the packaging requirements of 10 CFR Part 20 and/or 10 CFR Part 71 not satisfied, suspend shipments of defectively packaged solid radioactive wastes from the site.

b. With the solid radwaste system inoperable for more than 31 days, prepare and submit to the Commission within 30 days pursuant to Specification 6.9.2 a Special Report which includes the following information:

   1. Identification of the inoperable equipment or subsystems and the reason for inoperability,

   2. Action(s) taken to restore the inoperable equipment to OPERABLE status,

   3. A description of the alternative used for SOLIDIFICATION and packaging of radioactive wastes, and

   4. Summary description of action(s) taken to prevent a recurrence.

4.27 SOLID RADIOACTIVE WASTE - Surveillance Requirements

4.27.1.1 The solid radwaste system shall be demonstrated OPERABLE at least once per 92 days by:

a. Operating the solid radwaste system at least once in the previous 92 days in accordance with the PROCESS CONTROL PROGRAM, or

b. Verification of the existence of a valid contract for SOLIDIFICATION to be performed by a contractor in accordance with a PROCESS CONTROL PROGRAM.

523 244

4.27.1.2 THE PROCESS CONTROL PROGRAM shall be used to verify the SOLIDIFICATION of at least one representative test specimen from at least every tenth batch of each type of wet radioactive waste.

a. If any test specimen fails to verify SOLIDIFICATION, the SOLIDIFICATION of the batch under test shall be suspended until such time as additional test specimens can be obtained, alternative SOLIDIFICATION parameters can be determined in accordance with the PROCESS CONTROL PROGRAM, and a subsequent test verifies SOLIDIFICATION. SOLIDIFICATION of the batch may then be resumed using the alternative SOLIDIFICATION parameters determined by the PROCESS CONTROL PROGRAM.

b. If the initial test specimen from a batch of waste fails to verify SOLIDIFICATION, the PROCESSS CONTROL PROGRAM shall provide for the collection and testing of representative test specimens from each consecutive batch of the same type of wet waste until at least 3 consecutive initial test specimens demonstrate SOLIDIFICATION.

523 245

3/4.27 SOLID RADIOACTIVE WASTE

The OPERABILITY of the solid radwaste system ensures that the system will be available for use whenever solid radwastes require processing and packaging prior to being shipped off site. This specification implements the requirements of 10CFR Part 50.36a and General Design Criterion 60 of Appendix A to 10CFR Part 50.

523 246

3.28 Radiological Environmental Monitoring

3.28.1 Monitoring Program

3.28.1 The radiological environmental monitoring program shall be conducted as specified in Table 3.28-1 from the locations given in the ODCM. (Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, or to malfunction of automatic sampling equipment. If the latter, every effort shall be made to complete corrective action prior to the end of the next sampling period.)

APPLICABILITY: At all times.

ACTION:

a. With the radiological environmental monitoring program not being conducted as specified in Table 3.28-1, prepare and submit to the Commission, in the Annual Radiological Operating Report, a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the level of radioactivity in an environmental sampling medium at one or more of the locations specified in Table 3.28-1 exceeding the report levels of Table 6.9-1 when averaged over any calendar quarter, prepare and submit to the Commission within 30 days from the end of the affected calendar quarter, a Special Report which includes an evaluation of any release conditions, environmental factors or other aspects which caused the limits of Table 6.9-1 to be exceeded. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

c. With milk samples unavailable from any one or more of the milk sample locations required by Table 3.28-1, a grass sample shall be substituted until a suitable milk location is evaluated as a replacement or until milk is available from the original location. Such an occurrence will be documented in the annual report.

4.28.1 Monitoring Program

4.28.1.1 The radiological environmental monitoring samples will be collected and analyzed as required above.

523 247

TABLE 3.28-1

CONNECTICUT YANKEE RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
1. Gamma Dose-TLD	10	Monthly	Gamma Dose-Monthly
2. Airborne Particulate	10	Continuous Sampler Weekly Filter Change	Gross Beta-Weekly Gamma Spectrum-Monthly on Composite (by Location), and on Individual Sample if Gross Beta 10 Times Mean of the Weekly Control Stations Gross Beta Results
3. Airborne Iodine	4	Continuous Sampler Weekly Canister Change	I-131-Weekly
4. Vegetation	3	One Sample Near Middle and One Near End of Growing Season	Gamma Isotopic and I-131 on Each Sample
5. Milk	6	Monthly	Gamma Isotopic, I-131, Sr-89 and Sr-90 on Each Sample
6. Well Water	2	Monthly at Indicator Quarterly at Background	Gross Beta, Gamma Isotopic, and Tritium on Each Sample

TABLE 3.28-1 (Continued)

Exposure Pathway and/or Sample	Number of Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
7. Bottom Sediment	3	Quarterly	Gamma Isotopic
8. River Water	2	Quarterly Sample Indicator is Continuous Composite Sample Background is Composite of 6 Weekly Grab Samples	Quarterly - Gross Beta, Gamma Isotopic and Tritium
9. Fish - Bullheads and When Available - Perch	3	Quarterly	Gamma Isotopic
10. Shellfish	2	Quarterly	Gamma Isotopic

523 249

TABLE 3.28-2

MAXIMUM VALUES FOR LOWER LIMITS OF DETECTION (LLD)[a]

Analysis	Well Water (pCi/l)	River* Water (pCi/l)	Airborne Particulate or Gas (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/l)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
gross beta	4	4	1×10^{-2}				
^{3}H	1000	1000					
^{54}Mn	15	30		130			
^{59}Fe	30	60		260			
$^{58,60}Co$	15	30		130			
^{65}Zn	30	60		260			
^{95}Zr	30	60					
^{95}Nb	15	30					
^{131}I			7×10^{-2}		1	60[b]	
^{134}Cs	15	30	1×10^{-2}	130	15	60	150
^{137}Cs	18	40	1.2×10^{-2}	160	18	75	180
^{140}Ba	30	60			30		
^{140}La	15	30			15		

* - River Water MDL's shall be reduced to those given for well water if the gross beta for the sample exceeds 15 pCi/l.

523 250

TABLE 3.28-2 (Continued)

TABLE NOTATION

a - The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E * V * 2.22 * Y * \exp(-\lambda \Delta t)}$$

where

LLD is the lower limit of detection as defined above (as pCi per unit mass or volume)

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E is the counting efficiency (as counts per transformation)

V is the sample size (in units of mass or volume)

2.22 is the number of transformation per minute per picocurie

Y is the fractional radiochemical yield (when applicable)

λ is the radioactive decay constant for the particular radionuclide

Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interferring nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

b - LLD for leafy vegetables.

523 251

3.28.2 LAND USE CENSUS

3.28.2.1 A land use census shall be conducted and shall identify the location of the nearest milk animal and nearest residence in each of the 16 meteorological sectors within a distance of five miles.

APPLICABILITY: At all times.

ACTION:

a. With a land use census identifying a location(s) which yields a calculated dose or dose commitment greater than the doses currently being calculated in the ODCM, make the appropriate changes in the ODCM.

b. With a land use census identifying a location(s) which has a higher D/Q than a current indicator location the following shall apply:

   (1) If the D/Q is at least 20% greater than the previously highest D/Q, replace one of the present sample locations with the new one within 30 days.

   (2) If the D/Q is not 20% greater than the previously highest D/Q, consider both direction, distance and D/Q in deciding whether to replace one of the existing sample locations. If applicable, replacement should be within 30 days. If no replacement is made, sufficient justification should be given in the annual report.

Sample location changes should be noted in the annual report.

4.28.2 LAND USE CENSUS

4.28.2.1 The land use census shall be conducted at least once per 12 months just prior to grazing season by either a door-to-door survey, aerial survey, consulting local agriculture authorities, or any combination of these methods, using that information which would provide the best survey.

523 252

3.28.3 INTERLABORATORY COMPARISON PROGRAM

3.28.3.1 Analyses shall be performed on radioactive materials supplied as part of am Interlaboratory Comparison Program which has been approved by the NRC.

APPLICABILITY: At all times.

ACTION:

a. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report.

4.28.3 INTERLABORATORY COMPARISON PROGRAM

4.28.3.1 A summary of the results of analyses performed as part of the above required Quality Assurance Program shall be included in the Annual Radiological Environmental Operating Report.

523 253

3.28 RADIOLOGICAL ENVIRONMENTAL MONITORING

3.28.1 MONITORING PROGRAM

The radiological monitoring program required by this specification provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of individuals resulting from the station operation. This monitoring program thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. Program changes may be made based on operational experience.

The detection capabilities required by Table 3.28-2 are state-of-the-art for routine environmental measurements in industrial laboratories. The specified lower limits of detection for I-131 in water, milk and other food products correspond to approximately one-quarter of the Appendix I, 10 CFR Part 50 design objective dose-equivalent of 15 mrem/year for atmospheric releases and 10 mrem/year for liquid releases to the most sensitive organ and individual. They are based on the assumptions given in 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," March 1976, except the change for an infant consuming 330 liters/year of drinking water instead of 510 liters/year.

The reporting levels given in Table 6.9-1 correspond to the annual Appendix I design dose limitations for the maximum individual.

3.28.2 LAND USE CENSUS

This specification is provided to ensure that changes in the use of unrestricted areas are identified and that modifications to the monitoring program are made if required by the results of this census. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50.

3.28.3 QUALITY ASSURANCE PROGRAM

The requirement for participation in an Interlaboratory Comparison program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of a quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

523 254

AUDITS

6.5.2.8 Audits of facility activities shall be performed under the cognizance of the NRB. These audits shall encompass:

a. The conformance of facility operation to provisions contained within the Technical Specifications and applicable license conditions at least once per year.

b. The performance, training and qualifications of the entire facility staff at least once per year.

c. The results of all actions taken to correct deficiencies occurring in facility equipment, structures, systems or method of operation that affect nuclear safety at least once per six months.

d. The performance of all activities required by the Quality Assurance Program to meet the criteria of Appendix "B", 10 CFR 50, at least once per two years.

e. The Facility Emergency Plan and implementing procedures at least once per two years.

f. The Facility Security Plan and implementing procedures at least once per two years.

g. Any other area of facility operation considered appropriate by the NRB or the Vice President-Nuclear Engineering and Operations.

h. The Facility Fire Protection Program and implementing procedures at least once per two years.

i. An inspection and audit of the Fire Protection and loss prevention program shall be performed annually by an outside firm experienced in fire protection and loss prevention.

j. The Radiological Environmental Monitoring Program and the results thereof at least once per 12 months.

k. The OFFSITE DOSE CALCULATION MANUAL at least once per 24 months.

523 255

6.7 SAFETY LIMIT VIOLATION

6.7.1 The following actions shall be taken in the event a Safety Limit is violated:

a. The provisions of 10 CFR 50.36 (c) (1) (i) shall be complied with immediately.

b. The Safety Limit violation shall be reported to the Commission, the Superintendent of Nuclear Production and to the NRB immediately.

c. A Safety Limit Violation Report shall be prepared. The report shall be reviewed by the PORC. This report shall describe (1) applicable circumstances preceding the violation, (2) effects of the violation upon facility components, systems or structures, and (3) corrective action taken to prevent recurrence.

d. The Safety Limit Violation Report shall be submitted to the Commission, the NRB and the Superintendent of Nuclear Production within 14 days of the violation.

6.8 PROCEDURES

6.8.1 Written procedures and administrative policies shall be established, implemented and maintained that meet or exceed the requirements and recommendations of Sections 5.1 and 5.3 of ANSI N18.7-1972 and Appendix "A" of USAEC Regulatory Guide 1.33 except as provided in 6.8.2 and 6.8.3 below. Procedures shall be established and maintained for implementation of the Facility Fire Protection Program.

6.8.2 Except as specified in 6.8.4, each procedure and administrative policy of 6.8.1 above, and changes thereto, shall be reviewed by the PORC and approved by the Plant Superintendent prior to implementation and periodically as set forth in each document.

523 256

6.8.3 Except as specified in 6.8.4, temporary changes to procedures of 6.8.1 above may be made provided:

a. The intent of the original procedure is not altered.

b. The change is approved by two members of the plant management staff, at least one of whom holds a Senior Reactor Operator's License on the unit affected.

c. The change is documented, reviewed by the PORC and approved by the Plant Superintendent within 14 days of implementation.

6.8.4 All procedures and procedure changes required for Section 3/4.28 of these technical specifications (radiological environmental monitoring) do not require review as specified in Sections 6.8.2 and 6.8.3.

Rather, all such procedures shall be reviewed by a qualified engineer, other than the author, of the Radiological Assessment Branch or Environmental Services Section and approved by supervision of the Radiological Assessment Branch. (These two groups are part of the Northeast Utilities Service Company as identified in Figure 6.2-1.) Temporary changes may be made provided the intent of the original procedure is not altered and the change is documented and reviewed by a qualified engineer, other than the author, of the Radiological Assessment Branch or Environmental Services Section, within 14 days of implementation.

523 257

6.9 REPORTING REQUIREMENTS

In addition to the applicable reporting requirements of Title 10, Code of Federal Regulations, the following identified reports shall be submitted to the Director of the appropriate Regional Office of Inspection and Enforcement unless otherwise noted.

6.9.1 ROUTINE REPORTS

a. Startup Report - A summary report of plant startup and power escalation testing shall be submitted following (1) receipt of an operating license, (2) amendment to the license involving a planned increase in power level, (3) installation of fuel that has a different design or has been manufactured by a different fuel supplier, and (4) modifications that may have significantly altered the nuclear, thermal, or hydraulic performance of the plant. The report shall address each of the tests identified in the FSAR and shall in general include a description of the measured values of the operating conditions or characteristics obtained during the test program and a comparison of these values with design predictions and specifications. Any corrective actions that were required to obtain satisfactory operation shall be described. Any additional specific details required in license conditions based on other commitments shall be included in this report.

   Startup reports shall be submitted within (1) 90 days following completion of the startup test program, (2) 90 days following resumption or commencement of commercial power operation, or (3) 9 months following initial criticality, whichever is earliest. If the Startup Report does not cover all three events (i.e., initial criticality, completion of startup test program, and resumption or commencement of commercial power operation), supplementary reports shall be submitted at least every three months until all three events have been completed.

b. Steam Generator Tube Inspection - The complete results of the steam generator tube in-service inspection shall be reported within ninety days after completion of the inspection. This report shall include:

   (1) Number and extent of tubes inspected.

   (2) Location and percent of wall thickness penetration for each indication of an imperfection.

523 258

(3) Identification of tubes plugged.

c. Occupational Exposure Report - The annual report shall be submitted prior to March 1 of each year and shall cover the previous calendar year. The initial report shall be submitted prior to March 1 of the year following initial criticality.

This annual report shall include a tabulation on an annual basis of the number of station, utility, and other personnel (including contractors) receiving exposures greater than 100 mrem/yr. and their associated man-rem exposure according to work and job functions, 4/e.g., reactor operations and surveillance; in-service inspection, routine maintenance, special maintenance (describe maintenance), waste processsing and refueling. The dose assignment to various duty functions may be estimated based on pocket dosimeter, TLD, or film badge measurements. Small exposures totalling less than 20% of the individual total dose need not be accounted for. In the aggregate, at least 80% of the total whole body dose received from external sources shall be assigned to specific major work functions.

d. Monthly Operating Report - Routine reports of operating statistics and shutdown experience shall be submitted on a monthly basis to the Office of Inspection and Enforcement, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, with a copy to the appropriate Regional Office, to be postmarked no later than the tenth of each month following the calendar month covered by the report.

The monthly report shall include a narrative summary of operating experience during the report period relating to safe operation of the facility, including safety-related maintenance.

e. Reports required as per 10 CFR 50.59b.

f. Annual Radiological Environmental Monitoring Report - Routine radiological environmental monitoring reports covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year.

The annual radiological environmental operating reports shall include summaries, interpretations, and statistical evaluation of the results of the radiological environmental surveillance activities for the report period, including a comparison with previous environmental surveillance reports and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of the land use censuses required by Specification 3.28.2. If harmful effects are detected by the monitoring, the report shall provide an analysis of the problem and a planned course of action to alleviate the problem.

The annual report shall include a summary table of all radiological environmental samples which shall include the following information for each pathway sampled and each type of analysis:

(1) Total number of analyses performed at indicator locations.

523 259

(2) Total number of analyses performed at control locations.

(3) Lower limit of detection (LLD).

(4) Mean and range of all indicator locations together.

(5) Mean and range of all control locations together.

(6) Name, distance and direction from discharge, mean and range for the location with the highest annual mean (indicator or control).

(7) Number of nonroutine reported measurements as defined in these specifications.

In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

The report shall also include a map of sampling locations keyed to a table giving distances and directions from the discharge; the report shall also include a summary of the Quality Assurance Data required by Specification 3.28.3.

g. Semiannual Radioactive Effluent Release Report - Routine radioactive effluent release reports covering the operation of the unit during the previous 6 months of operation shall be submitted within 60 days after January 1 and July 1 of each year.

The report shall include a summary of the quantities of radioactive liquid and gaseous effluents released from the unit as outlined in U.S.N.R.C. Regulatory Guide 1.21, Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

In addition, the report to be submitted 60 days after January 1 of each year shall include an annual summary of hourly meteorological data collected over the previous year. This annual summary shall be in the form of joint frequency distributions of wind speed, wind direction, and atmospheric stability. This same report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the site during the previous calendar year. The meteorological conditions concurrent with the time of release of radioactive material in gaseous effluents shall be used for determining the gaseous pathway doses. Dose calculations shall be performed in accordance with the Offsite Dose Calculation Manual.

In addition, the report to be submitted 60 days after January 1 of each year shall include an assessment of radiation doses to the likely most exposed real individual from the site for the previous 12 consecutive months to show conformance with 40CFR190. Doses shall be calculated in accordance with the Offsite Dose Calculation Manual.

523 260

The semiannual effluent report shall also include a summary of each type of solid waste shipped offsite during the report period. This summary shall include the following information for each type of waste:

a. Type of Wate (e.g. - Spent Resin, Compacted Dry Waste, etc.)

b. Solidification Agent (e.g. - Cement)

c. Total Curies

d. Total Volume and Typical Container Volumes

e. Principal Radionuclides (those greater than 10% of total activity)

f. Types of Containers Used (e.g. - LSA, Type A, etc.)

The semiannual effluent report shall include the following information for all unplanned releases from the site to unrestricted areas of radioactive materials in gaseous and liquid effluents:

a. A description of the event and equipment involved.

b. Cause(s) for the unplanned release.

c. Actions taken to prevent recurrence.

d. Consequences of the unplanned release.

The semiannual effluent report shall also include changes made to the Process Control Program (PCP) made during the report period.

6.9.2 REPORTABLE OCCURRENCES

Reportable occurrences, including corrective actions and measures to prevent reoccurrence, shall be reported to the NRC. Supplemental reports may be required to fully describe final resolution of occurrence. In case of corrected or supplemental reports, a licensee event report shall be completed and reference shall be made to the original report date.

523 261

Note: This item is intended to provide for reporting of potentially generic problems.

b. Thirty-Day Written Reports. The reportable occurrences discussed below shall be the subject of written reports to the Director of the appropriate Regional Office within thirty days of occurrence of the event. The written report shall include, as a minimum, a completed copy of a licensee event report form. Information provided on the licensee event report form shall be supplemented, as needed, by additional narrative material to provide complete explanation of the circumstances surrounding the event.

(1) Reactor protection system or engineered safety feature instrument settings which are found to be less conservative than those established by the technical specification but which do not prevent the fulfillment of the functional requirements of affected systems.

(2) Conditions leading to operation in a degraded mode permitted by a limiting condition for operation or plant shutdown required by a limiting condition for operation.

Note: Routine surveillance testing, instrument calibration, or preventative maintenance which require system configurations as described in Items 2.b(1) and 2.b(2) need not be reported except where test results themselves reveal degraded mode as described above.

(3) Observed inadequacies in the implementation of administrative or procedural controls which threaten to cause reduction of degree of redundancy provided in reactor protection systems or engineered safety feature systems.

(4) Abnormal degradation of systems other than those specified in Item 2.a(3) above designed to contain radioactive material resulting from the fission process.

Note: Sealed sources or calibration sources are not included under this item. Leakage of valve packing or gaskets within the limits for identified leakage set forth in technical specifications need not be reported under this item.

(5) An unplanned off-site release of 1) more than 1 curie of radioactive material in liquid effluents, 2) more than 150 curies of noble gas in gaseous effluents, or 3) more than 0.05 curies of radioiodine in gaseous effluents. The report of an unplanned off-site release of radioactive material shall include the following information:

1) A description of the event and equipment involved.

2) [illegible]s) for the unplanned release.

523 262

3) Actions taken to prevent recurrence.

4) Consequences of the unplanned release.

(6) Measured levels of radioactivity in an environmental sampling medium determined to exceed the reporting level values of Table 6.9-1 when averaged over any calendar quarter sampling period. When more than one of the radionuclides in Table 6.9-1 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{limit level (1)}} + \frac{\text{concentration (2)}}{\text{limit level (2)}} + \ldots \geq 1.0$$

When radionuclides other than those in Table 6.9-1 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose to an individual is equal to or greater than the appropriate calendar year limit of Specifications 3.25.2.1, or 3.26.3.1. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report.

523 263

6.14 PROCESS CONTROL PROGRAM

6.14.1 The PCP shall be approved by the Commission prior to implementation.

6.14.2 Licensee initiated changes to the PCP:

1. Shall be submitted to the Commission in the semi-annual Radioactive Effluent Release Report for the period in which the change(s) was made. This submittal shall contain:

   a. sufficiently detailed information to totally support the rationale for the change without benefit of additional or supplemental information;

   b. a determination that the change did not reduce the overall conformance of the solidified waste product to existing criteria for solid wastes; and

   c. documentation of the fact that the change has been reviewed and found acceptable by PORC.

2. Shall become effective upon review and acceptance by PORC.

523 264

6.15 OFFSITE DOSE CALCULATION MANUAL (ODCM)

6.15.1 The ODCM shall describe the methodology and parameters to be used in the calculation of offsite doses due to radioactive gaseous and liquid effluents and in the calculation of gaseous and liquid effluent monitoring instrumentation alarm/trip setpoints consistent with the applicable LCO's contained in these technical specifications.

Changes in the ODCM shall be reviewed by PORC prior to implementation. All such changes shall be submitted to the Commission by inclusion in the Monthly Operating Report within 90 days of the date the change was approved by PORC, and should include sufficiently detailed information to support the rationale for the change.

523 265

6.16 MAJOR CHANGES TO RADIOACTIVE WASTE TREATMENT SYSTEMS (Liquid, Gaseous and Solid)

6.16.1 MAJOR CHANGES TO RADIOACTIVE WASTE SYSTEMS (liquid, gaseous and solid) shall be made as follows: "MAJOR CHANGES" is defined in Section 1 of these specifications.

1) The Commission shall be informed of all changes by the inclusion of a suitable discussion of each change in the Monthly Operating Report for the period in which the evaluation was completed. The discussion of each change shall contain:

   a) a summary of the evaluation that led to the determination that the change could be made (in accordance with 10 CFR 50.59);

   b) sufficient detailed information to totally support the reason for the change without benefit of additional or supplemental information;

   c) a detailed description of the equipment, components and processes involved and the interfaces with other plant systems;

   d) an evaluation of the change which shows the predicted releases of radioactive materials in liquid and gaseous effluents and/or quantity of solid waste from those previously predicted in the license application and amendments thereto;

   e) an evaluation of the change which shows the expected maximum exposures to individual in the unrestricted area and to the general population from those previously estimated in the license application and amendments thereto;

   f) an estimate of the exposure to plant operating personnel as a result of the change; and

   g) documentation of the fact that the change was reviewed and found acceptable by PORC.

2) The change shall become effective upon review and acceptance by PORC.

523 266

TABLE 6.9-1

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/Kg, wet)	Milk (pCi/l)	Vegetables (pCi/Kg, wet)
Mn-54	1×10^3		3×10^4		
Fe-59	4×10^2		1×10^4		
Co-58	1×10^3		3×10^4		
Co-60	3×10^2		1×10^4		
Zn-65	3×10^2		2×10^4		
I-131		1		3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	2×10^3	70	2×10^3
Ba-La-140	2×10^2			3×10^2	
Zr-Nb-95	4×10^2				

523 267

ENCLOSURE 3

REVISIONS TO THE

HADDAM NECK

OFFSITE DOSE

CALCULATION MANUAL

523 268

HADDAM NECK PLANT

OFFSITE DOSE

CALCULATION MANUAL

523 269

OCTOBER, 1979

OFFSITE DOSE CALCULATION MANUAL

TABLE OF CONTENTS

523 270

*Rev. 0 = October 1, 1979

TABLE OF CONTENTS (Cont'd)

523 271

*Rev. 0 = October 1, 1979

TABLE OF CONTENTS (Cont'd)

523 272

*Rev. 0 = October 1, 1979

LIST OF TABLES AND FIGURES

523 273

*Rev. 0 = October 1, 1979

APPENDICES

523 274

*Rev. 0 = October 1, 1979

A. INTRODUCTION

The purpose of this manual is to provide the parameters and methodology to be used in calculating offsite doses and effluent monitor setpoints at the Haddam Neck Plant. Included are methods for determining maximum individual whole body and organ doses due to liquid and gaseous effluents to assure compliance with the dose limitations in the Technical Specifications. Also included are methods for performing dose projections to assure compliance with the liquid and gaseous treatment system operability sections of the Technical Specifications. The manual also includes the methods used for determining quarterly individual and population doses for inclusion in the Semiannual Radioactive Effluents Release Report.

Another section of this manual discusses the methodology to be used in determining effluent monitor alarm/trip setpoints to be used to ensure compliance with the instantaneous release rate limits in the Technical Specifications.

Additional sections provide supplemental information on environmental sample locations and effluent flow paths.

The bases for some of the factors used in this manual are included as appendices to this manual.

523 275

This manual does not include the surveillance procedures and forms required to document compliance with the surveillance requirements in the Technical Specifications. All that is included here is the methodology to be used in performance of the surveillance requirements.

Most of the calculations in this manual have two or three methods given for the calculation of the same parameter. These methods are arranged in order of simplicity and conservatism, Method 1 being the easiest and most conservative. As long as releases remain low, one should be able to use Method 1 as a simple estimate of the dose. If release calculations approach the limit however, more detailed yet less conservative calculations may be used.

At any time a more detailed calculation may be used in lieu of a simple calculation.

523 276

B. RESPONSIBILITIES

All changes to this manual shall be reviewed by the Plant Operations Review Committee prior to implementation.

All changes and their rationale shall be documented in a monthly operating report within 90 days of the date of PORC approval.

It shall be the responsibility of the Station Superintendent to ensure that this manual is used in performance of the surveillance requirements specified in the Technical Specifications.

523 277

C. LIQUID DOSE CALCULATIONS

1. Compliance With Specification 3.25.2.1.a

a. Total Body Dose

(1) Method 1 - This method to be used until the calculated total body dose exceeds 0.15 mrem for the calendar quarter.

Step 1 - Determine C_F = total curies of fission and activation products, excluding tritium and dissolved noble gases released during the calendar quarter.

Step 2 - Determine C_T = total curies of tritium released during the calendar quarter.

Step 3 - Determine D_{QT} = quarterly dose to the total body in mrem.

523 278

$$D_{QT} = 1.28 * C_F + 2.6 * 10^{-6} * C_T \text{ [Note 1]}$$

[Note 1] - See Appendix A for derivation of these factors.

Step 4 - If D_{QT} > 0.15 mrem, go to Method 2.

(2) Method 2 - This method to be used until the calculated total body dose exceeds 0.75 mrem for the calendar quarter.

Step 1 - Determine C_{134} = total curies of CS-134 released during the calendar quarter.

Step 2 - Determine C_{137} = total curies of CS-137 released during the calendar quarter.

Step 3 - Determine C_T = total curies of tritium released during the calendar quarter.

Step 4 - Determine V = total volume of dilution water discharged during the calendar quarter in gallons.

Step 5 - Determine D_{QT} = quarterly total body dose, in mrem:

$$D_{QT} = \frac{1}{V} (3.3 \times 10^{11} C_{134} + 1.9 \times 10^{11} C_{137} + 1.3 \times 10^{5} C_T) \text{[Note 1]}$$

Step 6 - If $D_{QT} > 0.75$ mrem, go to Method 3.

(3) Method 3

523 279

Step 1 - Determine C_i = total curies of nuclide i released during the calendar quarter. This should be determined for each nuclide identified during the quarter per analyses required by Table 4.25-1 of the Technical Specification. For nuclides which are routinely observed but are not readily identifiable (for example - Sr-89 and Sr-90), use the last quarter for which analyses have been completed to determine an average $\mu C/ml$ for each nuclide and multiply by the volume of undiluted waste discharged during the present quarter to determine an approximate curie estimate for the quarter.

Step 2 - Determine N = number of weeks which have passed during the present calendar quarter.

Step 3 - Determine V = total volume of dilution water discharged during the calendar quarter in gallons.

Step 4 - Determine A_{iT} (total body dose factor) from Table 1 for each nuclide determined in Step 1.

Step 5 - Determine D_{QT} = quarterly dose to the total body in mrem.

523 280

$$D_{QT} = (\frac{N}{52} * 21) * \frac{1}{V} * 2.6 \times 10^{11} * \sum_i C_i \cdot A_{iT} \text{ [Note 1]}$$

Caution: Be sure C_i is in curies and V is in gallons.

b. Maximum Organ Dose

(i) Method 1 - This method to be used until the calculated dose to the maximum organ exceeds 0.5 millirem for the calendar quarter.

Step 1 - Determine C_F - as in C.1.a(1) - Step 1

Step 2 - Determine C_T - as in C.1.a(2) - Step 2

Step 3 - Determine D_{QO} = quarterly dose to the maximum organ in mrem.

$$D_{QO} = 1.85 * C_F + 2.6 \times 10^{-6} * C_T \text{ [Note 2]}$$

[Note 2] - See Appendix B for derivation of these factors.

Step 4 - If $D_{QO} > 0.5$ mrem, go to Method 2.

(2) Method 2 - This method to be used until the calculated total body dose exceeds 2.5 mrem for the calendar quarter.

Step 1 - Determine C_{134} - as in C.1.a(2) - Step 1

Step 2 - Determine C_{137} - as in C.1.a(2) - Step 2

Step 3 - Determine C_T - as in C.1.a(2) - Step 3

Step 4 - Determine C_{131} - total curies of I-131 released during the calendar quarter.

Step 5 - Determine V = total volume of dilution water discharged during the calendar quarter in gallons. 523 281

Step 6 - Determine D_{QL} = quarterly liver dose, in mrem.

$$D_{QL} = \frac{1}{V} (4.0 \times 10^{11} C_{134} + 2.9 \times 10^{11} C_{137} + 1.3 \times 10^{5} C_{T}) \text{[Note 2]}$$

Step 7 - Determine D_{QI} = quarterly thyroid dose, in mrem

$$D_{QI} = \frac{1}{V} (4.0 \times 10^{10} C_{131}) \text{ [Note 2]}$$

Step 8 - Record maximum organ dose as the greater of D_{QL} or D_{QI}.

Step 9 - If $D_{QL} > 2.5$ or $D_{QI} > 2.5$, go to method 3.

(3) Method 3

Step 1 - Determine C_i = total curies of each nuclide i as in C.1.a(3) - Step 1.

Step 2 - Determine N = number of weeks which have passed during the present calendar quarter.

Step 3 - Determine V = total volume of dilution water discharged during the calendar quarter in gallons.

Step 4 - Determine from Table 1 for each nuclide identified in Step 1 the following:

523 282

A_{iL} - liver dose factor

A_{iI} - thyroid dose factor

A_{iB} - bone dose factor

Step 5 - Determine D_{QL} = quarterly liver dose, in mrem.

$$D_{QL} = (\frac{N}{52} * 21) * 1/V * 2.6 \times 10^{11} * \sum_i C_i A_{iL} \text{ [Note 2]}$$

Step 6 - Determine D_{QI} = quarterly thyroid dose, in mrem.

$$D_{QI} = (\frac{N}{52} * 21) * 1/V * 2.6 \times 10^{11} * \sum_i C_i A_{iI} \text{ [Note 2]}$$

Step 7 - Determine D_{QB} = quarterly bone dose, in mrem.

$$D_{QB} = (\frac{N}{52} * 21) * 1/V * 2.6 \times 10^{11} * \sum_i C_i A_{iB} \text{ [Note 2]}$$

Step 8 - Record the maximum organ dose as the greater of D_{QL}, D_{QI} or D_{QB}.

2. Compliance With Specification 3.25.2.1.b

a. Total Body Dose

Determine D_{YT} = dose to the total body for the calendar year as follows:

523 283

$D_{YT} = \sum D_{QT}$ where the sum is over the first quarter through the present quarter total body doses.

The following should be used as D_{QT}:

(1) If the detailed quarterly dose calculations required per Section C.4 for the semiannual effluent report are complete for any calendar quarter, use that result.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined in Section C.1.a.

(3) If $D_{YT} > 3$ mrem and any D_{QT} determined as in Section C.1.a was not calculated using method 3 of that section, recalculate D_{QT} using Method 3 if this could reduce D_{YT} to less than 3 mrem.

b. Maximum Organ Dose

Determine D_{YO} = dose to the maximum organ for the calendar year as follows:

$D_{YO} = \sum D_{QO}$ or $\sum D_{QL}$ or $\sum D_{QI}$ or $\sum D_{QB}$ whichever is greater. The sum is over the first quarter through present quarter dose.

The following guidelines should be used:

523 284

(1) If the detailed quarterly dose calculations required per Section C.4 for the semiannual effluent report are complete for any calendar quarter, use that result.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined in Section C.1.b.

(3) If different organs are the maximum for different quarters, they may be summed together and D_{YO} can be recorded as a less than value as long as the value is less than 10 mrem.

(4) If $D_{YO} > 10$ mrem and any value used in its determination was calculated as in Section C.1.b but not with Method 3, recalculate that value using Method 3 if this could reduce D_{YO} to less than 10 mrem.

3. Compliance With Specification 3.25.3.1

a. Monthly Dose Projections to the Total Body & Maximum Organ

Step 1 - Determine D'_{MT} = total body dose from the previously completed month as calculated per the methods in Section C1.a (see Note 3).

Step 2 - Determine D'_{MO} = maximum organ dose from the previously completed month as calculated per the methods in Section C.1.b.

523 285

Step 3 - Estimate R_1 = ratio of the total estimated volume of liquid batches to be released in the present month to the volume released in the past month.

Step 4 - Estimate R_2 = ratio of the total estimated volume of steam generator blowdown to be released in present month to the volume released in the past month.

Step 5 - Estimate F_1 = fraction of curies released last month coming from steam generator blowdown.

$$\text{ie) } F_1 = \frac{\text{curies from blowdown}}{\text{curies from blowdown + curies from batch tanks}}$$

Step 6 - Estimate R_3 = ratio of estimated secondary coolant activity for the present month to that for the past month.

Step 7 - Estimate R_4 = ratio of estimated primary coolant activity for the present month to that for the past month.

Step 8 - Determine F_2 = factor to be applied to estimate ratio of final curie release if there are expected differences in treatment of liquid waste for the present month as opposed to the past month. NUREG-17 or past experience should be used to determine the effect of each form of treatment which will vary. F_2 = 1 if there are no expected differences.

Step 9 - Determine D^E_{MT} = estimated monthly total body dose as follows:

523 286

$$D^E_{MT} = D'_{MT} \left[(1 - F_1) R_1 R_4 F_2 + F_1 R_2 R_3 \right]$$

Step 10 - Determine D^E_{MO} = estimated monthly maximum organ dose as follows:

$$D^E_{MO} = D'_{MO} \left[(1 - F_1) R_1 R_4 F_2 + F_1 R_2 R_3 \right]$$

Note 3 - If the past month is not typical of expected operations in the present month, go back to the last typical month.

For example, if the plant was down for refueling the entire month of February and startup scheduled for March 3, use the last month of operation as the base month to estimate March's dose.

4. Quarterly Dose Calculations for Semi-Annual Radioactive Effluent Report

Detailed quarterly dose calculations required for the semi-annual Radioactive Effluent Report shall be done using the NRC computer code LADTAP. The use of this code, and the input parameters are given in Environmental Programs Branch Procedure #EPB-IV-5-8, Liquid Dose Calculations - LADTAP. This procedure is attached in Appendix C to this manual.

523 287

D. GASEOUS DOSE CALCULATIONS

1. Compliance With Specification 3.26.1.1

a. Determination of Noble Gas Release Rate Limit

Limit for Total Body:

$$1.32 \times 10^{-5} * \bar{K} * Q_N < 500 \text{ mrem/yr}$$

Limit for Skin:

$$1.32 \times 10^{-5} * \bar{S} * Q_N < 3000 \text{ mrem/yr.}$$

where:

1.32×10^{-5} = maximum annual average X/Q, sec/M^3 - 510 meters, NNW - See Appendix D.

$\bar{K}$ = Weighted average total body dose factor due to gamma emissions, mrem/yr per μC/m^3, as determined below.

$\bar{S}$ = Weighted average skin dose factor due to beta and gamma emissions, mrem/yr per μC/m^3, as determined below.

Q_N = release rate of noble gases in μC/sec.

523 288

Step 1 - Obtain results from last analysis of the flashed gases from primary coolant decay corrected to sample time.

Step 2 - For each noble gas radionuclide identified in Step 1, determine F_i = fraction nuclide i is of the total noble gas activity.

Step 3 - For each noble gas radionuclide identified in Step 1, determine K_i and S_i from Table 2.

Step 4 - Determine $\bar{K} = \sum_i F_i K_i$

Step 5 - Determine $\bar{S} = \sum_i F_i S_i$

Step 6 - Determine the release rate limit.

$$Q_N\ (\mu C/sec) \quad \frac{500}{1.32 \times 10^{-5} \times \bar{K}} \text{ or}$$

$$Q_N\ (\mu C/sec) \quad \frac{3000}{1.32 \times 10^{-5} \times \bar{S}}$$

whichever is lower.

Note - See Appendix D for justification of the method for determination of $\bar{S}$ and $\bar{K}$. 523 289

b. Determination of Iodine and Particulate Release Rate Limit

(1) Method 1 - The dose rate to the maximum organ will be less than 1500 mrem/yr provided:

(a) Release rate I-131 $< 8.0 \times 10^{-3}$ μC/sec

(b) Release rate of particulates with half lives greater than 8 days $< 8.3 \times 10^{-2}$ C/sec.

and (c) Release rate of tritium $< 1.2 \times 10^{4}$ μCi/sec

Step 1 - Verify that the release rates are less than the above values. If they are, the dose rate is < 1500 mrem/yr. If not, go to Method 2.

Note - See Appendix D for derivation of the above release rate limits.

(2) Method 2 - If any one of the above limits are exceeded, use the following method.

Step 1 - Determine Q_i (μCi/sec) for each of the following: I-131, H-3, and each particulate nuclide with a half life greater than 8 days identified in effluent samples.

523 290

Step 2 - Determine O_i = maximum organ dose factor for each nuclide identified in Step 1. These values can be determined from Table 3.

Step 3 - Determine D_O = dose rate to maximum organ (mrem/yr)

$$D_O = \sum_i Q_i \; O_i$$

D_O should be less than 1500 mrem/yr. If not go to Method 3.

(3) Method 3 - Use the GASPAR code - (procedure to use is given in Appendix E) to determine the maximum organ dose. For the Special Location, enter 1.32×10^{-5} for the X/Q's and 5.71×10^{-8} for the D/Q's. See Appendix D for the difference between Method 2 and 3.

2. Compliance With Specification 3.26.2.1

a. Quarterly Air Dose Limit Due to Noble Gases

(1) Method 1 - This method to be used until the calculated beta air dose exceeds 3 mrad.

Step 1 - Determine C_N = total curies from all sources of noble gases released during the calendar quarter.

Step 2 - Determine D_{QAG} = quarterly air gamma dose (mrad):

$$D_{QAG} = 4.5 \times 10^{-4} \; C_N \text{ [See Note 4]}$$

523 291

Step 3 - Determine D_{QAB} = quarterly air beta dose (mrad):

$$D_{QAB} = 1.6 \times 10^{-3} * C_N \text{ [See Note 4]}$$

Step 4 - If D_{QAB} exceeds 3 mrad, go to Method 2.

[Note 4] - See Appendix F for derivation of these factors.

(2) Method 2 - This method to be used until the calculated gamma air dose exceeds 5 mrads or the beta air dose exceeds 10 mrads.

Step 1 - Determine C_i = total curies of each identified noble gas nuclide i released during the quarter from all sources, both continuous and batch.

Step 2 - Determine M_i = gamma air dose factor for each noble gas nuclide identified above. Values are given in Table 2.

Step 3 - Determine N_i = beta air dose factor for each noble gas nuclide identified above. Values are given in Table 2.

Step 4 - Determine D_{QAG} = quarterly air gamma dose (mrad):

$$D_{QAG} = 1.7 \times 10^{-6} * \sum_i M_i C_i \text{ [See Note 4]}$$

523 292

Step 5 - Determine D_{QAB} = quarterly air beta dose (mrad):

$$D_{QAB} = 1.7 \times 10^{-6} * \sum_i N_i C_i \text{ [See Note 4]}$$

Step 6 - If $D_{QAG} > 5$ mrad or $D_{QAB} > 10$ mrad, go to Method 3.

(3) Method 3

Step 1 - Determine C_{iC} = total curies of each identified noble gas nuclide i released during the quarter from all continuous releases.

Step 2 - Determine C_{iB} = total curies of each identified noble gas nuclide i released during the quarter from all batch releases.

Step 3 - Determine $(X/Q)_{CA}$ = maximum real time site boundary X/Q for continuous releases during the entire period for which doses are being calculated. Call this location A. Real time X/Q data is available from NUSCO - Environmental Programs Branch.

Step 4 - Determine $(X/Q)_{BB}$ = maximum real time site boundary X/Q for batch releases using the actual hours of batch release. Call this location B.

523 293

Step 5 - Determine $(X/Q)_{CB}$ = real time site boundary X/Q for continuous releases at location B.

Step 6 - Determine $(X/Q)_{BA}$ = real time site boundary X/Q for batch releases at location A.

Step 7 - Determine M_i and N_i - as in Method 2.

Step 8 - Determine the quarterly gamma air dose at locations A and B.

$$D_{QAG} \text{ (LOC A)} = 3.17 \times 10^{-2} \left[(X/Q)_{CA} \sum_i C_{iC} M_i + (X/Q)_{BA} \sum_i C_{iB} M_i \right]$$

$$D_{QAG} \text{ (LOC B)} = 3.17 \times 10^{-2} \left[(X/Q)_{CB} \sum_i C_{iC} M_i + (X/Q)_{BB} \sum_i C_{iB} M_i \right]$$

D_{QAG} = greater of the two values.

Step 9 - Determine the quarterly beta air dose at locations A and B.

$$D_{QAB} \text{ (LOC A)} = 3.17 \times 10^{-2} \left[(X/Q)_{CA} \sum_i C_{iC} N_i + (X/Q)_{BA} \sum_i C_{iB} N_i \right]$$

$$D_{QAB} \text{ (LOC B)} = 3.17 \times 10^{-2} \left[(X/Q)_{CB} \sum_i C_{iC} N_i + (X/Q)_{BB} \sum_i C_{iB} N_i \right]$$

D_{QAB} = greater of the two values.

523 294

b. Annual Air Dose Limit Due to Noble Gases

Determine D_{YAG} and D_{YAB} = gamma air dose and beta air dose for the calendar year as follows:

$$D_{YAG} = \sum D_{QAT} \text{ and } D_{YAB} = \sum D_{QAB}$$

where the sum is over the first quarter through the present quarter doses.

The following should be used as D_{QAT} and D_{QAB}:

(1) If the detailed quarterly dose calculations required per Section D.4 for the semi-annual effluent report are complete for any calendar quarter, use those results.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined above in Section D.2.a.

(3) If $D_{YAG} > 10$ mrad or $D_{YAB} > 20$ mrad and any corresponding quarterly dose was not calculated using Method 3 of Section D.2.a, recalculate the quarterly dose using Method 3 if this could reduce the annual dose below the allowable limits.

3. Compliance With Specification 3.26.3.1

523 295

a. Quarterly Organ Dose Limit

(1) Method 1 - This method to be used until the calculated maximum organ dose exceeds 7.5 mrem.

Step 1 - Determine Q_{I131} = average μCi/sec of I-131 released during the calendar quarter.

Step 2 - Determine Q_{H-3} = average μCi/sec if H-3 released during the calendar quarter.

Step 3 - Determine Q_P = average μCi/sec of all particulates with half lives greater than 8 days released during the calendar quarter.

Step 4 - Determine N = number of weeks for which the dose is being calculated. For example, after the 2nd month of the quarter, N would be approximately 9 weeks.

Step 5 - Determine D_{QT} = quarterly thyroid dose as follows:

$$D_{QT} = \frac{N}{52} * [6.3 \times 10^4 * Q_{I-131} + 4.0 \times 10^{-2} Q_{H3}]$$ [See Note 6]

Step 6 - Determine D_{QO} = quarterly dose to maximum organ other than the thyroid:

$$D_{QO} = N/52\ [4.0 \times 10^{-2} Q_{H3} + 6.0 \times 10^3 Q_P]$$ [See Note 6]

523 296

Step 7 - D_{QMO} = Maximum organ dose equals the greater of D_{QT} or D_{QO}. If either is greater than 7.5 mrem, go to Method 2.

Note 6 - See Appendix F for derivation of the factors given here.

(2) Method 2 - The GASPAR code should be used to determine the maximum quarterly organ dose. Real time meteorology should be used. Specific curies for each iodine and particulate nuclide should be entered. Only continous releases and meteorology need be considered as they are the source of the iodines and particulates. Only those pathways which are actually in existence at the time should be used (for example - do not use milk pathway in 1st. quarter). Vegetation and milk pathway doses should be calculated only at real locations.

The procedure for use of the GASPAR code is presented in Appendix E.

b. Annual Organ Dose Limit

Determine D_{YO} = maximum organ dose for the calendar year as follows:

$D_{YO} = \sum D_{QMO}$ where the sum is over the first quarter through the present quarter doses to the maximum organ. 523 297

The following guidelines should be used for use of D_{QMO}:

(1) If the detailed quarterly dose calculations required per Section D.4 for the semi-annual effluent report are complete for any calendar quarter, use those results.

(2) If the detailed calculations are not complete for a particular quarter, use the results as determined above in Section D.3.a.

(3) If D_{YO} is greater than 15 mrem and any quarterly dose was not calculated using Method 2 of Section D.3.a, recalculate the quarterly dose using Method 2 if this could reduce the annual dose below 15 mrem.

(4) If different organs are the maximum organ for different quarters, they can be summed together and D_{YO} recorded as a less than value as long as the value is less than 15 mrem. If it is not, the sum for each organ involved should be determined.

4. Compliance With Specification 3.26.4.1

a. Monthly Dose Projections From Gaseous Radwaste Treatment System

Step 1 - Estimate C_N^E = the number of curies of gas to be processed during the next month.

523 298

Step 2 - Determine D^{E}_{MAG} = estimated monthly gamma air dose for process gas:

$$D^{E}_{MAG} = 1.9 \times 10^{-4} * C^{E}_{N} \text{ (mrad)}$$

(Note - factor from section D.2.a.(1).)

Step 3 - Determine D^{E}_{MAB} = estimated monthly beta air dose for process gas:

$$D^{E}_{MAB} = 7.4 \times 10^{-4}\ C^{E}_{N} \text{ (mrad)}$$

(Note - factor from section D.2.a.(2).)

b. Monthly Dose Projections From Continuous Ventilation Releases

Step 1 - For the last quarter of operation, determine D_{QMO} as determined per Section D.3.a.

Step 2 - Estimate R_1 = expected ratio of primary coolant iodine level for the coming month as compared with the average level during the quarter used in Step 1.

Step 3 - Estimate R_2 = expected ratio of primary leakage rate for the coming month as compared with the average leakage rate during the quarter used in Step 1.

523 299

Step 4 - Determine D^E_{MO} = estimated monthly dose to the maximum organ.

$$D^E_{MO} = 1/3\ R_1\ R_2\ D_{QMO}$$

5. Quarterly Dose Calculations for Semi-Annual Report

Detailed quarterly dose calculations required for the Semi-Annual Radioactive Effluent Report shall be done using the computer code GASPAR. The use of this code and required input parameters are given in Environmental Programs Branch Procedure #EPB IV-5-9, Gaseous Dose Calculations - GASPAR. This procedure is attached in Appendix E.

6. Compliance With Specification 3.26.5.1

The following sources should be considered in determining the total dose to a real individual from uranium fuel cycle sources:

a. CY gaseous doses - as calculated in Section D above.

b. CY liquid doses - as calculated in Section C above.

c. CY - direct radiation from the site.

d. Since all other uranium fuel cycle sources are greater than 20 miles away, they need not be considered.

523 300

E. LIQUID MONITOR SETPOINTS

1. Test Tank Discharge Line Monitor

The trip/alarm setting on the test tank discharge line monitor depends on dilution water flow, test tank discharge flow, the isotopic composition of the liquid to be discharged, the background count rate of the monitor and the efficiency of the monitor. Due to the variability of these parameters, an alarm/trip setpoint will be determined prior to the release of each batch. The following methodology will be used:

Step 1. From the tank isotopic analysis and the MPC valves for each identified nuclide, determine the dilution required.

$$D.R. = \sum_i (C_i/MPC_i)$$

where:

D.R. = dilution required

C_i = concentration of nuclude i (u Ci/ml)

MPC_i = MPC value (10CFR20, Appendix B, Table 2, Column 2) for nuclide i (u Ci/ml)

523 301

Step 2. Determine the existing dilution ratio:

$$D.E. = \frac{\text{\# Circ. Pumps Running} \times 92{,}000}{50}$$

where:

92,000 = GPM flow from 1 circ. pump

50 = maximum possible GPM from test tank line

D.E. = existing dilution ratio

Step 3. Determine A (u Ci/ml) = $\sum_i C_i$ = total u Ci/ml in tank.

Step 4. Determine monitor set point in u Ci/ml (S) as follows:

$$S\ (u\ Ci/ml) = A\ (u\ Ci/ml)\ \frac{D.E.}{D.R.}$$

Step 5. Using the monitor calibration curve, determine the CPM corresponding to S (u Ci/ml). The monitor alarm/trip setpoint should be set at less than this corresponding value plus the background count rate.

2. Steam Generator Blowdown Monitor

Step 1. Maximum possible liquid discharge rate = 70 GPM (maximum blowdown rate = 100 gpm of which 30% flashes to steam).

Step 2. Minimum possible dilution flow rate = 276,000 GPM (minimum of 3 circ. pumps during periods of blowdown).

Step 3. Unidentified MPC for unrestricted area = 1×10^{-7} u Ci/ml.

523 302

Step 4. Therefore, alarm/setpoint should be:

$$S\ (u\ Ci/ml) = 1 \times 10^{-7} \times \frac{276,000}{70} = 3.9 \times 10^{-4}\ u\ Ci/ml$$

Step 5. Using the monitor calibration curve, determine the CPM corresponding to 3.9×10^{-4} u Ci/ml. The monitor alarm setpoint should be set at less than this corresponding value plus the background count rate.

3. Service Water Radiation Monitor

Step 1. Maximum possible service water flow from potentially contaminated areas = 5,000 GPM.

Step 2. Dilution flow F_D (gpm)

F_D = # Circ. pumps x 92,000 + # service water pumps x 6000 GPM.

Step 3. Unidentified MPC for unrestricted area = 1×10^{-7} u Ci/ml.

Step 4. Therefore alarm setpoint should be:

$$S\ (u\ Ci/ml) = 1 \times 10^{-7} \times \frac{F_D}{5000}$$

523 303

Step 5. Using the monitor calibration curve, determine the CPM corresponding to S (u Ci/ml). The monitor alarm setpoint should be set at less than this corresponding value plus the background count rate.

F. GASEOUS MONITOR SETPOINTS

1. Stack Noble Gas Activity Monitor

Step 1. As given in Section D.1.a. of this manual, determine the noble gas release rate limit Q_N in u Ci/sec.

Step 2. Estimate maximum possible stack flow rate = F_S (CC/sec) = 1.2 x # purge fans x 52,000 CFM x 472 CC/SEC/CFM.

Where 52,000 CFM = Flow from one purge flow and 1.2 = conservative factor for maximum possible flow.

$$F_S = 3 \times 10^7 \times \# \text{ purge fans (CC/SEC)}$$

Step 3. Determine monitor alarm/trip setpoint

$$S = Q_N/F_S \text{ (u Ci/cc)}$$

Step 4. Using the monitor calibration curve, determine the CPM corresponding to S (u Ci/CC). The monitor alarm setpoint should be set at less than this corresponding value.

523 304

G. ENVIRONMENTAL MONITORING PROGRAM

SAMPLING LOCATIONS

The following lists the environmental sampling locations and the types of samples obtained at each location. The distances given are to the nearest half mile. Sampling locations are also shown on Figures 1 and 2:

Location Number	Location Name	Direction + Distance	Sample Types
5-I*	Onsite-Injun Hollow Rd.	0.5 Mi, NW	TLD, Air Particulate, Iodine
6-I	Onsite-Substation	1.0 Mi, ENE	TLD, Air Particulate, Iodine
7-I	Haddam	2.0 Mi, SE	TLD, Air Particulate, Iodine
8-I	East Haddam	3.0 Mi, ESE	TLD, Air Particulate
9-I	Higganum	3.5 Mi, WNW	TLD, Air Particulate
10-I	Hurd Park Road	3.0 Mi, NNW	TLD, Air Particulate
11-C	Middletown	10.0 Mi, NW	TLD, Air Particulate
12-C	Deep River	8.0 Mi, SSE	TLD, Air Particulate
13-C	North Madison	12.0 Mi, SW	TLD, Air Particulate, Iodine
14-C	Colchester	10.0 Mi, ENE	TLD, Air Particulate
15-I	Onsite Wells	0.5 Mi, SE	Well Water
16-C	Well-State Highway Dept.-E. Haddam	3.0 Mi, S	Well Water
17-C	Fruits & Vegetables	Beyond 10 Miles	Vegetation
18-I	Site Boundary	0.5 Mi, NW	Vegetation
19-I	Cow Location #1	1.6 Mi, N	Milk
20-I	Cow Location #2	2.2 Mi, ESE	Milk
21-I	Cow Location #3	2.8 Mi, E	Milk
22-C	Cow Location #4	11 Mi, ENE	Milk
23-C	Goat Location #1	6 Mi, N	Milk
24-I	Goat Location #2	1.3 Mi, NW	Milk
25-I	Fruits & Vegetables	Within 10 Miles	Vegetation
26-I	Conn. River-Near Intake	0.5 Mi, SSW	Fish
27-C	Conn. River-Higganum Light	3 Mi, NW	Bottom Sediment, Shellfish
28-I	Conn. River-E. Haddam Bridge	[illegible] Mi, SE	Bottom Sediment
29-I	Vicinity of Discharge	0.75 Mi, ESE	Bottom Sediment, Water, Fish
30-C	Conn. River-Middletown	9 Mi, NW	Water, Fish
31-I	Mouth of Salmon River	1.5 Mi, SE	Shellfish

*I = Indicator   C = Control

523 305

H. EFFLUENT FLOW DIAGRAMS

Figures 3 and 4 present the flow diagrams for the liquid and gaseous radwaste systems. They also indicate the location of the radiation monitors listed in Sections 3.23 and 3.24 of the Technical Specifications.

523 306

TABIE 1

LIQUID DOSE FACTORS - CY - ADULTS*

Radionuclide	Total Body A_{iT} (mrem.l/pCi.kg)	Liver A_{iL}	Thyroid A_{iI}	Bone A_{iB}
H-3	9.5×10^{-8}	9.5×10^{-8}	9.5×10^{-8}	-
P-32	7.5×10^{-1}	1.2×10^{0}	-	1.9×10^{1}
Cr-51	5.3×10^{-7}	-	3.2×10^{-7}	-
Mn-54	3.5×10^{-4}	1.8×10^{-3}	-	-
Fe-55	4.4×10^{-5}	1.9×10^{-4}	-	2.7×10^{-4}
Fe-59	3.9×10^{-4}	1.0×10^{-3}	-	4.3×10^{-4}
Co-58	8.4×10^{-5}	3.7×10^{-5}	-	-
Co-60	2.4×10^{-4}	1.1×10^{-4}	-	-
Zn-65	1.4×10^{-2}	3.1×10^{-2}	-	9.7×10^{-3}
Rb-86	2.0×10^{-2}	4.2×10^{-2}	-	-
Sr-89	2.7×10^{-4}	-	-	9.2×10^{-3}
Sr-90	5.6×10^{-2}	-	-	2.3×10^{-1}
Y-91	9.4×10^{-8}		-	3.5×10^{-6}
Zr-95	2.2×10^{-8}	$3.2\ \ 10^{-8}$	-	1.0×10^{-7}
Zr-97	5.1×10^{-10}	1.1×10^{-9}	-	5.5×10^{-9}
Nb-95	5.6×10^{-5}	1.0×10^{-4}	-	1.8×10^{-4}
Mo-99	8.2×10^{-6}	4.3×10^{-5}	-	-
Ru-103	8.0×10^{-7}	-	-	1.9×10^{-6}
Ru-106	3.5×10^{-6}	-	-	2.8×10^{-5}
Ag-110m	2.0×10^{-7}	3.4×10^{-7}	-	3.6×10^{-7}
Te-125m	1.4×10^{-4}	3.8×10^{-4}	3.2×10^{-4}	1.1×10^{-3}
Te-127m	3.3×10^{-4}	9.7×10^{-4}	6.9×10^{-4}	2.7×10^{-3}
Te-129m	7.3×10^{-4}	1.7×10^{-3}	1.6×10^{-3}	4.6×10^{-3}
Te-131m	2.8×10^{-4}	3.4×10^{-4}	5.4×10^{-4}	6.9×10^{-4}
Te-132	6.1×10^{-4}	6.5×10^{-4}	7.2×10^{-4}	1.0×10^{-3}
I-131	5.1×10^{-5}	8.9×10^{-5}	2.9×10^{-2}	6.2×10^{-5}
I-133	1.1×10^{-5}	3.7×10^{-5}	5.4×10^{-3}	2.1×10^{-5}
Cs-134	2.4×10^{-1}	3.0×10^{-1}	-	1.2×10^{-1}
Cs-136	3.7×10^{-2}	5.1×10^{-2}	-	1.3×10^{-2}
Cs-137	1.[illegible] $\times 10^{-1}$	2.2×10^{-1}	-	1.6×10^{-1}
Ba-140	5.3×10^{-6}	1.0×10^{-7}	-	8.1×10^{-5}
La-140	8.3×10^{-9}	3.2×10^{-8}	-	6.3×10^{-8}
Ce-141	7.18×10^{-10}	6.3×10^{-9}	-	9.4×10^{-9}
Ce-143	1.35×10^{-10}	1.2×10^{-6}	-	1.7×10^{-9}
Ce-144	2.62×10^{-8}	2.0×10^{-7}	-	4.9×10^{-7}
Np-239	6.5×10^{-10}	1.2×10^{-9}	-	1.2×10^{-8}

* - Determined by multiplying the bioaccumulation factor for freshwater fish times the adult ingestion dose factor - both taken from Reg. Guide 1.109-Rev. 1.

TABLE 2

DOSE FACTORS FOR NOBLE GASES & DAUGHTERS

Radionuclide	Total Body Factor K_i (mrem/yr per $\mu Ci/m^3$)	Skin Factor S_i** (mrem/yr per $\mu Ci/m^3$)	Gamma Air Dose Factor M_i (mrad/yr per $\mu Ci/m^3$)	Beta Air Dose Factor N_i (mrad/yr per $\mu Ci/m^3$)
Kr-83m	7.56 (-2)*	2.12 (1)	1.93 (1)	2.88 (2)
Kr-85m	1.17 (3)	2.81 (3)	1.23 (3)	1.97 (3)
Kr-85	1.61 (1)	1.36 (3)	1.72 (1)	1.95 (3)
Kr-87	5.92 (3)	1.65 (4)	6.17 (3)	1.03 (4)
Kr-88	1.47 (4)	1.91 (4)	1.52 (4)	2.93 (3)
Kr-89	1.66 (4)	2.91 (4)	1.73 (4)	1.06 (4)
Kr-90	1.56 (4)	2.52 (4)	1.63 (4)	7.83 (3)
Xe-131m	9.15 (1)	6.48 (2)	1.56 (2)	1.11 (3)
Xe-133m	2.51 (2)	1.35 (3)	3.27 (2)	1.48 (3)
Xe-133	2.94 (2)	6.94 (2)	3.53 (2)	1.05 (3)
Xe-135m	3.12 (3)	4.41 (3)	3.36 (3)	7.39 (2)
Xe-135	1.81 (3)	3.97 (3)	1.92 (3)	2.46 (3)
Xe-137	1.42 (3)	1.39 (4)	1.51 (3)	1.27 (4)
Xe-138	8.83 (3)	1.43 (4)	9.21 (3)	4.75 (3)
Ar-41	8.84 (3)	1.29 (4)	9.30 (3)	3.28 (3)

* 7.56 (-2) = 7.56×10^{-2}

**$S_i = L_i + 1.1 M_i$ from NRC proposed specifications.

TABLE 3

DOSE FACTORS FOR IODINES & PARTICULATES

Radionuclide	O_i* (mrem/yr per μCi/Sec)
H-3	4.0 (-2)
P-32	8.6 (3)
Mn-54	6.3 (1)
Fe-59	4.0 (1)
Co-58	3.3 (1)
Co-60	2.6 (2)
Zn-65	9.7 (2)
Rb-86	9.1 (2)
Sr-89	5.7 (2)
Sr-90	6.0 (3)
Y-91	1.1 (2)
Zr-95	2.0 (1)
Nb-95	2.1 (1)
Ru-103	1.9 (3)
Ru-106	2.5 (4)
Ag-110m	8.6 (2)
Cd-115m	5.7 (0)
Sm-123	2.0 (2)
Sm-126	7.9 (1)
Sb-124	6.4 (1)
Sb-125	6.3 (1)
Te-127m	4.2 (3)
Te-129m	7.5 (1)
Cs-134	3.0 (3)
Cs-136	3.1 (2)
Cs-137	2.7 (3)
Ba-140	1.4 (1)
Ce-141	5.1 (0)
Ce-144	3.9 (1)
I-131	6.3 (4)
I-133	6.0 (2)

* - O_i - determined by: $1.32 \times 10^{-5} \times P_i$ inhalation + $5.71 \times 10^{-8} \times P_i$ Food = O_i

Where 1.32×10^{-5} is max. X/Q and 5.71×10^{-8} is max. D/Q and P_i inhalation and food are from NRC draft spec. - NUREG 472 - May 1978.

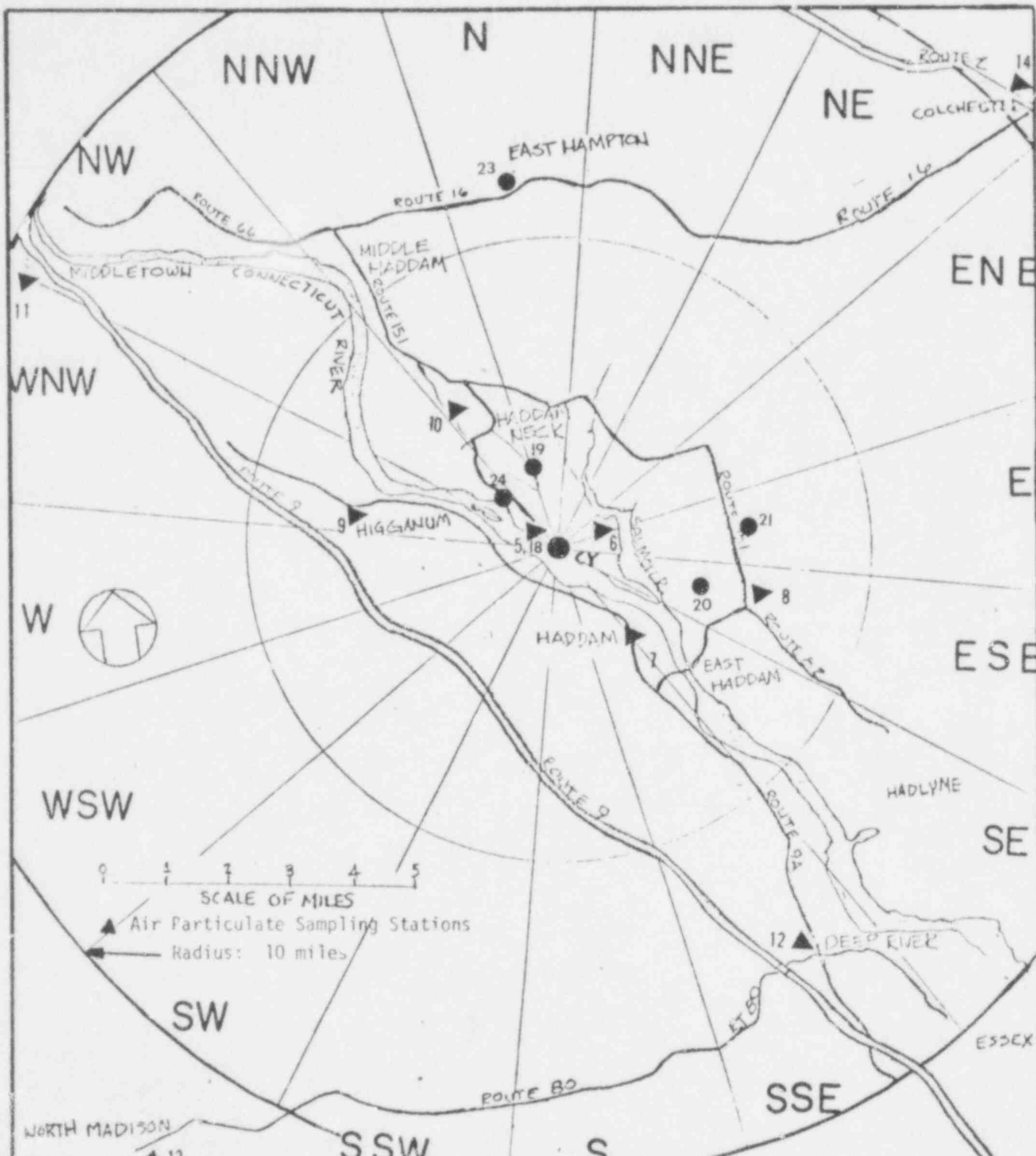


FIGURE 1
Inner and Outer Terrestrial Monitoring Stations
Haddam Neck Plant

523 310

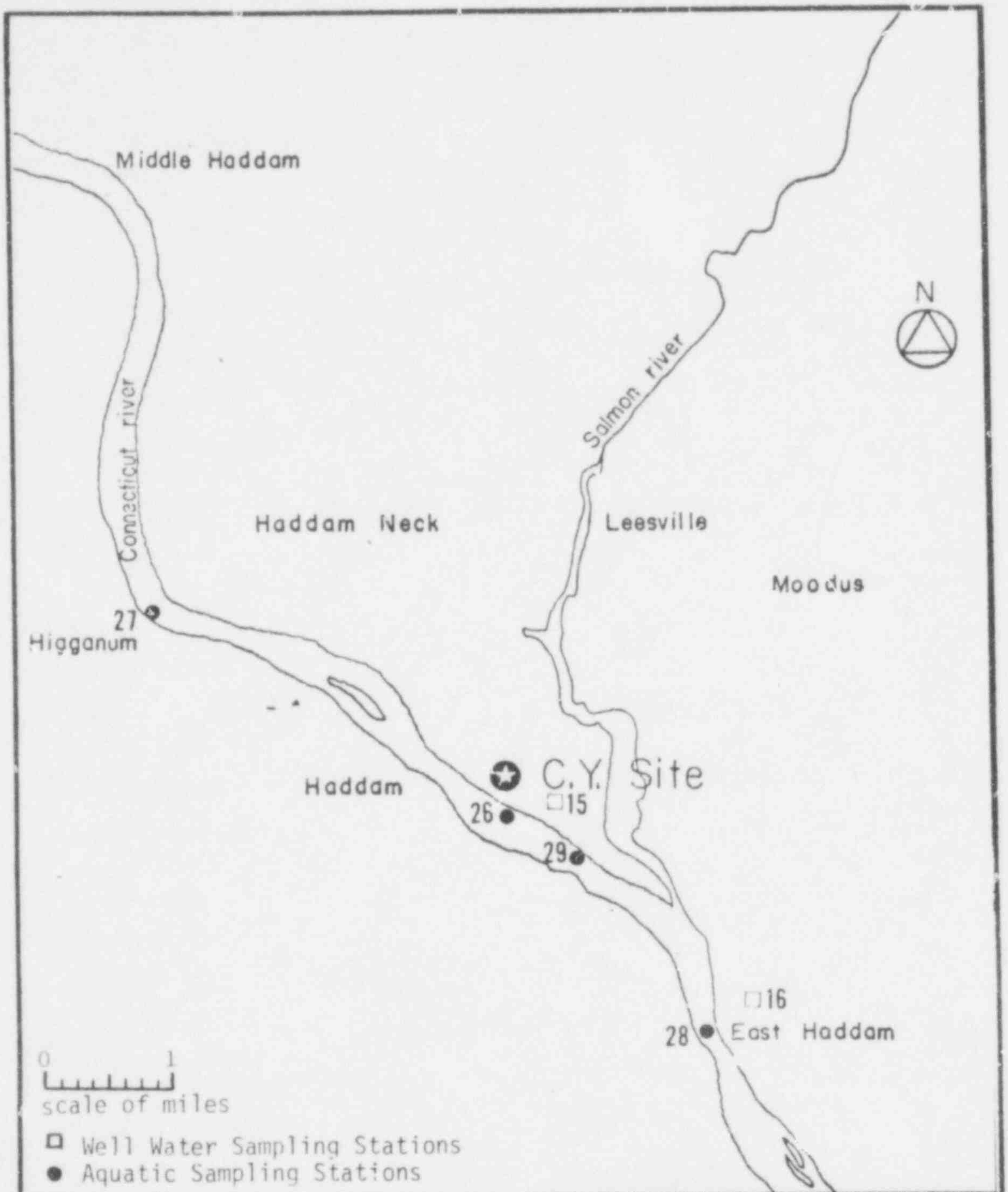
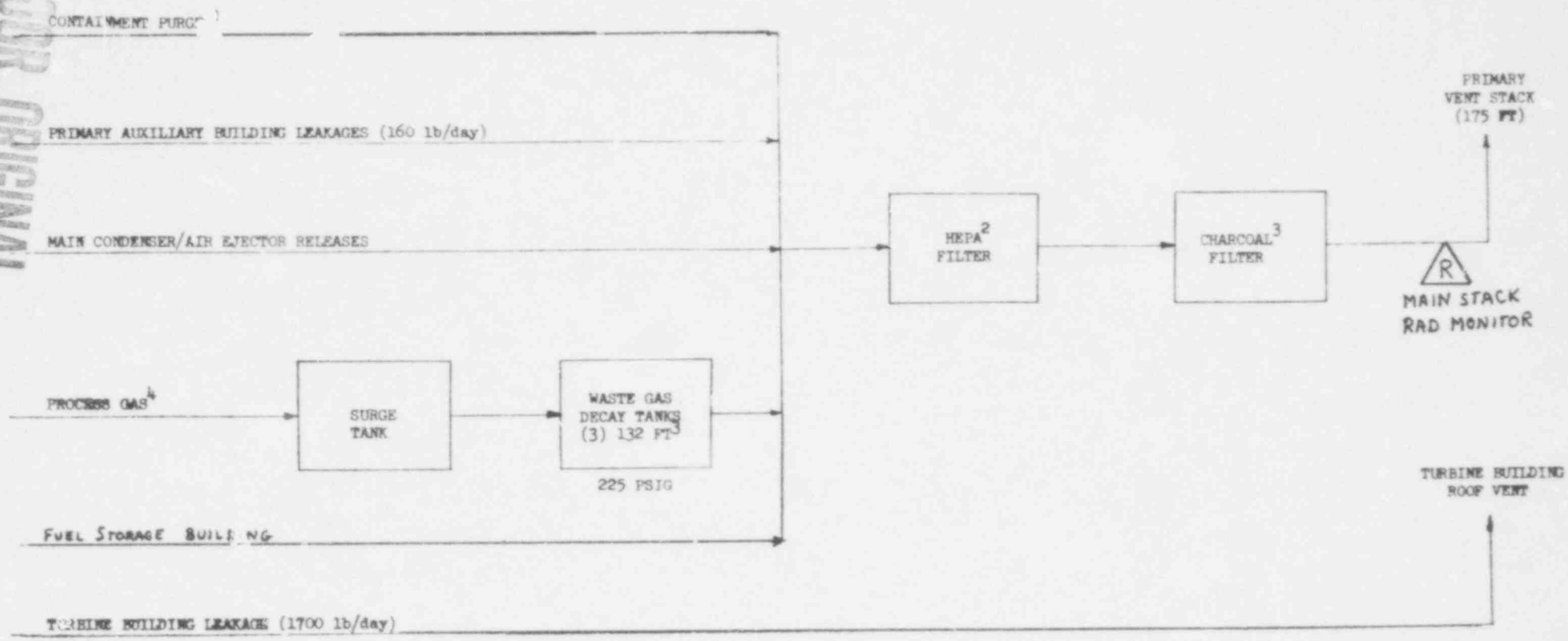


FIGURE 2
Aquatic and Well Water Sampling Stations
Haddam Neck Plant

FIGURE 4

GASEOUS WASTE FLOW DIAGRAM

HADDAM NECK STATION
CONNECTICUT YANKEE ATOMIC POWER COMPANY



523 312

1 Four cold purges per year with purge duration of two days each

2 DF of 100 for particulates

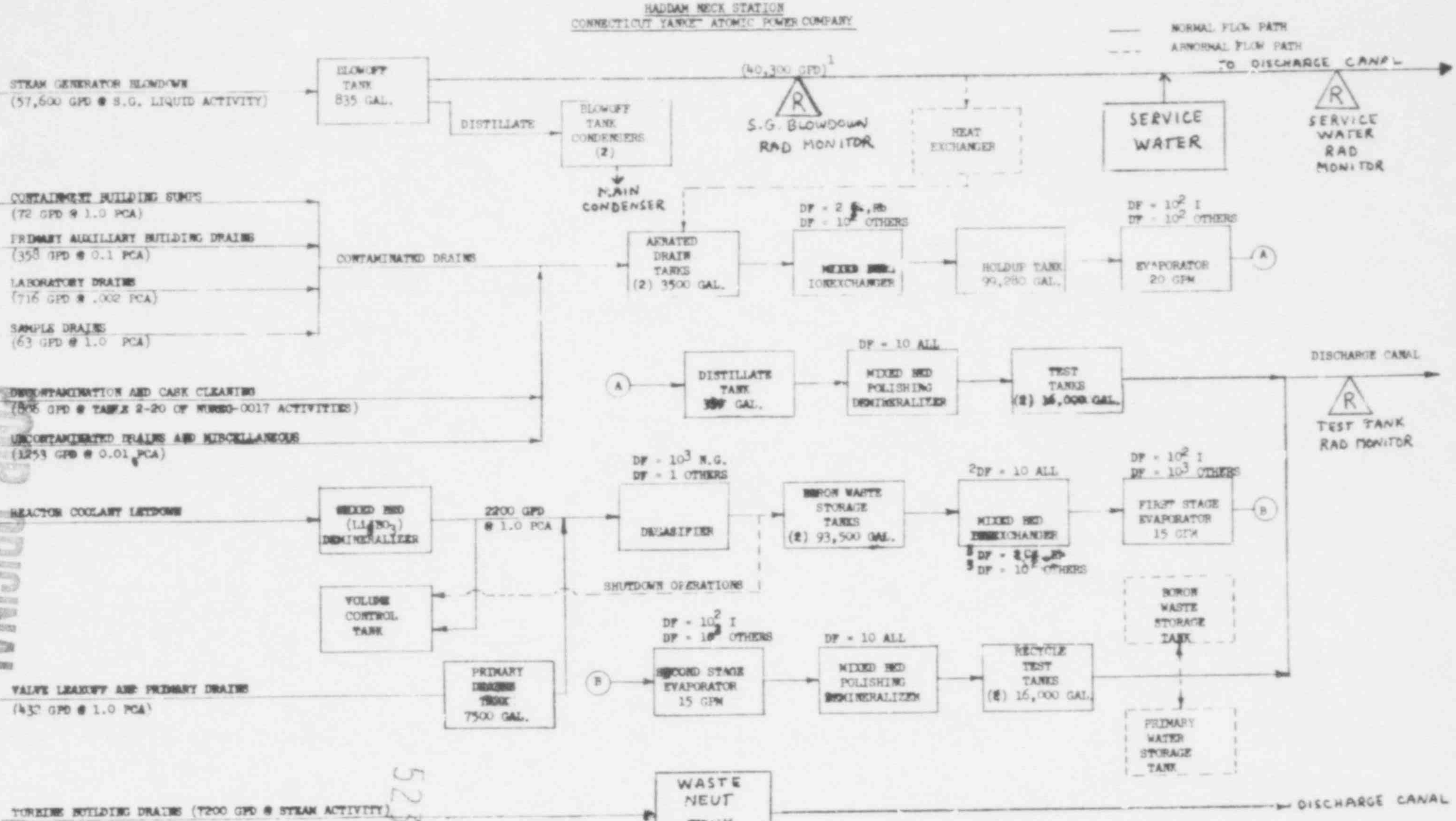
3 DF of 10 for iodines

4 Total release of 50,000 scf/yr with a release rate of 5 scfm

FIGURE 3

LIQUID WASTE FLOW DIAGRAM

HADDAM NECK STATION
CONNECTICUT YANKEE ATOMIC POWER COMPANY



[1] Fraction of S.G. liquid activity:

[2] Reactor coolant letdown

[3] Valve leakoff

523 313

POOR ORIGINAL

APPENDIX A

DERIVATION OF FACTORS FOR SECTION C.1.a

1. Section (1) - Step 3

CY LIQUID DOSES

Year	Quarter	C'_F	$D'_{QT(F)}$	D'_{QT}/C'_F	C'_T	$D'_{GT}\ (H_3)$	$D'_{QT}\ (H'_3)/C'_T$
1976	1	0.040	0.0046	0.115	1800	1.2 (-3)	6.7 (-7)
	2	0.029	0.0038	0.131	2620	2.5 (-3)	9.5 (-7)
	3	0.018	0.043	2.391	130	4.3 (-4)	3.3 (-6)
	4	0.043	0.035	0.814	310	1.0 (-3)	3.2 (-6)
1977	1	0.021	0.038	1.81	600	2.0 (-3)	3.3 (-6)
	2	0.214	0.036	0.168	1010	3.3 (-3)	3.3 (-6)
	3	0.232	0.29	1.25	4050	1.3 (-2)	3.2 (-6)
	4	1.48	0.20	0.135	1010	3.2 (-3)	3.2 (-6)
1978	1	0.55	1.9	3.45	610	1.5 (-3)	2.5 (-6)
	2	0.27	0.68	2.52	540	1.4 (-3)	2.6 (-6)

C'_F - Curies of fission and activation products released during calendar quarter.

$D'_{QT(F)}$ - Calculated dose (mrem) due to fission and activation products. Dose calculated using computer code LADTAP total body dose to maximum individual.

C'_T - Curies of tritium released during calendar quarter.

$D'_{QT}(H'_3)$ - Calculated dose (mrem) due to tritium. Dose calculated using computer code LADTAP-total body dose to maximum individual.

Avg value of $D'_{QT(F)}/C'_F$ = **1.28** mrem/Ci

523 314

Max value of $D'_{QT(F)}/C'_F$ = 3.45 mrem/Ci

or Max = 2.7 x Avg

∴ dose should not exceed 2.7 x 0.15 = 0.4 mrem with Method 1.

Avg value $D'_{QT(H3)}/C'_T$ = **2.6×10^{-6}** mrem/Ci

Max value of $D'_{QT(H3)}/C'_T = 3.3 \times 10^{-6}$ or 1.3 x Avg.

∴ dose should not exceed 1.3 x 0.15 = 0.2 mrem with Method 1.

2. Section (2) - Justification for Only Using 3 Nuclides

Year	Quarter	Cs-134	Cs-137	H-3	Co-60	Sr-90
		Nuclide - % of Total Body Dose				
1976	1	14	59	25	-	-
	2	-	30	68	-	-
	3	1	97	1	-	-
	4	37	58	2	-	-
1977	1	14	79	5	-	-
	2	19	66	9	3	-
	3	23	61	4	-	10
	4	63	33	1	-	-
1978	1	60	38	-	-	-
	2	59	40	-	-	-
	Avg =	29	56	11	< 1	1

Only Cs-134, Cs-137 and H-3 have contributed more than 10% of the dose in any one quarter and on the average they constitute 99% of the dose.

Therefore, using only these three nuclides for Method 2, the real dose should not exceed 1.1 x 0.75 = 0.83 mrem.

3. Section (2) - Step 3

$$\text{Dose Cs-134} = \frac{\text{C134 (Ci)}}{\text{V (gal)}} \times 10^{12}\ \text{pCi/Ci} \times 2.0 \times 10^{3}\ \text{pCi/kg} - \frac{\text{liter}}{\text{pCi}}$$

$$\times\ 1.21 \times 10^{-4}\ \text{mrem/pCi} \times 21/4\ \text{kg} \times 0.26\ \text{gal/liter}$$

where

2.0×10^{3} = Bioaccumulation factor for Cs for freshwater fish - Table A-1 Reg. Guide 1.109.

1.21×10^{-4} = Ingestion dose factor for adults total body - Cs-134 - Table E-11, Reg. Guide 1.109

21/4 = Quarterly usage factor - adult - fish

$$\text{Dose Cs-134} = \frac{\text{C134}}{\text{V}} \times \boxed{3.3 \times 10^{11}}$$

523 315

$$\text{Dose Cs-137} = \frac{\text{C137 (Ci)}}{\text{V (gal)}} \times 10^{12}\ \text{pCi/Ci} \times 2.0 \times 10^{3}\ \text{pCi/kg liter/pCi}$$

$$\times\ 7.14 \times 10^{-5}\ \text{mrem/pCi} \times 21/4\ \text{kg} \times 0.26\ \text{gal/liter}$$

where 7.14×10^{-5} = ingestion dose factor for adults total body - Cs-137 - Table E-11 - Reg. Guide 1.109.

$$\text{Dose Cs-137} = \frac{C137}{V} \times \boxed{1.9 \times 10^{11}}$$

$$\text{Dose H-3} = \frac{CT\ (Ci)}{V\ (gal)} \times 10^{12}\ pCi/Ci \times 0.9\ pCi/kg\ liter/pCi$$

$$\times\ 1.05 \times 10^{-7}\ mrem/pCi \times 21/4\ kg \times 0.26\ gal/liter$$

where 0.9 = bioaccumulation factor for H3 for freshwater fish - Table A-1 - Reg. Guide 1.109

1.05×10^{-7} = ingestion dose factor for adult total body - H-3 - Table E-11 - Reg. Guide 1.109

$$\text{Dose H-3} = \frac{CT}{V} \times \boxed{1.3 \times 10^{5}}$$

4. Section (3) - Step 5

10^{12} pCi/Ci x 0.26 gal/l = $\boxed{2.6 \times 10^{11}}$

APPENDIX B

DERIVATION OF FACTORS FOR SECTION C.1.b

1. Section (1) - Step 3

CY LIQUID DOSES

Year	Quarter	C'_F	Max Organ	D'_{QO}	D'_{QO}/C'_F	C'_T	$D'_{QO}(H_3)$	$D'_{QO}(H_3)/C'_T$
1976	1	0.040	Liver	0.0062	0.155	1800	1.2 (-3)	6.7 (-7)
	2	0.029	Liver	0.0044	0.152	2620	2.5 (-3)	9.5 (-7)
	3	0.018	Liver	0.066	3.66	130	4.3 (-4)	3.3 (-6)
	4	0.043	Liver	0.049	1.13	310	1.0 (-3)	3.2 (-6)
1977	1	0.021	Liver	0.055	2.62	600	2.0 (-3)	3.3 (-6)
	2	0.213	Liver	0.052	0.24	1010	3.3 (-3)	3.3 (-6)
	3	0.232	Bone	0.39	1.67	4050	1.3 (-2)	3.2 (-6)
	4	1.48	Thyroid	0.82	0.55	1010	3.2 (-3)	3.2 (-6)
1978	1	0.55	Liver	2.65	4.82	610	1.5 (-3)	2.5 (-6)
	2	0.27	Liver	0.94	3.48	540	1.4 (-3)	2.6 (-6)

C'_F = Curies of fission and activation products released during calendar quarter.

D'_{QO} = Calculated dose (mrem) to the maximum adult organ dose calculated using the computer code LADTAP.

C'_T = Curies of tritium released during calendar quarter.

$D'_{QO(H3)}$ = Calculated dose (mrem) to the maximum organ due to tritium dose calculated using computer code LADTAP.

Avg. value of D'_{QO}/C'_F = **1.85** mrem/Ci

523 317

Max. value of D'_{QO}/C'_F = 4.82 mrem/Ci or 2.6 x Avg. value.

∴ Dose should not exceed 2.6 x 0.5 = 1.3 mrem with Method 1.

Avg. value of $D'_{QO\ (H3)}/C'_Y$ = **2.6×10^{-6}** mrem/Ci

Max. value of $D'_{QO\ (H3)}/C'_T = 3.3 \times 10^{-6}$ or 1.3 x Avg. value.

∴ Dose should not exceed 1.3 x 0.5 = 0.65 mrem with Method 1.

2. Section (2) - Justification for Organ and Nuclide Selection

Year	Quarter	Organ	Cs-134	Cs-137	H-3	Co-60	Sr-90	I-131
			Nuclide - % of Organ Dose					
1976	1	Liver	12	67	18	-	-	-
	2	Liver	-	40	59	-	-	-
	3	Liver	1	98	-	-	-	-
	4	Liver	33	64	2	-	-	-
1977	1	Liver	12	83	3	-	-	-
	2	Liver	17	73	6	1	-	-
	3	Liver	22	73	3	-	-	-
	3	Bone	9	54	-	-	35	-
	4	Liver	59	38	1	-	-	-
	4	Thyroid	-	-	-	-	-	99
1978	1	Liver	55	44	-	-	-	-
	2	Liver	54	45	-	-	-	-

The above listed nuclides are the only ones which have contributed more than 1% to the maximum organ dose. Eight out of ten times the maximum organ was the liver, to which only three nuclides have contributed more than 1% of the dose. Since Sr-90 is not readily determined, one can not routinely determine if the Sr-90 concentrations are relatively higher than normal. Therefore, one only needs to do a thyroid calculation using I-131 and a liver calculation using Cs-134, Cs-137 and H-3.

3. Section (2) - Step 6

See Appx. A - Section 3.

Cs-134

$$\text{Liver dose factor} = \text{total body dose factor} \times \frac{\text{Liver Dose Conv. Factor}}{\text{Total Body Dose Conv. Factor}}$$

$$= 3.3 \times 10^{11} \times \frac{1.43 \times 10^{-4}}{1.21 \times 10^{-4}} = \boxed{4.0 \times 10^{11}}$$

523 318

Likewise

$$\text{Cs-137} = 1.9 \times 10^{11} \times \frac{1.09 \times 10^{-4}}{7.14 \times 10^{-5}} = \boxed{2.9 \times 10^{11}}$$

For

H-3 - dose factor the same for liver and total body = $\boxed{1.3 \times 10^{5}}$

4. <u>Section (2) - Step 7</u>

$$\text{Thyroid Dose} = \text{I-131} = \frac{\text{C131 (Ci)}}{\text{V (gal)}} \times 10^{12}\ \text{pCi/Ci} \times 1.5 \times 10^{1}\ \text{pCi/kg}\ \frac{\text{liter}}{\text{pCi}}$$

$$\times\ 1.95 \times 10^{-3}\ \text{mrem/pCi} \times 21/4 \times 0.26\ \text{gal/liter}$$

Where

1.5×10^{1} - bioaccumulation factor for I for freshwater fish - Table A-1 - Reg. Guide 1.109 - Rev. 1.

1.95×10^{-3} - Ingestion dose factor for adults thyroid - I-131 - Table E-11 - Reg. Guide 1.109.

21/4 - Quarterly usage factor - adult fish.

$\therefore$ Thyroid dose due to I-131 = $\frac{\text{C131}}{\text{V}} \times \boxed{4.0 \times 10^{10}}$

5. <u>Section (3) - Steps 5, 6 & 7</u>

10^{12} pCi/Ci x 0.26 gal/l = $\boxed{2.6 \times 10^{11}}$

APPENDIX C

LADTAP - LIQUID DOSE CALCULATIONS

The LADTAP code was written by the NRC to compute doses from liquid releases using the models given in Regulatory Guide 1.109. There is no revision date on the copy of the code which was obtained, but it was purchased in March, 1976. The only change made to the code since that time was a change in the ingestion dose factors from those given in Rev. 0 of Regulatory Guide 1.109 to those in Rev. 1.

For calculating the maximum individual dose at Connecticut Yankee, the following options and parameters are used:

1. Real time, measured dilution flow.

2. Fresh water site, no reconcentration.

3. Shorewidth factor = 0.1 for discharge canal.

4. No dilution for max individual pathways.

5. 1-hour discharge transit time - approximate time to reach 1/2 canal length.

6. Regulatory Guide 1.109 usage factors for max individual for fish, shoreline, swimming and boating.

7. Zero usage for shellfish, algae, drainking water, and irrigated food pathways.

The following pages of Appendix C present the in-house procedure written for running this code. It is written for running the quarterly dose calculations but can easily be used to perform monthly calculations.

APPENDIX C

LIQUID DOSE CALCULATIONS - LADTAP

A. PURPOSE

This procedure may be used to calculate the quarterly (or any other time period) doses to both the maximum individual and the 50 mile population due to radionuclides released in liquid effluents from either Connecticut Yankee or Millstone Units 1 or 2. The procedure involves the use of the computer code LADTAP which was developed by the NRC in order to perform dose calculations in accordance with Regulatory Guide 1.109.

B. REFERENCES

1. User's Manual for the LADTAP Program - 8 page printout.
2. U.S. N.R.C. Regulatory Guide 1.109.
3. U.S. N.R.C. Regulatory Guide 1.113.
4. Millstone 3 - Demonstration of Compliance with 10CFR50, Appendix I - Part 2B - Nov. 76.

   Final Environmental Statements - CY and Millstone 1 and 2.

C. PREREQUISITES

The plant must supply the total number of Curies released for each radionuclide during the time period involved.

D. PRECAUTIONS

None.

E. LIMITATIONS AND ACTIONS

None.

523 321

F. PROCEDURE

1. Review the plant curie tables for accuracy and completeness. If the strontium results are not yet available, but the calculations must be performed in order to meet the semiannual effluent report schedule, the code may be run without the strontium values and the doses due to strontium ratioed by hand by comparison with the previous quarter's results.
2. Obtain the computer deck for the proper site - there is one deck for Connecticut Yankee and one deck for Millstone. The Millstone deck may be used for both Units 1 and 2, however the quarterly doses must be calculated for each plant separately.

3. The following control cards are required for either deck:

```
// 082), 'CRANDALL', MSGLEVEL = 1, CLASS = B
//STEP1 EXEC PGM = PFLADTAP
//FT10F001 DD DSN=FANG.DOSE.FACTOR.FOR.PFLADTAP, DISP=OLD
//FTØ6FØØ1 DD SYSOUT = A
//FTØ5FØØ1 DD *

            INPUT CARDS

/*
```

4. The deck should be in the order as used during the previous quarter. If not, refer to reference 1 to ensure the proper input cards are used. Pay particular attention to the number of blank cards required.

5. The following values are incorporated in the input cards and need not be revised routinely. Check the basis as given below used to generate these values. If there has not been a change in the basis, proceed to step 6 - if there has been a change, revise the appropriate card (and the procedure if the change is permanent).

Card 2

a. Site type - CY = 0 = fresh MP = 1 = salt

b. Release multiplier - CY & MP = 1 - calculation done for 1 unit at a time.

c. Percentage dose printout - CY & MP = 1 - prints nuclide breakdown of dose.

Card 3

a. 50 mile population - CY = 3.83E+06 - 1980 population estimate-ER
MP = 3.03E+06 - 1980 population estimate-ER

b. Change the standard population distribution - CY & MP = 0 = NO

Assumes population around CY & MP is typical as far as fraction which is adult, teenager and child.

Card 6

a. CY = no reconcentration - river site - blank card.

b. MP = Model #2 - ocean site.
Cycle Time = 12 hr. - total cycle.
Recycle Fraction = 0.025 - from MP 1&2 FES.

Card 7

a. Change the standard usage factors CY & MP = 1 factors must be changed.

b. Shorewidth factor -

CY = 0.1 - canal shorewidth factor from reference 1 - using for max individual dose.
MP = 0.5 - ocean site from reference 1.

c. Dilution for aquatic foods -

CY = 1 - From table A-1 of Reg Guide 1.109 - Surface - Low Velocity discharge.
MP = 5 - From table A-1 of Reg Guide 1.109 - Surface - High Velocity discharge.

d. Dilution for shoreline -

CY = 1 - Same as 7c.
MP = 5 - Same as 7c.

e. Dilution for drinking water -

CY = 5 - Arbitrary number since usage factor is zero.
MP = 5 - Arbitrary number since usage factor is zero.

f. Discharge transit time.

CY = 1 hr - From FES canal transit time is 50-100 min.
MP = 1 hr - Estimated quarry transit time from chlorine study.

g. Transit time to drinking water intake.

CY = 5 hr - arbitrary number since usage factor is zero.
MP = 5 hr - arbitrary number since usage factor is zero.

Card 7a - Adult usage factor - max individual

a. Fish consumption - CY & MP = 21 kg/yr - from reference 1.

b. Invertebrate consumption -

CY = 0 - river site.
MP = 5 kg/yr - from reference 1.

c. Algae consumption - CY & MP = 0 - no body eats algae.

d. Water - CY & MP = 0 - no drinking water source for either plant.

e. Shoreline - CY & MP - 12 hr/yr - from reference 1.

f. Swimming - CY & MP - 12 hr/yr - assume the same as shoreline recreation.

g. Boating - CY & MP - 52 hr/yr - from Reg Guide 1.109.

Card 7b Teenager usage factors - max individual (basis are the same as 7a).

a. Fish consumption - CY & MP = 16 kg/yr.

b. Invertebrate consumption - CY = 0
MP = 3.8 kg/yr

c. Algae consumption - CY & MP = 0

d. Water - CY & MP = 0

e. Shoreline - CY & MP = 67 hr/yr

f. Swimming CY & MP - 67 hr/yr

g. Boating CY & MP - 52 hr/yr

Card 7c - Child usage factors - max individual (basis are the same as 7a).

a. Fish consumption - CY & MP = 6.9 kg/yr

b. Invertebrate consumption - CY = 0
MP = 1.7 kg/yr

c. Algae consumption - CY & MP = 0

d. Water - CY & MP = 0

e. Shoreline - CY & MP = 14 hr/yr

f. Swimming - CY & MP = 14 hr/yr

g. Boating - CY & MP = 29 hr/yr

Card 7d - Infant usage factors - max individual.

a. Fish consumption - CY & MP = 0 - infants don't eat fish.

b. Invertebrates consumption - CY & MP = 0 - infants don't eat invertebrates.

c. Algae consumption - CY & MP = 0 - infants don't eat algae.

d. Water - CY & MP = 0 - no drinking water supply.

e. Shoreline - CY & MP = 14 hr/yr - assume same as child.

f. Swimming - CY & MP = 0

g. Boating - CY & MP = 29 hr/yr - assume same as child.

Card 8 - Leave blank unless special calculation is desired.

Card 9 - Sport fish harvest.

a. Fish harvest.

CY - 83,000 kg/yr

Based on pg. 109 - The Connecticut River Ecological Study - Merriman & Thorpe Jan.-Jun. 1973 - 16,000 fish caught in discharge canal. Add 30% for July-Dec. = 16,000 x 1.3 = 20,800 fish.

Assume 4 kg/fish = 83,000 kg/yr.

MP = 1.54 E + 05 kg/yr.

Based on U.S. Dept. of Interior - Commercial Landing Record for New London County 1971-1973. Used 1973 data (highest of 3 years). Commercial fish (excluding menhaden) = 1.54×10^5 kg/yr.

Assume an equal amount of sport fish.

b. Dilution.

CY = 1 - dilution factor for discharge canal.

MP = Based on Section 1.3 of reference 4.

Assume 50% caught - near field dilution = 5
50% caught - far field dilution = 18.6

Average dilution factor = 11.8.

c. Transit Time.

CY = 0.5 hrs. - half way through canal.

MP = 1 hr. = quarry transit time.

Card 10 - Commercial fish harvest.

a. Fish harvest.

CY - 470,000 kg/yr

Based on U.S. Dept. of Interior Commercial Fish Landing Records for 1972 and 1973 @ Middlesex County.

Avg. of 2 years = 470,000 kg/yr.

MP - 1.54 E + 0.5 - See card 9 for basis.

b. Dilution.

CY = 5 - assumed dilution for Conn. River.

MP = 11.8 - See card 9.

c. Transit Time.

CY = 1 hr. - c ᐧ¹ transit time.

MP - 1 hr. - quarry transit time.

Card 11 - Sport Invertebrate harvest.

a. CY - Blank card - no significant invertebrate catch.

b. MP - harvest 8.6×10^4 kg/yr.

Based on U.S. Dept. of Interior Commercial Shellfish catch for New London County for 1973.

Commercial catch = 5.72×10^5 kg/yr.
Assume sport catch = 15% of commercial catch.

Dilution = 11.8 - see card 9.
Transit Time   1 hr.

Card 12 - Commercial Invertebrate Harvest.

a. CY - Blank card - see card 11.

b. MP - Harvest = 5.72×10^5 kg/yr. See card 11.
Dilution = 11.8 - See card 9.
Transit Time = 1 hr.

Card 13 - Population Drinking Water.

CY & MP - Blank card - no drinking water source for either site.

Card 14 - Population Shoreline.

a. Usage (manhours).

CY = 100,000 manhours.

Based on 2 Parks - Gilette Castle State Park and Selden Neck State Park 26 weeks x 1000 persons/wk x 4 hours/person = 104,000 manhours.

Millstone = 1.5×10^6 manhours.

Based on table 1.1.2-5 of reference 4.

b. Dilution.

CY = 5 - Assumed river dilution.

MP = 11.6 - Average dilution factor for 7 beaches - See Table 1.3.2-1 of reference 4.

c. Transit Time-Hrs.

CY = 10 hrs. - assumed river transit time to 2 beaches.

MP = 1 hr. - quarry transit time.

d. Shorewidth factor.

CY = 0.2 - river shorewidth factor.

MP = 0.5 - ocean shorewidth factor.

e. Location Identification

CY & MP - Parks - rather than doing each park separately, this card combines them all and uses average dilution factor.

Card 15 - Population Swimming

a. CY - blank card - no swimming in Connecticut River.

b. MP - Usage - 1.4×10^6 manhours - Table 1.1.2-4 of reference 4.
Dilution = 11.6 - See card 14.
Transit Time = 1 hr. - See card 14.
Location ID = Beaches.

Card 16 - Population Boating

a Usage

CY - 100,000 manhours = from Environmental Statement.

MP - 5.8×10^5 manhours = from Table 1.1.2-3 of reference 4.

b. Dilution

CY = 5 - See card 13.

523 327

MP = 11.8 - See card 9.

c. Transit Time

CY = 10 hrs. - See card 13.

MP = 1 hr. - quarry transit time.

d. Location ID

CY = river
MP = ocean

Cards 17 & 18 - Irrigated Foods

CY & MP - blank card - no irrigation pathway.

Card 19 - Biota

a. Dilution

CY = 5
MP = 11.8

b. Transit time

CY = 1 hr.
MP = 1 hr.

6. The following input cards must be changed routinely for each quarterly run of the program:

Card 1 - Title card - Format - 2X, A78

Enter the plant name, "Liquid Dose Calculation", and the time period of the dose calculation.

Card 2 - Columns 11-20 - Format E10 - Dilution Flow.

Determine the average dilution flow rate (ft 3/sec) for the quarter by:

a. Determine the total dilution volume for the quarter.

This should be the total dilution volume for the entire quarter and not just for the periods of discharge. It should be on the order of 1 x 10" liters.

b. Divide by the number of seconds in the quarter.

c. Convert liters/sec to ft^3/sec by dividing by 28.32.

For CY the normal full power flow is 882 ft^3/sec.

For M1 plus M2 the normal full power flow is 2265 ft^3 /sec.

Card 4 - Source term identification - Format 2X, A78.

Identify the time period of the releases.

Cards 5.1, 5.2 - Source terms - Format 2X, A2, A5, 1X, E10

One card is required for each nuclide.

Enter the nuclides chemical symbol beginning in column 3 -left justified.

Enter the isotopes number beginning in column 5 - left justified.

Enter the number of curies released in scientific notation beginning in column 11 and ending in column 20. Be sure to sum the totals from all continuous and batch release tables.

Examples:

Column No:	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20
			H		3						2	.	6	2			E	+	Ø	3
			I		1	3	1				6	.	9	9			E	-	Ø	4
			C	0	6	Ø					1	.	8	Ø			E	-	Ø	2

There is no need to enter the dissolved noble gases as they will not be included in the calculation. The last nuclide is followed by a blank card.

7. Save the old cards for approximately 1 year in case doses must be recalculated.

8. Submit the cards in order to run the program on the IBM-370.

G. ACCEPTANCE CRITERIA

None.

H. CHECKLISTS

None.

I. DEFINITIONS

LADTAP = Liquid Annual Doses to all Persons.

J. RESPONSIBILITY

Environmental Programs Branch.

523 329

APPENDIX D

DERIVATION OF FACTORS FOR SECTION D.1

1. Section a. - X/Q Value

CY - Annual Average X/Q's

Downwind Sector	Site Boundary (Meters)	Annual Avg X/Q's - @ Site Boundary 1976	1977	Average	
SSW	120	0.129(-6)	0.215(-6)	0.172(-6)	
SW	120	0.612(-6)	0.434(-6)	0.523(-6)	
WSW	130	0.167(-5)	0.497(-5)	0.332(-5)	
W	170	0.104(-5)	0.130(-5)	0.117(-5)	
WNW	310	0.101(-5)	0.102(-5)	0.102(-5)	
NW	550	0.563(-5)	0.561(-5)	0.562(-5)	
NNW	510	0.129(-4)	0.134(-4)	0.132(-4)	Maximum
N	630	0.103(-4)	0.753(-5)	0.852(-5)	
NNE	690	0.947(-5)	0.730(-5)	0.839(-5)	
NE	710	0.653(-5)	0.547(-5)	0.600(-5)	
ENE	1240	0.169(-5)	0.142(-5)	0.156(-5)	
E	1510	0.171(-5)	0.164(-5)	0.168(-5)	
ESE	1370	0.107(-5)	0.102(-5)	0.105(-5)	
SE	340	0.235(-5)	0.293(-5)	0.264(-5)	
SSE	230	0.646(-6)	0.166(-5)	0.126(-5)	
S	150	0.262(-6)	0.678(-6)	0.470(-6)	

2. Section a - Justification for Method Used to Determine $\bar{K}$ & $\bar{S}$

There are many different sources contributing to the releases from the ventilation stack. These include releases from the building ventilation, condenser air ejector, containment purges, flashed gases which occur while obtaining primary coolant samples, and discharges from the waste gas tanks. These sources may exist in any possible combination and each has its own particular, but changing, nuclide mixture. Thus, the ratio of nuclides being released is a constantly changing parameter.

It is impractical to change the value of $\bar{K}(\bar{S})$ and thus the release rate limit and monitor set-points each time a source stream is initiated or terminated or an isotopic analysis is performed on any of the source streams. Instead, we can choose a conservative value for $\bar{K}(\bar{S})$ such that whatever combination of source streams exists, the actual value of $\bar{S}$ or $\bar{K}$ will be less than that assumed.

Table 2 indicates that the highest values of $K_i(S_i)$ occur for the shorter half-life noble gases. Therefore, the highest value of $\bar{K}(\bar{S})$ would be obtained with a sample having the least amount of decay. Thus, if we determine $\bar{K}(\bar{S})$ using the gas mixture in the primary coolant we will be conservative because the mixture from any other source will be decayed from this value.

3. Section b. - X/Q and D/Q Values

CY - Annual Average X/Q's & D/Q's

Downwind Sector	Land Boundary (Meters)	Annual Avg. X/Q's 1976	Annual Avg. X/Q's 1977	Annual Avg. X/Q's Avg.	Annual Avg. D/Q's 1976	Annual Avg. D/Q's 1977	Annual Avg. D/Q's Avg.
SSW	700	0.126(-6)	0.211(-6)	0.169(-6)	0.130(-8)	0.266(-8)	0.198(-8)
SW	580	0.349(-6)	0.336(-6)	0.343(-6)	0.416(-8)	0.357(-8)	0.387(-8)
WSW	580	0.276(-6)	0.663(-6)	0.470(-6)	0.128(-7)	0.298(-7)	0.213(-7)
W	620	0.173(-6)	0.251(-6)	0.212(-6)	0.110(-7)	0.127(-7)	0.119(-7)
WNW	550	0.481(-6)	0.475(-6)	0.478(-6)	0.278(-7)	0.250(-7)	0.264(-7)
NW	550	0.536(-5)	0.561(-5)	0.562(-5)	0.549(-7)	0.592(-7)	0.571(-7)
NNW	510	0.129(-4)	0.134(-4)	0.132(-4)	0.388(-7)	0.381(-7)	0.385(-7)
N	630	0.103(-4)	0.753(-5)	0.892(-5)	0.430(-7)	0.284(-7)	0.357(-7)
NNE	690	0.947(-5)	0.730(-5)	0.839(-5)	0.581(-7)	0.373(-7)	0.477(-7)
NE	710	0.653(-5)	0.547(-5)	0.600(-5)	0.327(-7)	0.279(-7)	0.303(-7)
ENE	1240	0.169(-5)	0.142(-5)	0.156(-5)	0.118(-7)	0.105(-7)	0.112(-7)
E	1970	0.133(-5)	0.126(-5)	0.130(-5)	0.103(-7)	0.934(-8)	0.982(-8)
ESE	1970	0.879(-6)	0.869(-6)	0.874(-6)	0.194(-7)	0.177(-7)	0.186(-7)
SE	1300	0.361(-5)	0.404(-5)	0.383(-5)	0.183(-7)	0.208(-7)	0.196(-7)
SSE	890	0.401(-6)	0.606(-6)	0.504(-6)	0.858(-8)	0.128(-7)	0.107(-7)
S	740	0.111(-6)	0.125(-6)	0.118(-6)	0.359(-8)	0.510(-8)	0.435(-8)

4. Section b - Determination of Release Rate Limits - Method 1

From above:

Maximum X/Q for inhalation pathway = 1.32×10^{-5} sec/m^3

Maximum D/Q for food pathway = 5.71×10^{-8} M^{-2}

For iodine-131 releases - dose parameters from NRC proposed (May 1978) tech spec - Table 4.11-4.

P_{I-131} (inhalation) = 1.5×10^7 mrem/yr per μCi/M^3

P_{I-131} (food & ground) = 1.1×10^{12} m^2 mrem/yr per μCi/sec

∴ maximum organ dose rate from I-131

$$= [1.32 \times 10^{-5} \times 1.5 \times 10^7 + 5.71 \times 10^{-8} \times 1.1 \times 10^{12}]\ Q_{I131} < 1500 \text{ mrem/yr}$$

$$Q_{I-131}\ (\mu\text{Ci/sec}) < \frac{1500}{6.3 \times 10^4}$$

$$Q_{I-131}\ (\mu\text{Ci/sec}) < 2.4 \times 10^{-2}$$

Assume 1/3 of allowable dose due to I-131

523 331

$$\therefore \text{limit for I-131} < \frac{2.4 \times 10\text{-}2}{3} = \boxed{8.0 \times 10^{-3}}\ \mu\text{Ci/sec}$$

For particulates with half lives greater than 8 days

Sr-90 has the most restrictive dose parameter of all particulates in Table 4.11-4. Therefore, assume all releases are Sr-90.

P_{Sr-90} (inhalation) = 4.1×10^7 mrem/yr per μCi/M^3

P_{Sr-90} (food & ground) = 9.5×10^{10} m^2 mrem/yr per μCi/sec

$\therefore$ maximum organ dose rate

$= [1.32 \times 10^{-5} \times 4.1 \times 10^7 + 5.71 \times 10^{-8} \times 9.5 \times 10^{10}]\ Q_{particulate} < 1500$ mrem/yr

$Q_{particulates}$ (μCi/sec) $< 2.5 \times 10^{-1}$

Assume 1/3 of allowable dose due to particulates

$\therefore$ limit for particulates < 8.3×10^{-2} μCi/sec

For tritium

Food pathway is based on X/Q and not D/Q

P_{H-3} (inhalation) = 6.5×10^2 mrem/yr per μCi/M^3

P_{H-3} (food & ground) = 2.4×10^3 mrem/yr per μCi/M^3

$\therefore$ maximum organ dose rate

$= 1.32 \times 10^{-5}\ (6.5 \times 10^2 + 2.4 \times 10^3)\ Q_{H-3} < 1500$ mrem/yr

Q_{H3} (μCi/sec) $< 3.7 \times 10^4$

Assume 1/3 of allowable dose rate due to H-3

$\therefore$ limit for tritium < 1.2×10^4 μCi/sec)

5. Section b - Determination of Release Rate Limit - Methods 2 & 3

Method 2 still uses the super organ technique in that the dose factors given in Table 3 are for the critical organ for that particular nuclide, yet they are all summed together as if they were all the same organ.

Method 3, by use of the GASPAR code, eliminates some of this conservatism by calculating the dose to each organ using the dose factor for that particular organ for each nuclide, then the critical organ can be determined.

APPENDIX E

GASEOUS DOSE CALCULATIONS - GASPAR

The GASPAR code was written by the NRC to compute doses from gaseous releases using the models given in Regulatory Guide 1.109. The revision date of the code which was purchased is February 20, 1976. The only changes made to the code were to change the dose factors and inhalation rates from those given in Rev. 0 of Regulatory Guide 1.109 to those in Rev. 1.

For calculating the maximum individual dose at Connecticut Yankee, the following options and parameters are used:

1. Real time meteorology using a X/Q, D/Q model which incorporates the methodology of Regulatory Guide 1.111 - see Appendix G. Meteorology is determined separately for continuous releases and batch releases.
2. 100% of vegetation grown locally, 76% of vegetation intake from garden.
3. Animals on pasture April through September - 100% pasture intake.
4. Air water concentration equals 8 g/m^3.
5. Maximum individual dose calculations are performed at the nearest land site boundary with maximum delayed X/Q, at the nearest vegetable garden (assumed to be nearest residence) with the maximum depleted X/Q, and at the cow and goat farms with maximum D/Q's.

The following pages of Appendix E present the in-house procedure written for running this code. It is written for running the quarterly dose calculations but can easily be used to perform monthly calculations.

APPENDIX E

GASEOUS DOSE CALCULATIONS - GASPAR

A. PURPOSE

This procedure is used to implement the NRC computer code GASPAR in order to calculate the maximum individual and population doses due to radionuclides released in gaseous effluents. The code implements the semi-infinite cloud model and the dose calculation models of Reg Guide 1.109 and is used to calculate the following:

1. All maximum individual and population doses from Connecticut Yankee.
2. All maximum individual and population doses from Millstone Unit 2.
3. Population doses from Millstone Unit 1.
4. Maximum individual organ doses from Millstone Unit 1.

The maximum individual whole body and skin doses due to elevated releases from Millstone 1 should be calculated using the finite cloud model as performed by the EPA code AIREM.

A more detailed description of the GASPAR code can be found in reference 1.

B. REFERENCES

1. GASPAR dose code manuals - dated 10/17/75 and 2/20/76.
2. U.S. NRC Regulatory Guide 1.109.
3. U.S. NRC Regulatory Guide 1.111.

C. PREREQUISITES

1. The plant must supply the total number of Curies released for each radionuclide during the time period involved.
2. The meteorological programs must be run to generate the required input cards for X/Q, decayed X/Q, depleted X/Q and D/Q.

D. PRECAUTIONS

None.

E. LIMITATIONS AND ACTIONS

None.

F. PROCEDURE

1. Review the plant curie release tables for accuracy and completeness. If the strontium results are not yet available, but the calculations must be performed in order to meet the semi-annual effluent report schedule, the code may be run without the strontium values and the doses due to strontium ratioed by hand by comparison with the previous quarters results.

2. Obtain the computer deck for the GASPAR code for the nuclear site involved.

3. The deck should be in the following order:

```
// 082), 'CRANDALL', MSGLEVEL=1, CLASS=B
// STEP 1 EXEC PGM=PFGASPAR
// FT06F001 DD SYSOUT=A
// FT05F001 DD *
```

| Adult, teenager, child and infant dose factor cards. |

Blank Card.

| Input cards as discussed below. |

3 blank cards
/ *

4. Due to different meteorology calculations, the code must be run separately for each of the following cases:

   a. CY - continuous, semi-elevated releases - ventilation.

   b. CY - batch mode, semi-elevated releases - waste gas tanks.

   c. M1 - continuous, elevated releases - ventilation and off gas.

   d. M2 - continuous, semi-elevated releases - ventilation.

   e. M2 - batch mode, semi-elevated releases - containment purges.

   f. M2 - batch mode, elevated releases - waste gas tanks and some containment purges.

   The resulting doses must then be summed by hand for each unit.

5. The input cards are as follows. Those parameters which must be changed each quarter are enclosed in blocks / 7.

   a. [CARD 1] - Title card - Format - 2X, 78A1

   Millstone Unit One - Gaseous [Identify Release Type] 523 335
   [1st] Quarter [1976.]

b. CARD 2 - Job control card - Format 10I2.

Column 2=0 - will calculate population doses and maximum individual.
Column 4=1 - number of source terms - done for each unit separately.
Column 6=1 - arbitrary if number in column 4 is 1.

c. CARD 3 - Site parameters - Format 10E8.0 - Same for CY and Millstone.

Columns 1-5=500.0 - distance from site to NE corner of U.S.
Columns 14-16=1.0 - fraction of fresh leafy vegetation grown locally.
Columns 22-24=1.0 - fraction of year milk animals on pasture.
Columns 29-32=0.76 - fraction of veg. intake grown in garden - from Reg Guide 1.109.
Columns 38-40=1.0 - fraction of animals intake from pasture when on pasture.
Columns 46-48=8.0 - air water concentration (g/m^3).

Note: Do not add in milk or vegetation results during 1st or 4th quarter.

d. CARD 4 - Population title card - Format = 2X, 78A1.

Population Data

e. CARD 4.1 - Population data format - Format = 3I5.

Column 5=0 - Population data starts in north sector.
Column 10=5 - Number of radial locations for which data is supplied on first card.
Columns 14&15=10 - Total number of radial locations.

f. CARDS 4.2---4.33

32 cards of population data - based on 1980 population estimates from Conn. Yankee and Millstone Environmental Reports.

g. CARD 5 - Milk data title card - Format = 2X, 78A1.

Milk data - NRC Memo - 10-15-75 - State of CT.

h. CARD 5.1 - Milk data format.

Columns 9&10 = 16 - Dummy number since using default values.

i. CARD 5.2 - Milk data.

Columns 3-10=4.4E + 08 - 50 mile milk usage from reference 1.

j. CARDS 6-6.2 - Same as 5-5.2 except for meat instead of milk usage factor = 2.0E+07.

k. CARDS 7-7.2 - Same as 5-5.2 except for vegetation instead of milk usage factor = 3.2E+07.

l. CARD 8 - Source term title card - Format - 2X, 78A1.

Source Terms - 1ST QUARTER 1976.

m. CARD 8.1 - Source description - Format = (E10, 2(9X,I1)).

Columns 8-10 = 1.0 - release point multiplier
Column 20 = 0 - see reference 1.
Column 30 = 0 - see reference 1.

n. CARDS 8.2 - 8.X - Source data - Format = 2X, A2, 5A1, 1X, E10.0.

Enter total curies released for each nuclide for the particular release mode as listed in step 4 of this procedure.

One card per nuclide. Isotope chemical symbol and atomic number and curies released are all left justified.

The following are examples of the input format:

Column No.:	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20
			I		1	3	1				Ø	.	5	7	9					
			H		3						3	.	7	1						
			K	R	8	5	M				7	1	2	Ø	.	Ø				
			K	R	8	7					1	9	Ø	Ø	Ø	.	Ø			
			C	O	6	Ø					Ø	.	Ø	Ø	Ø	8	9			

o. CARD 8.n - blank card following source data.

p. CARD 9 - X/Q title card.

q. CARD 9.1 - X/Q format - Format = 3I5.

Column 5=0 - Data starts with north as the downwind sector (south wind).
Column 10=5 - There are 5 X/Q values on the first card for each sector.
Column 14&15=10 - There are a total of 10 X/Q values for each sector.

NOTE WELL There are two possible computer codes used to generate the X/Q cards - one was written by the NRC (XOQDOQ) and one by NUSCO (PFAADRG). The NRC code punches cards such that they start with the south downwind sector and have 7 values on the first card and 3 on the second.

Changing 0 to 1 in column five will designate that south is the first sector, and changing 5 to 7 in column ten will indicate that there are 7 values on the first card, also change cards 10.1, 11.1 and 12.1. The NUSCO code should start with the north downwind sector and have five values per card.

r. CARDS 9.2 to 9.33 - X/Q Data - Format - Alternate (5X, 7E10.0) and (8E10.0) insert the 32 X/Q cards as generated by the meteorological program. Be certain the sectors are in the proper order as required by card 9.1.

s. CARD 10 - Decayed X/Q title card.

t. CARD 10.1 - Same as 9.1 except for decayed X/Q's.

u. CARDS 10.2 to 10.33 - Same as 9.2 to 9.33 expect for decayed X/Q's.

v. CARD 11 - Depleted X/Q title card.

w. CARD 11.1 - Same as 9.1 except for depleted X/Q's.

x. CARDS 11.2 to 11.33 - Same as 9.2 to 9.33 except for depleted X/Q's.

y. CARD 12 - D/Q title card.

z. CARD 12.1 - Same as 9.1 except for D/Q.

aa. CARDS 12.2 to 12.33 - Same as 9.2 to 9.33 except for D/Q.

bb. CARDS 13.1 to 13.n - Special locations for Maximum Individual.

These cards are submitted to calculate whole body and organ doses to the maximum individual. One card is required for each location at which these doses are to be calculated. A maximum of 5 is all that can be done.

The meteorological program outputs the X/Q, decayed X/Q, depleted X/Q, and D/Q for the site boundary, nearest land, nearest residence and vegetable garden, goat farms and cow farms in each sector.

The following locations should be entered:

1) The nearest land with highest decayed X/Q.

2) The nearest residence with highest depleted X/Q.

3) The goat farm with highest D/Q - 2nd & 3rd quarters only.

4) The cow farm with highest D/Q - 2nd & 3rd quarters only.

The GASPAR program will calculate the whole body and organ doses for each pathway at each location. There is no way to control this with the input, but rather the final results will have to be selectively analyzed. For example, for the nearest residence location, one should only sum the dose due to the plume, ground deposition, inhalation and vegetation pathways and not from the cow's milk, goat's milk, and meat pathways.

NOTE 1: For elevated releases from the Millstone 1 stack, the nearest land boundary and nearest residence may not be the location of highest X/Q's. Therefore the meteorological output table of X/Q's from 0-50 miles must be used and interpolated to determine these locations.

NOTE 2: For CY and M2 which have more than one type of release (batch, continuous, semi-elevated), the locations of highest X/Q's or D/Q's for one type of release may not be the same as the locations for a different type of release.

In that case, the location of highest X/Q or D/Q for one type of release should also be entered for the other releases along with their highest locations, such that the total sum from all releases may determined at each location to determine the location of maximum dose. However, a maximum of 5 locations can be done. Thus, to prevent using the program more than once, some pre-judgement might be necessary.

The format for the Special Location cards is as follows:

Column 2= 1 - Eliminates pages of printout of nuclide breakdown for each pathway and age group.

Columns 3-18 - Location name - Example - Nearest Land.

Columns 19-22 - Compass direction - Example - ENE

Columns 23-29 - Distance in miles - Example - 1.9.

Columns 30-39 - X/Q for that location - right justified - Example 0.273 E-07.

Columns 40-49 - Same as 30-39 except for decayed X/Q.

Columns 50-59 - Same as 30-39 except for depleted X/Q.

Columns 60-69 - Same as 30-39 except for D/Q.

Columns 70, 71, 72, 73, 74, 75 and 76 - 0 in each column - controls printout.

Last special location card is followed by 3 blank cards.

6. Save the old cards f[illegible] approximately 1 year in case doses must be recalculated.

7. Submit the cards in order to run the program on the IBM-370.

G. ACCEPTANCE CRITERIA

None.

H CHECKLISTS

None.

I. DEFINITIONS

None.

J. RESPONSIBILITY

Environmental Programs Branch.

APPENDIX F

DERIVATION OF FACTORS FOR SECTIONS D.2 & D.3

1. Section D.2.a(1)

CY - Noble Gas Air Doses

Year	Qtr.	Curies Noble Gas	(mrad)* Gamma Air Dose	(mrad)* Beta Air Dose	Gamma mrad per Curie	Beta mrad per Curie
1976	1	128	0.0048	0.0249	3.8(-5)	1.9(-4)
	2	160	0.034	0.098	2.1(-4)	6.1(-4)
	3	112	0.026	0.161	2.3(-4)	1.4(-3)
	4	92	0.030	0.147	3.3(-4)	1.6(-3)
1977	1	248	0.112	0.349	4.5(-4)	1.4(-3)
	2	260	0.015	0.050	5.8(-5)	1.9(-4)
	3	443	0.117	0.490	2.6(-4)	1.1(-3)
	4	2170	0.272	0.892	1.3(-4)	4.1(-4)
1978	1	599	0.041	0.150	6.8(-5)	2.5(-4)
	2	592	0.045	0.147	7.6(-5)	2.5(-4)
				Avg. =	1.9(-4)	7.4(-4)

*Calculated maximum air dose (mrad) due to noble gases calculated using NRC computer code GASPAR.

Since the beta dose is always more than 2 times the gamma dose it should always be controlling.

Avg. value of gamma air dose per curie = 1.9×10^{-4} mrad/Ci

Max. value of gamma air dose per curie = $\boxed{4.5 \times 10^{-4}}$

Ratio Max./Avg. = 2.4

Avg. value of beta air dose per curie = 7.4×10^{-4} mrad/Ci

Max. value of beta air dose per curie = $\boxed{1.6 \times 10^{-3}}$

Ratio max./avg. = 2.2

Therefore, use of maximum observed values should only be a factor of two conservative on the average.

2. Section D.2(a)(2)

   a. Justification for the use of only annual average X/Q's for both continuous and batch releases:

523 341

Number of hours during which batch releases were in progress during the period 1/1/77 - 9/30/78 between the hours of:

Time	# Hours	Time	# Hours
0000-0100	20	1200-1300	20
0100-0200	19	1300-1400	19
0200-0300	21	1400-1500	20
0300-0400	20	1500-1600	22
0400-0500	20	1600-1700	24
0500-0600	20	1700-1800	25
0600-0700	21	1800-1900	27
0700-0800	21	1900-2000	25
0800-0900	21	2000-2100	25
0900-1000	23	2100-2200	24
1000-1100	22	2200-2300	25
1100-1200	22	2300-2400	23

Avg. = 22 Hours Range 19-27

The above table is a compilation of 28 batches with durations ranging from 0 to 65 hours.

The table shows that the time period for batch releases is random when compared with time of day and thus the avg. X/Q and D/Q for batch releases should be approximately equal to the annual average X/Q's and D/Q's.

b. Derivation of factors for D.2.(a)(2) - Method 2

(1) Step 4

Quarterly Average X/G's - Critical Site Boundary

1st Qtr. 1976 - 1.45×10^{-5} Sec./M^3
2nd Qtr. 1976 - 1.94×10^{-5} Sec./M^3
3rd Qtr. 1976 - 3.2×10^{-5} Sec./M^3
4th Qtr. 1976 - 3.0×10^{-5} Sec./M^3
1st Qtr. 1977 - 5.3×10^{-5} Sec./M^3
2nd Qtr. 1977 - 7.2×10^{-6} Sec./M^3
3rd Qtr. 1977 - 2.4×10^{-5} Sec./M^3
4th Qtr. 1977 - 1.1×10^{-5} Sec./M^3
1st Qtr. 1978 - 5.5×10^{-6} Sec./M^3
2nd Qtr. 1978 - 1.4×10^{-5} Sec./M^3
3rd Qtr. 1978 - 2.0×10^{-5} Sec./M^3
4th Qtr. 1978 - 8.5×10^{-6} Sec./M^3

∴ Maximum quarterly average X/Q observed in three years = 5.3×10^{-5}

D_{QAGi} = Quarterly gamma air dose due to nuclide i

$$= C_i \text{ (Ci)} \times M_i \left(\frac{\text{mrad}}{\text{yr}} \cdot \frac{m^3}{\text{Ci}}\right) \times 5.3 \times 10^{-5} \text{ sec/m}^3 \times$$

$$10^6 \text{ uCi/Ci} \times 3.17 \times 10^{-8} \text{ (yr/sec)}$$

(As indicated above, the same X/Q can be used for both batch and continuous releases due to the random nature of batch releases.

$D_{QAGi} = 1.7 \times 10\text{-}6 \; M_i \; C_i$

$D_{QAG} = \sum$ over all nuclides = $\boxed{1.7 \times 10^{-6}} * \sum_i M_i \; C_i$

(2) Step 5

Likewise for the beta air dose, all factors are the same except the dose conversion factor M_i should be replaced by N_i.

$D_{QAB} = \boxed{1.7 \times 10^{-6}} * \sum_i N_i \; C_i$

3. Derivation of Factors for Section D.3.a(1)

From Appendix D:

Maximum X/Q for inhalation pathway = 1.32×10^{-5} sec/M^3

Maximum D/Q for food pathway = 5.71×10^{-8} M^{-2}

From NRC proposed tech spec (May 1978) - dose parameters are:

For I-131 - inhalation - 1.5×10^7 mrem/yr per μCi/M^3
For I-131 - food 1.1×10^{12} m^2 mrem/yr per μCi/sec
For H-3 - inhalation - 6.5×10^2 mrem/yr per μCi/M^3
For H-3 - food - 2.4×10^3 mrem/yr per μCi/M^3

For particulates the most critical nuclide is Sr-90
Assume all particulates are Sr-90.

For Sr-90 - inhalation - 4.1×10^7 mrem/yr per μCi/M^3
For Sr-90 - food - 9.5×10^{10} m^2 mrem/yr per μCi/se[illegible]

Iodine and tritium are the only two nuclides which woul[illegible]ate to the thyroid dose. If another nuclide could add a sig[illegible]cant percent to the dose, some other organ will be critical. Iodine will not add to the other organs. If it could add a significant percent, the thyroid will be the critical organ.

The use of these dose factors gives an annual dose assuming an average Ci/sec release rate. Since these dose calculations are for a period less than a year, a correction factor equal to the fraction of the year must be applied.

Therefore, thyroid dose =

$$N/52\ [1.32 \times 10^{-5} \times 1.5 \times 10^{7} + 5.71 \times 10^{-8} \times 1.1 \times 10^{12}]\ Q_{1-131}$$

$$+\ N/52\ [(1.32 \times 10^{-5})(6.5 \times 10^{2} + 2.4 \times 10^{3})]\ Q_{H-3}$$

$$=\ N/52\ [6.3 \times 10^{4}\ Q_{I-131} + 4.0 \times 10^{-2}\ Q_{H-3}]$$

Maximum org n dose =

$$N/52\ (1.32 \times 10^{-5})(6.5 \times 10^{2} + 2.4 \times 10^{3})\ Q_{H-3}$$

$$+\ N/52\ [1.32 \times 10^{-5} \times 4.1 \times 10^{7} + 5.71 \times 10^{-8} \times 9.5 \times 10^{10}]\ Q$$

$$=\ N/52\ [4.0 \times 10^{-2}\ Q_{H-3} + 6.0 \times 10^{3}\ Q_{p}]$$

APPENDIX G

METEOROLOGICAL CALCULATIONS

Values of X/Q and D/Q are calculated using an in-house computer code (PFAADRG), developed in accordance with the requirements of Regulatory Guide 1.111. The program uses quarter-hourly meteorological data determined during the actual periods of release.

The following lists the methodology, assumptions and input parameters used in this code:

1. Basic formula for elevated release:

$$X/Q = (RECIRC)(RDECAY)(DRYDEP)(WETDEP)\ \frac{2.032}{\sigma_z \bar{u} x} \left\{ \exp \left[-1/2 \frac{(he)^2}{(\sigma_z)^2} \right] \right\} \quad (1)$$

Where

RECIR = An input matrix of correction factors for recirculation of plume, given in attached Table G.1.

RDECAY = A radioactive decay factor computed from travel time from source to receptor (SEC) derived from $X/\bar{u}$ and an input half-life (HLIFE) (SEC) via the expression:

$$RDECAY = EXP \left\{ -0.693 \frac{x}{\bar{u}} \Big/ (HLIFE) \right\}$$

Half life is set at 2.26 days to calculate X/Q decayed. Half life is set at 8 days to calculate X/Q depleted and D/Q.

DRYDEP = A dry deposition factor to account for depletion of a portion of plume due to contact with surface; factor is a function of stability class (based on delta-T) distance X(M) to receptor, and physical stack height h_s (M). The functions are given in Figures 3-6 of Regulatory Guide 1.111. Curvefit functions are calculated using the DEPLET subroutine taken from the NRC XOQDOQ code, revised November 8, 1976.

WETDEP = A wet deposition factor to account for depletion of a portion of plume due to washout of nuclides by rain. This has not been developed at this time, so WETDEP is set to 1.0.

$h_e = h_s + h_{pr} - h_t - c$ (if $h_e < 0$, SET = 0.0)

h_s = stack height = 53.3 meters

$$h_{pr} = 3 \frac{Vs}{\bar{u}} d$$

523 345

V_s = Stack exit velocity = .3.4 m/sec

d = Stack diameter = 1.52 m

$\bar{u}$ = Avg. wind speed = m/sec

h_t = Terrain height (m) from terrn input matrix, given in Table G-2. If any H_t in terrn input is <0, it is set equal to 0. The maximum height between the source and receptor is used.

C = Downwash correction factor = $3\left(1.5 - \frac{V_s}{\bar{u}}\right) d$

Applied only when $V_s < 1.5\ \bar{u}$, otherwise set equal to 0.

2. Basic formula for a ground release:

$$X/Q = (RECIRC)(RDECAY)(DRYDEP)(WETDEP) \frac{2.032}{\Sigma_z \bar{u} x} \quad (2)$$

Where

Σ_z = A vertical dispersion coefficient corrected for building wake:

$= \left(\sigma_z^{\ 2} + 0.5 \frac{D^2}{\pi}\right)^{1/2}$

σ_z is calculated at distance x, D is height of building = 51.8 m.

Σ_z - Limited to $\leq$ 1.73 σ_z

3. Mixed Releases

Releases from the CY stack may occur in the elevated, ground level or mixed mode. In the mixed mode a weighted combination of the elevated and ground release formulas must be used. This weighting depends on the ratio of the stack exit velocity (V_s) to the wind speed ($\bar{u}$) and is determined as follows:

For $V_s/\bar{u} \geq 5.0$ - use elevated formula (1).

For $V_s/\bar{u} < 1.0$ - use ground formula (2).

For $1.0 \leq V_s/\bar{u} < 5.0$ use a weighted combination as follows:

$$X/Q = [(1-E_t) \times (1)] + [E_t \times (2)] \quad (3)$$

Where,

E_t = Weighted coefficient derived from

$E_t = 2.58 - 1.58\ (V_s/\bar{u})$ for $1.0 \leq V_s/\bar{u} \leq 1.5$

$E_x = 0.3 - 0.06\ (V_s/\bar{u})$ for $1.5 < V_s/\bar{u} < 5$

523 346

4. Relative Deposition (D/Q)

In order to determine the relative deposition (L in M^{-2}) at each receptor poi.t, the following methodolo. is used:

a. 3 mat ices of downwind sector versus stability class are dete mined. One matrix is for elevated releases (i.e., where equation (1) was used), one for ground releases (i.e., where equ tion (2) was used), and one for mixed releases (i.e. whe e equation (3) was used). The matrix elements are the num er of hours associated with a particular combination of dow wind sector, stability class, and release mode.

b. RDRATE = relative deposition rate is determined a each receptor point. This factor is a function of release mode, stability, stack height and downwind distance. The functions are given in Figures 7-10 of Regulatory Guide 1.111. The program calculates this function using the DEPOST subroutine taken from the NRC XOQDOQ code, revised November 8, 1976. For mixed mode releases the ground level curve is used.

c. D/Q = relative deposition is determined as follows:

$$D/Q = \sum_i \frac{\text{RDRATE x matrix element i}}{\text{0.3927 D x total hours}}$$

Where D = downwind distance in meters

Total hours = Total number of hours IN ALL MATRICES
= number of valid data in sample

5. Other Notes

a. For case where wind speed = calm, the wind speed is set at the threshold value = 0.5 m/sec.

b. Wind speed at 196' is used to determine if elevated, ground or mixed release. For elevated formula, 196' wind speed is used. For ground formula, 33' wind speed is used.

523 347

CONN YANKEE NUCLEAR POWER STATION / UNIT I

RECIRCULATION RATE

	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	20000	30000	40000	50000	60000	70000	80000
NNE	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
NE	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
ENE	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	[illegible]	1.0000	1.0000
E	4.0000	3.2000	2.1000	[illegible]	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	[illegible]	1.0000	1.0000
ESE	4.0000	3.2000	2.1000	1.6000	[illegible]	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SE	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SSE	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
S	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SSW	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SW	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
WSW	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
W	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
WNW	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
NW	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
NNW	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
N	4.0000	3.2000	2.1000	1.6000	1.4000	1.3000	1.2500	1.1800	1.1500	1.1200	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table G.2

CONN YANKEE NUCLEAR POWER STATION / UNIT 1

TERRAIN HEIGHT (FT)

	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	20000	30000	40000	50000	60000	70000	80000
NNE	310.	310.	230.	345.	420.	410.	460.	390.	440.	440.	600.	688.	914.	800.	927.	1200.	1200.
NE	250.	280.	290.	340.	360.	440.	460.	540.	540.	575.	500.	680.	600.	700.	745.	805.	792.
ENE	240.	191.	220.	250.	360.	430.	480.	480.	530.	510.	609.	523.	500.	552.	600.	739.	700.
E	250.	170.	190.	360.	460.	477.	490.	600.	560.	530.	500.	591.	323.	541.	500.	433.	535.
ESE	0.	-10.	250.	346.	340.	347.	530.	600.	580.	540.	432.	265.	280.	195.	180.	80.	0.
SE	0.	200.	280.	200.	290.	330.	320.	330	280.	250.	300.	300.	-20.	81.	80.	80.	-20.
SSE	70.	310.	338.	320.	310.	380.	420.	420.	340.	290.	280.	200.	-20.	86.	247.	247.	-20.
S	50.	314.	490.	540.	550.	561.	477.	480.	480.	470.	395.	100.	-20.	30.	30.	30.	45.
SSW	120.	340.	490.	510.	440.	460.	500.	540.	560.	530.	300.	200.	-20.	-20.	209.	214.	275.
SW	140.	340.	280.	350.	460.	560.	640.	640.	630.	580.	500.	200.	300.	100.	100.	70.	200.
WSW	70.	230.	300.	[illegible]	460.	600.	630.	630.	650.	610.	700.	700.	639.	600.	600.	600.	762.
W	0.	130.	310.	500.	588.	560.	590.	540.	670.	710.	700.	600.	800.	761.	753.	903.	1041.
WNW	0.	40.	250.	380.	390.	273.	310.	450.	640.	628.	500.	900.	1004.	1020.	1100.	1154.	1663.
NW	160.	110.	250.	310.	320.	440.	400.	450.	540.	570.	[illegible]	200.	700.	990.	1171.	1204.	1656.
NNW	280.	400.	400.	450.	454.	470.	540.	540.	568.	450.	800.	600.	200.	900.	600.	1100.	1300.
N	300.	370.	370.	370.	340.	473.	550.	550.	556.	570.	896.	861.	800.	733.	1073.	1100.	907.