

10/27/78

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION



BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)
) Docket 50-344
PORTLAND GENERAL ELECTRIC COMPANY,)
et al) (Control Building Proceeding)
)
(Trojan Nuclear Plant))

CERTIFICATE OF SERVICE

I hereby certify that on October 27, 1978:

- 1) Licensee's letter to Director of Nuclear Reactor Regulation dated October 27, 1978 and attachment, "Further Response to NRC Staff Technical Questions of October 16, 1978".
- 2) Licensee's Responses to Columbia Environmental Council Interrogatories to Licensee dated October 16, 1978.
- 3) Licensee's Supplemental Responses dated October 27, 1978 to Consolidated Intervenors' Interrogatories received August 14, 1978.
- 4) Licensee's Supplemental Responses dated October 27, 1978 to Stephen M. Willingham's Interrogatories to the Applicant dated August 11, 1978.
- 5) Licensee's Supplemental Responses dated October 27, 1978 to CSFP Interrogatories to Applicant Portland General Electric dated September 6, 1978.
- 6) Affidavits of John L. Frewing, S. R. Christensen, Bart D. Withers, Ronald W. Johnson, Lief W. Erickson and Richard C. Anderson.

have been served upon the persons listed below by delivery to a messenger for service or by depositing copies thereof in the United States mail with proper postage affixed for first class mail.

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U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

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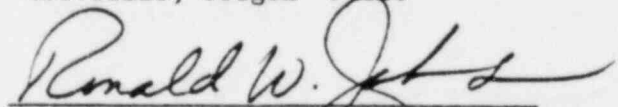
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Dated: October 27, 1978

APPENDIX CLIQUID DOSE CALCULATIONS - LADTAPA. 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.
5. 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.

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
//FT06F001 DD SYSOUT = A
//FT05F001 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 = 1.54×10^5 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. - canal transit time.

MP - 1 hr. - quarry transit time.

Card 11 - Sport Invertebrate harvest.

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

b. MP - harvest 3.6×10^4 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 - Gillette 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.

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 (ft³/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 1×10^8 liters.

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

- c. Convert liters/sec to ft³/sec by dividing by 28.32.

For CY the normal full power flow is 882 ft³/sec.

For M1 plus M2 the normal full power flow is 2265 ft³ /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.

7. 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	0	1	2	3	4	5	6	7	8	9	0
			H		3						2	.	6	2			E	+	0	3
			I		1	3	1				6	.	9	9			E	-	0	4
			C	0	6	0					1	.	8	0			E	-	0	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.

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)	0.892(-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	0.846(-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 ValuesCY - Annual Average X/Q's & D/Q's

Downwind Sector	Land Boundary (Meters)	Annual Avg. X/Q's			Annual Avg. D/Q's		
		1976	1977	Avg.	1976	1977	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:

$$\text{Maximum X/Q for inhalation pathway} = 1.32 \times 10^{-5} \text{ sec/m}^3$$

$$\text{Maximum D/Q for food pathway} = 5.71 \times 10^{-8} \text{ M}^{-2}$$

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

$$P_{I-131} (\text{inhalation}) = 1.5 \times 10^7 \text{ mrem/yr per } \mu\text{Ci/M}^3$$

$$P_{I-131} (\text{food \& ground}) = 1.1 \times 10^{12} \text{ m}^2 \text{ mrem/yr per } \mu\text{Ci/sec}$$

\therefore maximum organ dose rate from I-131

$$= [1.32 \times 10^{-5} \times 1.5 \times 10^7 + 5.71 \times 10^{-8} \times 1.1 \times 10^{12}] Q_{I-131} < 1500 \text{ mrem/yr}$$

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

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

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

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

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.

$$P_{\text{Sr-90}} (\text{inhalation}) = 4.1 \times 10^7 \text{ mrem/yr per } \mu\text{Ci/M}^3$$

$$P_{\text{Sr-90}} (\text{food \& ground}) = 9.5 \times 10^{10} \text{ m}^2 \text{ mrem/yr per } \mu\text{Ci/sec}$$

∴ maximum organ dose rate

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

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

Assume 1/3 of allowable dose due to particulates

$$\therefore \text{limit for particulates} < \boxed{8.3 \times 10^{-2}} \mu\text{Ci/sec}$$

For tritium

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

$$P_{\text{H-3}} (\text{inhalation}) = 6.5 \times 10^2 \text{ mrem/yr per } \mu\text{Ci/M}^3$$

$$P_{\text{H-3}} (\text{food \& ground}) = 2.4 \times 10^3 \text{ mrem/yr per } \mu\text{Ci/M}^3$$

∴ maximum organ dose rate

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

$$Q_{\text{H3}} (\mu\text{Ci/sec}) < 3.7 \times 10^4$$

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

$$\therefore \text{limit for tritium} < \boxed{1.2 \times 10^4} \mu\text{Ci/sec}$$

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 EGASEOUS DOSE CALCULATIONS - GASPARA. 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 GASPARG 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 .

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

Millstone Unit One - Gaseous Identify Release Type
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=0.5 - 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).
- 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 Conu. 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,11)).
Columns 8-10 = 1.0 - release point multiplier
Column 20 = 6 - 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	0	1	2	3	4	5	6	7	8	9
			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 except 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 be 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 for 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

I. 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. = $\overline{1.9(-4)} \quad \overline{7.4(-4)}$

*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 = 4.5×10^{-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 = 1.6×10^{-3}

Ratio max./avg. = 2.2

∴ Beta air dose should not exceed $3 \text{ mrad} \times 2.2 = 6.6 \text{ mrad}$

∴ Gamma air dose should not exceed $\frac{3}{7.4 \times 10^{-4}} \times 1.9 \times 10^{-4} \times 2.4 = 1.85 \text{ mrad}$

2. Section D.2(a)(2)

- a. Justification for the use of only annual average X/Q's for both continuous and batch releases:

Number of hours during which batch releases were in progress during the period 1/1/77 - 9/30/78 between the hours of:

<u>Time</u>	<u># Hours</u>	<u>Time</u>	<u># Hours</u>
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

D_{QAGi} = Quarterly gamma air dose due to nuclide i

$$= C_i (Ci) \times M_i \left(\frac{mrad}{yr} \cdot \frac{m^3}{Ci} \right) \times 1.32 \times 10^{-5} \text{ sec/m}^3 \times 10^6 \mu\text{Ci/Ci} \times 3.17 \times 10^{-8} \text{ (yr/sec)}$$

where 1.32×10^{-5} = maximum site boundary annual average X/Q as determined in Appendix D. As indicated in Section 2.a. above, the same X/Q can be used for both batch and continuous releases due to the random nature of batch releases.

10^6 = conversion from Ci to μCi .

3.17×10^{-8} = conversion from seconds to years

-3-

$$D_{QAGi} = 4.2 \times 10^{-7} M_i C_i$$

$$D_{QAG} = \sum \text{over all nuclides} = \boxed{4.2 \times 10^{-7}} * \sum_i M_i C_i$$

(2) Step 5

Likewise for the beta air dose, all factors are the same except the dose conversion factor M_i should be replaced with N_i .

$$D_{QAB} = \boxed{4.2 \times 10^{-7}} * \sum_i N_i C_i$$

3. Derivation of Factors for Section D.3.a(1)

From Appendix D:

$$\text{Maximum } X/Q \text{ for inhalation pathway} = 1.32 \times 10^{-5} \text{ sec/M}^3$$

$$\text{Maximum } D/Q \text{ for food pathway} = 5.71 \times 10^{-8} \text{ M}^{-2}$$

From NRC proposed tech spec (May 1978) - dose parameters are:

$$\text{For I-131 - inhalation} - 1.25 \times 10^7 \text{ mrem/yr per } \mu\text{Ci/M}^3$$

$$\text{For I-131 - food} - 1.1 \times 10^2 \text{ mrem/yr per } \mu\text{Ci/sec}$$

$$\text{For H-3 - inhalation} - 6.5 \times 10^2 \text{ mrem/yr per } \mu\text{Ci/M}^3$$

$$\text{For H-3 - food} - 2.4 \times 10^3 \text{ mrem/yr per } \mu\text{Ci/M}$$

For particulates the most critical nuclide is Sr-90

Assume all particulates are Sr-90.

$$\text{For Sr-90 - inhalation} - 4.1 \times 10^7 \text{ mrem/yr per } \mu\text{Ci/M}^3$$

$$\text{For Sr-90 - food} - 9.5 \times 10^{10} \text{ mrem/yr per } \mu\text{Ci/sec}$$

Iodine and tritium are the only two nuclides which would contribute to the thyroid dose. If another nuclide could add a significant 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 =

$$N/52 [1.32 \times 10^{-5} \times 1.5 \times 10^7 + 5.71 \times 10^{-8} \times 1.1 \times 10^{12}] Q_{I-131}$$

$$+ N/52 [(1.32 \times 10^{-5})(6.5 \times 10^2 + 2.4 \times 10^3)] Q_{H-3}$$

$$= N/52 [6.3 \times 10^4 Q_{I-131} + 4.0 \times 10^{-2} Q_{H-3}]$$

Maximum organ dose =

$$\begin{aligned} & N/52 (1.32 \times 10^{-5})(6.5 \times 10^2 + 2.4 \times 10^3) Q_{H-3} \\ & + N/52 [1.32 \times 10^{-5} \times 4.1 \times 10^7 + 5.71 \times 10^{-8} \times 9.5 \times 10^{10}] Q_p \\ & = N/52 [4.0 \times 10^{-2} Q_{H-3} + 6.0 \times 10^3 Q_p] \end{aligned}$$