DUKE POWER COMPANY

OCONEE NUCLEAR STATION

IMPLEMENTING PROCEDURES

Revision 83-1
January 10, 1983

Table of Contents (Implementing Procedures - Continued)

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DUKE POWER COMPANY
PROCEDURE PREPARATION
PROCESS RECORD

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(2) STATION: Oconee Nuclear Station

(3) PROCEDURE TITLE: Estimate of Failed Fuel Based on I-131 Concentration

(4) PREPARED BY: [signature] DATE: 12-8-82

(5) REVIEWED BY: [signature] DATE: 12/10/82

Cross-Disciplinary Review By: ______ N/R: [initials]

(6) TEMPORARY APPROVAL (IF NECESSARY):

By: ______ (SRO) Date: ______

By: ______ Date: ______

(7) APPROVED BY: [signature] Date: 12/15/82

(8) MISCELLANEOUS:

Reviewed/Approved By: C. Jennings Date: 12/9/82

Reviewed/Approved By: ______ Date: ______

DUKE POWER COMPANY

OCONEE NUCLEAR STATION

ESTIMATE OF FAILED FUEL BASED ON I-131 CONCENTRATION

1.0 Purpose

This procedure describes the method for calculating the number of failed fuel pins and the percent failed fuel for four fuel conditions using the I-131 concentration (in µCi/ml) in the Reactor Coolant System (RCS).

2.0 Limits and Precautions

2.1 The numbers obtained by using this procedure are at best, estimates only.

2.2 All formulas quoted are based upon equilibrium full power core iodine. If fuel damage is suspected to have occurred during times of reduced power or near the time of significant power change, the core I-131 inventory must be adjusted by using Enclosure 10.2. This is the correction factor Y.

2.3 All values given are normalized to volumes of coolant at normal reactor coolant system pressure and temperature. To correct for other RCS system temperatures or RCS sample temperatures, use Enclosure 10.1. This is the correction factor X.

2.4 The decay of Te-131 to I-131 has been neglected as insignificant in this analysis.

2.5 Iodine spiking may occur after a shutdown or significant power change. Data from other nuclear power plants have shown that the iodine spiking process has been observed to occur during a period of 1 to 3 days after the change or shutdown. However, the spike seems to peak during the period from 4 to 8 hours after the change. I-131 concentrations can increase by a factor of 2 to 25 above the equilibrium levels during these times, although an increase over a factor of 10 is unusual and would only be seen at a shutdown. Increases by a factor of 2 to 3 are typical for a significant power decrease (i.e., 100% to 50% power). Do not misinterpret this temporary change for fuel failure if there is no other evidence of fuel damage. Other evidence of fuel damage can be constituted by any indication of inadequate core cooling, loose parts indication, high incore thermocouple indication, etc.

2.6 If estimates for fuel failure are needed for fuel conditions other than those covered by the four cases described below, or if more accurate fuel failure data is needed, see Section 7.0 of this procedure.

2.7 The following four cases cover a very board range of core conditions. Choose the one that best suits the existing conditions.

2.8. Follow up as necessary with Babcock and Wilcox site managers depending on the plant situation.

3.0 Case I - Normal Operation

3.1 Initial Conditions

3.1.1 The conditions which pertain to Case I - Normal operation are as follows:

3.1.1.1 Normal reactor operation at any power or shutdown with no unusual conditions prior to shutdown. Adequate core cooling has been maintained.

3.2 Procedure

3.2.1 If 3.1.1 describes the core conditions, use the following formulas to calculate the range of failed fuel values. Evaluate correction factors X and Y by using Enclosures 10.1 and 10.2.

3.2.1.1 $$\frac{(\text{Measured I-131 concentration } \mu Ci/ml)(X)(Y)}{3.5 \times 10^{-3}\ \mu Ci/ml} =$$

= Number of failed pins (Max. expected and best estimate)

3.2.1.2 $$\frac{(\text{Measured I-131 concentration } \mu Ci/ml)(X)(Y)}{4.9 \times 10^{-3}\ \mu Ci/ml} =$$

= Number of failed pins (Min. expected)

3.2.1.3 $$\frac{(\text{Measured I-131 concentration } \mu Ci/ml)(X)(Y)}{1.8\ \mu Ci/ml} =$$

= Percent failed fuel (Max. expected and best estimate)

3.2.1.4 $$\frac{(\text{Measured I-131 concentration } \mu Ci/ml)(X)(Y)}{2.5\ \mu Ci/ml} =$$

= Percent failed fuel (Min. expected)

NOTE: Values for I-131 concentration in μCi/ml for Oconee at normal operating conditions are between 1.0×10^{-3} and 5.0×10^{-1} μCi/ml.

4.0 Case II - Macroscopic Clad Damage

4.1 Initial Conditions

4.1.1 The conditions which pertain to Case II - Macroscopic clad damage are as follows:

4.1.1.1 Normal reactor operation at any power, or shutdown where some mechanical clad failure (i.e., a loose part monitor indication) or a flow induced failure is suspected. The core has adequate cooling and no significant fuel overtemperature is observed.

4.2 Procedure

4.2.1 If 4.1.1 best describes the core conditions, use the following formulas to calculate the range of failed fuel values. Evaluate correction factors X and Y by using Enclosure 10.1 and 10.2.

4.2.1.1 $\frac{\text{(Measured I-131 concentration μCi/ml)(X)(Y)}}{5.5 \times 10^{-2}\ \text{μCi/ml}}$ =

= Number of failed pins (Max. expected)

4.2.1.2 $\frac{\text{(Measured I-131 concentration μCi/ml)(X)(Y)}}{16.5 \times 10^{-2}\ \text{μCi/ml}}$ =

= Number of failed pins (Best estimate)

4.2.1.3 $\frac{\text{(Measured I-131 concentration μCi/ml)(X)(Y)}}{27.4 \times 10^{-2}\ \text{μCi/ml}}$ =

= Number of failed pins (Min. expected)

4.2.1.4 $\frac{\text{(Measured I-131 concentration μCi/ml)(X)(Y)}}{27.9\ \text{μCi/ml}}$ =

= Percent failed fuel (Max. expected)

4.2.1.5 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{83.7\ \mu\text{Ci/ml}}$ = Percent failed fuel (Best estimate)

4.2.1.6 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{139.5\ \mu\text{Ci/ml}}$ = Percent failed fuel (Min. expected)

5.0 Case III - Severe Fuel Overtemperature

5.1 Initial Conditions

5.1.1 The conditions which pertain to Case III - Severe Fuel Overtemperature are as follows:

5.1.1.1 TMI type accident where there has been an abnormal shutdown and it is suspected that the fuel has been at least partially uncovered for a period of time greater than a few minutes. Voiding in the core is detected by high incore thermocouple readings and loss of margin to saturation. Fuel clad oxidation is detected by excess hydrogen in the containment or in the reactor coolant sample; however, no fuel melting is suspected.

5.2 Procedure

5.2.1 If 5.1.1 best describes the core conditions, use the following formulas to calculate the range of failed fuel values. Evaluate correction factors X and Y by using Enclosures 10.1 and 10.2.

5.2.1.1 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{2.4\ \mu\text{Ci/ml}}$ = Number of failed pins (Max. expected)

5.2.1.2 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{2.9\ \mu\text{Ci/ml}}$ = Number of failed pins (Best estimate)

5.2.1.3 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{3.2\ \mu\text{Ci/ml}}$ = Number of failed pins (Min. expected)

5.2.1.4 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{1255\ \mu\text{Ci/ml}}$ =

= Percent failed fuel (Max. expected)

5.2.1.5 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{1535\ \mu\text{Ci/ml}}$ =

= Percent failed fuel (Best estimate)

5.2.1.6 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{1675\ \mu\text{Ci/ml}}$ =

= Percent failed fuel (Min. expected)

6.0 Case IV - Fuel Melting

6.1 Initial Conditions

6.1.1 The conditions which pertain to Case IV - Fuel Melting, are as follows:

6.1.1.1 Severe accident where there has been an abnormal shutdown and the core is uncovered for a long period of time. Incore thermocouple temperature readings are above 2300°F for a long period of time. Fuel melting is suspected (i.e., fuel temperature exceeds 5000°F) and is verified by the inability to operate the incore instrumentation system properly.

6.2 Procedure

6.2.1 If 6.1.1 best describes the core conditions, use the following formulas to caluclate the failed fuel values. Evaluate correction factors X and Y by using Enclosures 10.1. and 10.2.

6.2.1.1 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{5.5\ \mu\text{Ci/ml}}$ =

= Number of failed pins (Best estimate)

6.2.1.2 $\frac{\text{(Measured I-131 concentration } \mu\text{Ci/ml)(X)(Y)}}{2790\ \mu\text{Ci/ml}}$ =

= Percent of failed fuel (Best estimate)

7.0 Case V - Other Fuel Conditions

7.1 If fuel conditions other than those described above exist, or if a more detailed failed fuel estimation is desired for either emergency or normal operation, contact the appropriate B&W Site Managers or the Crisis Management Center for assistance.

8.0 Data Disposition

8.1 When plant conditions dictate that the Technical Support Center (TSC) is not necessary to the Safe Operation of ONS:

8.1.1 Deliver Enclosures 10.4 - 10.7 to the Station Chemist in the Technical Services Building. Deliver a copy to the Primary Chemistry Supervisor.

8.2 When plant conditions, addressed in the Emergency Plan, dictate that the TSC be manned:

8.2.1 Deliver Enclosures 10.4 - 10.7 to the Station Chemist in the TSC. Deliver a copy of Enclosures 10.4 - 10.7 to the Power Chemistry Supervisor in the Operational Support Center (OSC).

8.3 After completing failed fuel calculations, compare data with the guidelines given in Enclosure 10.8 to determine appropriate Station Emergency Action Level (EAL). Appropriate EAL and supporting data should be recorded in comments section of Enclosures 10.4 - 10.7 and delivered in accordance with 8.1.1 and 8.1.2.

9.0 References

9.1 Letter of 4/14/82 from R. Michael Glover to C. C. Jennings, Subject: "Failed Fuel Estimating"

9.2 ONS Emergency Plan, Section II.D

9.3 MNS Administrative Procedure AP/0/A/5500/33

9.4 ONS FSAR

10.0 Enclosures

10.1 Density Correction Factor, (X)

10.2 Core I-131 Inventory Correction Factor, (Y)

10.3 Examples

10.4 Failed Fuel Calculations - Case I

10.5 Failed Fuel Calculations - Case II

ENCLOSURE 10.1

DENSITY CORRECTION FACTOR

(X)

Find the appropriate RC System temperature at the time of accident. Find the approximate temperature at which the RC samples are taken. The intersection of both numbers is the density correction factor, X.

NOTE: Normal RC System sample temperature is approximately 90°F. Use this temperature if no other information is available.

	RCS Sample Temperature °F			
		80	90	100
RCS Temperature °F	100	.996	.998	1
	150	.983	.985	.987
	200	.966	.968	.970
	250	.945	.947	.949
	300	.921	.923	.924
	350	.894	.895	.897
	400	.862	.864	.865
	450	.827	.828	.830
	500	.787	.788	.790
	550	.739	.740	.741
	560	.728	.729	.731
	570	.717	.718	.719
	580	.706	.708	.708
	590	.693	.694	.695
	600	.680	.681	.683

ENCLOSURE 10.2

CORE I-131 INVENTORY CORRECTION FACTOR

(Y)

10.2.1 Situation 1:

Use the following equation to calculate (Y) at power operation (except 0%) where the power level has not changed more than ± 10% within the last 22 days.

Eq. 10.2.1.1 $Y = \frac{100}{PL}$

Where: Y = the Core I-131 inventory correction factor.

PL = the power level, in %, at the suspected time of fuel failure.

10.2.2 Situation 2:

Use the following equation to calculate (Y) at times other than covered by Situation 1 above.

Eq. 10.2.2.1 $Y = \frac{100}{(PL_i)(e^{-\lambda t}) + (PL_f)(1-e^{-\lambda t})}$

Where: Y = the core I-131 inventory correction factor.

PL_i = the initial power level before the power change.

PL_f = the final power level before/at the suspected time of fual failure

λ = the decay constant for I-131, 0.084 day^{-1}

$t = t_1 + t_2$

t_1 = the median time, in days, to make the power change from PL_i to PL_f.

t_2 = the time, in days, after the final power level (PL_f) is reached that the fuel failure is suspected to have occurred.

ENCLOSURE 10.3
EXAMPLES

Problem 1

a. Power level has been decreased from 85% to 50%.

b. This power change took four hours and occurred between 1200 and 1600. T_{AVG} at 50% is 570°F.

c. At 1800 a loose part monitor alarm goes off indicating a loose object in the core. The reactor is not tripped.

d. A Chemistry team is immediately dispatched to take a sample RC System as failed fuel is suspected.

e. Chemistry sample indicates I-131 concentration is 10.0 µCi/ml.

Part 1. Determine the best estimate of the number of failed pins.

Part 2. Determine the best estimate of percent failed fuel.

Solution

This is Case II, Section 4.0

Use equation 4.2.1.2 for Part 1

Use equation 4.2.1.5 for Part 2

Part 1. $$\frac{\text{Measured I-131 concentration } \mu Ci/ml}{16.5 \times 10^{-2}\ \mu Ci/ml} (X)(Y) = \text{Number of failed pins}$$

Determine X: Enclosure 10.1

T_{AVG} is 570°F at 50%.
Assume RCS Sample Temperature is 90°F
Therefore, X = .718

Determine Y: Enclosure 10.2

$\lambda_I = .0864\ day^{-1}$

$t = \frac{(4)}{2} + (2) = 4$ hours

Remember, t is the median time to make a power change plus the difference between the time when the damage is suspected and the time the new power level is reached.

Convert t to days $t = 4 \text{ hours} \times \frac{1 \text{ day}}{24 \text{ hrs.}} = .167$ days

ENCLOSURE 10.3
EXAMPLES

$$Y = \frac{100}{(85)e^{-(.0864\ \text{day}^{-1})(.167\ \text{day})} + (50)\ 1-e^{-(.0864\ \text{day}^{-1})(.167\ \text{day})}}$$

$$Y = \frac{100}{(85)(.9857) + (50)(.0143)} = 1.183$$

Part 1. $\frac{10\ \mu Ci/ml}{16.5 \times 10^{-2}\ \mu Ci/ml}$ (.718) (1.183) = 51.5 ≅ 52 failed pins <u>Answer</u>

Part 2. $\frac{\text{Measured I-131 Concentration}\ \mu Ci/ml}{83.7\ \mu Ci/ml}$ (X)(Y) = % failed fuel

$\frac{10\ \mu Ci/ml}{83.7\ \mu Ci/ml}$ (.718) (1.183) = 0.1% failed fuel <u>Answer</u>

ENCLOSURE 10.3
EXAMPLES

Problem 2

a. The reactor has just tripped instantly from 100% power due to a malfunctioning instrument. There were no unusual conditions prior to the trip.

b. T_{AVG} is now 557°F at 0% power.

c. The operator, while having no reason to suspect failed fuel, is curious about the amount of failed fuel present now following the trip.

d. A Chemistry team is sent to take an RC sample 12 hours after the trip.

e. The Chemistry sample gives an I-131 concentration of 2.0×10^{-2} μCi/ml. (A typical value for a normally operating plant. See Note under Case I, Section 3.0)

f. Chemistry personnel also indicate that RC sample temperature is 100°F.

Part 1. Determine the maximum expected number of failed fuel pins.

Part 2. Determine the maximum expected percent failed fuel in the core.

Solution

This is Case I, Section 3.0

Use equation 3.2.1.1 for Part 1

Use equation 3.2.1.3 for Part 2

Part 1. $$\frac{\text{Measured I-131 concentration } \mu\text{Ci/ml}}{3.5 \times 10^{-3}\ \mu\text{Ci/ml}} (X)(Y) = \text{Number of failed pins}$$

Determine X: Enclosure 10.1

RC Temperature is 557°F at 0%
RC sample temperature is 100°F
Therefore, X ≅ .732

ENCLOSURE 10.3
EXAMPLES

<u>Determine Y</u>: Enclosure 10.2

Situation 2: $t = 12 \text{ hours} \times \frac{1 \text{ day}}{24 \text{ hrs.}} = .5 \text{ days}$

$$Y = \frac{100}{(100)\, e^{-(.0864)\,(.5)} + (0)\ 1 - e^{-(.0864)\,(.5)}}$$

$Y = 1.044$

NOTE: If $t = 0$ or a sample was taken immediately, $Y = 1.0$.

Part 1. $\frac{2.0 \times 10^{-2}\ \mu Ci/ml}{3.5 \times 10^{-3}\ \mu Ci/ml}\,(.732)(1.044) = 4.4$

or ≅ 4 to 5 failed pins <u>Answer</u>

Part 2. $\frac{\text{Measured I-131 Concentration } \mu Ci/ml}{1.8\ \mu Ci/ml}\,(X)(Y) = \%\ \text{failed fuel}$

$\frac{2.0 \times 10^{-2}\ \mu Ci/ml}{1.8\ \mu Ci/ml}\,(.732)\ (1.044) = .0085\ \%\ \text{failed fuel}$

The above numbers are indicative of normal operation.

<u>Answer</u>

NOTE: I-131 spiking may be a problem here. See Section 2.5.

ENCLOSURE 10.3
EXAMPLES

Problem 3

a. Power level has been between 50% and 65% for the last 30 days and is presently at 60% at 1800.

b. T_{AVG} is ≅ 575°F at 60% power.

c. It is desired to see if any significant failed fuel exists in the core even though no abnormal occurrences have taken place.

d. At 2200 the same day, a Chemistry sample is taken of the RC system.

e. The Chemistry sample indicates I-131 concentration is 3.9×10^{-2} µCi/ml.

Part 1. Determine the best estimate of the number of failed pins.

Part 2. Determine the best estimate of the % failed fuel.

Solution

This is Case I, Section 3.0

Use equation 3.2.1.1 for Part 1

Use equation 3.2.1.3 for Part 2

Part 1. $$\frac{\text{Measured I-131 concentration } \mu\text{Ci/ml}}{3.5 \times 10^{-3}\ \mu\text{Ci/ml}}\ (X)(Y) = \text{Number of failed pins}$$

Determine X: Enclosure 10.1

T_{AVG} is 575°F at 60% power
Assure RCS sample temp. of 90°F
Therefore, X ≅ .713

Determine Y: Enclosure 10.2

Situation 1

$$Y = \frac{100}{60} = 1.67$$

ENCLOSURE 10.3
EXAMPLES

Part 1. $\frac{3.9 \times 10^{-2}\ \mu Ci/ml}{3.5 \times 10^{-3}\ \mu Ci/ml}$ (.713)(1.67) = 13.27

≅ 14 failed pins Answer

Part 2. $\frac{\text{Measured I-131 Concentration } \mu Ci/ml}{1.8\ \mu Ci/ml}$ (X)(Y) = % failed fuel

$\frac{3.9 \times 10^{-2}\ \mu Ci/ml}{1.8\ \mu Ci/ml}$ (.713)(1.67) = .026% failed fuel Answer

The above numbers are acceptable for a normally operating plant.

ENCLOSURE 10.3
EXAMPLES

Problem 4

a. The unit has been at 97% power for a month when a depressurization of the RC system occurs.

b. The reactor trips.

c. Heavy vibration is observed in the RC pumps.

d. Thermocouple temperatures over 1000°F are indicated in the core.

e. High Pressure Injection was delayed and it is suspected the core was uncovered between 30 and 60 minutes before sufficient reactor vessel water level was regained.

f. The incore instrumentation system is still operable.

g. The RC sample indicates an I-131 concentration of 3800 μCi/ml.

h. A Chemistry sample is taken immediately (within the hour) after the trip.

Part 1. Determine the maximum expected number of failed pins.

Part 2. Determine the maximum expected % of failed fuel.

Solution

This is Case III, Section 5.0

Use equation 5.2.1.1 for Part 1

Use equation 5.2.1.4 for Part 2

Determine X: Enclosure 10.1

RC Temp. T_{AVG} at 0% power is 557°F
Assume sample temperature of 90°F
Therefore, X ≅ .730

Determine Y: Enclosure 10.2

$$Y = \frac{100}{97} = 1.03$$

ENCLOSURE 10.3
EXAMPLES

Part 1. $\frac{3800\ \mu Ci/ml}{2.4\ \mu Ci/ml}$ (.730)(1.03) = 1190.5

≅ 1191 number failed pins, max. expected Answer

Part 2. $\frac{3800\ \mu Ci/ml}{1255\ \mu Ci/ml}$ (.730)(1.03) = 2.28% failed fuel, max. expected Answer

ENCLOSURE 10.4

FAILED FUEL CALCULATIONS

CASE I

UNIT ________ DATE/TIME ________ BY ________

X = ________ Y = ________ I-131 ________ µCi/ml

Maximum Number of Failed Fuel Pins (Best Estimate):

$\frac{\quad}{3.5\ E\text{-}3}$ ( ) ( ) =

Minimum Number of Failed Fuel Pins:

$\frac{\quad}{4.9\ E\text{-}3}$ ( ) ( ) =

Maximum % Failed Fuel (Best Estimate):

$\frac{\quad}{1.3}$ ( ) ( ) = %

Minimum % Failed Fuel:

$\frac{\quad}{2.5}$ ( ) ( ) = %

COMMENTS:

Reviewed By ________

ENCLOSURE 10.5

FAILED FUEL CALCULATIONS

CASE II

UNIT__________ DATE/TIME__________ BY______________

X = __________ Y = __________ I-131 ____________μCi/ml

Maximum Number of Failed Fuel Pins:

$\frac{\quad}{5.5\ E\text{-}2}$ ( ) ( ) =

Best Estimate of Failed Fuel Pins:

$\frac{\quad}{1.65\ E\text{-}1}$ ( ) ( ) =

Minimum Number of Failed Fuel Pins:

$\frac{\quad}{2.74\ E\text{-}1}$ ( ) ( ) =

Maximum % Failed Fuel:

$\frac{\quad}{27.9}$ ( ) ( ) = %

Best Estimate Failed Fuel:

$\frac{\quad}{83.7}$ ( ) ( ) = %

Minimum % Failed Fuel:

$\frac{\quad}{139.5}$ ( ) ( ) = %

COMMENTS:

Reviewed By ______________

ENCLOSURE 10.6

FAILED FUEL CALCULATIONS

CASE III

UNIT__________ DATE/TIME__________ BY________________

X = __________ Y = __________ I-131 ____________μCi/ml

Maximum Number of Failed Fuel Pins:

$\frac{\quad}{2.4}$ ( ) ( ) =

Best Estimate of Failed Fuel Pins:

$\frac{\quad}{2.9}$ ( ) ( ) =

Minimum Number of Failed Fuel Pins:

$\frac{\quad}{3.2}$ ( ) ( ) =

Maximum % Failed Fuel:

$\frac{\quad}{1255}$ ( ) ( ) = %

Best Estimate Failed Fuel:

$\frac{\quad}{1535}$ ( ) ( ) = %

Minimum % Failed Fuel:

$\frac{\quad}{1675}$ ( ) ( ) = %

COMMENTS:

Reviewed By______________

ENCLOSURE 10.7

FAILED FUEL CALCULATIONS

CASE IV

UNIT__________ DATE/TIME__________ BY______________

X = __________ Y = __________ I-131 ____________μCi/ml

Best Estimate of Failed Fuel Pins:

$\frac{\quad}{5.5}$ ( ) ( ) =

Best Estimate of % Failed Fuel:

$\frac{\quad}{2790}$ ( ) ( ) = %

COMMENTS:

Reviewed By__________

ENCLOSURE 10.8

EMERGENCY ACTION LEVELS

(EAL)

Following reactor coolant sampling and completion of the failed fuel calculations, compare I-131 concentrations or percent failed fuel with the following guidelines to determine the appropriate Station Emergency Action Level. Appropriate action level should be highest applicable EAL.

1.0 Unusual Event

1.1 Initial indicator is high reactor coolant activity; total activity > $\frac{224}{\bar{E}}$.

1.2 Suspected damage mechanism is mechanical clad failure or flow induced failure.

1.2.1 I-131 concentration in reactor coolant in range of 70 µCi/ml to 350 µCi/ml.

2.0 Alert

2.1 Initial indicator is very high reactor coolant activity; total activity >> $\frac{224}{\bar{E}}$.

2.2 Suspected damage mechanism is mechanical clad failure or flow induced failure.

2.2.1 Total failed fuel exceeds 5%, but less than 25%.

2.2.2 I-131 concentration between 350 and 1770 µCi/ml.

3.0 Site Area Emergency

3.1 Initially suspected degraded core with possible loss of coolable geometry.

3.2 Substantial mechanical clad failure or flow induced failure with total failed fuel > 25%.

3.2.1 I-131 concentration from 1770 to 7000 µCi/ml (7000 µCi/ml equivalent to 100% failure under this damage mechanism).

3.3 Substantial damage to clad from severe fuel over temperature (fuel clad oxidation evident from excess hydrogen in containment or reactor coolant, no fuel melt suspected).

3.3.1 I-131 concentration from 1300 to 13,000 µCi/ml (1% to 10% fuel failure under this damage mechanism).

3.4 Substantial damage to fuel and clad from fuel melt conditions (incore thermocouple > 2300°F for period of time; fuel temperature > 5000°F).

3.4.1 I-131 concentration from 1180 to 11,800 μCi/ml (0.5% to 5% failed fuel under this damage mechanism).

4.0 General Emergency

4.1 Initially loss of cladding and primary coolant boundary with potential loss of containment.

4.2 Substantial damage to clad from severe fuel overtemperature (fuel clad oxidation evident from excess hydrogen in containment or reactor coolant, no fuel melt suspected).

4.2.1 I-131 concentration > 13,000 μCi/ml (> 10% fuel failure under this mechanism).

4.3 Substantial damage to fuel and clad from fuel melt (severe accident where core is uncovered for a period of time and incore temperature > 2300°F for long period; fuel melt suspected by fuel temperature > 5000°F and verified by inoperable incore instrumentation.

4.3.1 I-131 concentration > 11,800 μCi/ml, for this damage mechanism failed fuel > 5%.

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C. Jennings

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Form SPD-1002-1

DUKE POWER COMPANY
PROCEDURE PREPARATION
PROCESS RECORD

(1) ID No: HP/0/B/1009/14
Change(s) 2 to
N/A Incorporated

(2) STATION: Oconee

(3) PROCEDURE TITLE: Projection of Offsite Dose From Releases Other Than Through The Unit Vent

(4) PREPARED BY: Sarah A. Coy DATE: 12-15-82

(5) REVIEWED BY: CT Yongue / DL Dowdle DATE: 12-17-82

Cross-Disciplinary Review By: ______ N/R: ______

(6) TEMPORARY APPROVAL (IF NECESSARY):

By: ______ (SRO) Date: ______

By: ______ Date: ______

(7) APPROVED BY: Tony B. Owen Date: 12/20/82

(8) MISCELLANEOUS:

Reviewed/Approved By: ______ Date: ______

Reviewed/Approved By: ______ Date: ______

DUKE POWER COMPANY

OCONEE NUCLEAR STATION

PROJECTION OF OFF-SITE DOSE FROM RELEASES

OTHER THAN THROUGH THE UNIT VENT

1.0 Purpose

This procedure should be used for projecting dose commitment from a noble gas or iodine release, other than a unit vent release, during an emergency.

2.0 References

2.1 Reg Guide 1.109

2.2 Reg Guide 1.4

2.3 HP/0/B/1009/13, Procedure for Implementation and Verification for the Availability of a Backup Source of Meteorological Data.

3.0 Limits and Precautions

3.1 It is assumed that a small percentage of the total containment inventory of iodine is released. The iodine whole body dose from a release is very small compared to the iodine thyroid dose. Thus, iodine whole body dose is not considered here.

3.2 This procedure applies to releases made from Oconee Nuclear Station only. Many of the values contained in this procedure are site specific.

3.3 This procedure considers all releases to be ground level releases.

3.4 Enclosure 5.6 should be done in conjuction with the Field Monitoring Coordinator.

3.5 Meteorology data needed to calculate offsite dose should be obtained as required by Enclosure 5.1. Data not available from the primary source should be obtained from the backup source. The order of preference for each data point is listed each place meteorological data is required. All meteorology data obtained from the tower or river must be a 15 minute average. National Weather Service (NWS) data is a standard observation and is not a 15 minute average.

3.5.1 Every 15 minutes the wind direction and wind speed will be rechecked in accordance with Enclosure 5.1 to ensure additional sectors have not been affected. Once a sector has been determined to be affected, it cannot be removed from the list of affected sectors.

3.5.2 The following are conversion formulas for the meteorological data obtained from the National Weather Service:

mph ≈ 1.15 (knots)

$°F = (9/5\ °C) + 32$

4.0 Procedure

4.1 Acquire the following information and record on Enclosure 5.1.

NOTE: The sources of meteorological data are listed in order of preference on Enclosure 5.1.

4.1.1 Reactor Unit, date and time of reactor trip.

4.1.2 Wind speed (mph).

4.1.3 Wind direction in degrees from North (North = 0°).

4.1.4 Temperature gradient ($\Delta T°F$).

4.1.5 Radiation Monitor reading (R/hr) calculated per Enclosure 5.2.

4.1.6 Present date and time.

4.1.7 Time meteorology data determined.

4.2 Determine the Containment Building leakage rate (LR) and record it on Enclosure 5.1.

4.2.1 LR is the total leak rate for the containment which is:

a) a "best guess" assumption,

b) assumed to be the design leak rate (see note below), or

c) the measured leak rate where suitable means are available.

Record the leak rate onto Enclosure 5.1.

NOTE: The design leakage rate (LR_{DLR}) is determined by,

$$LR_{DLR} = \text{Containment Volume} \cdot \text{Design Leak Constant}$$

$$= (5.38 \times 10^{10}\ \text{ml}) \cdot \left(\frac{0.0025}{\text{day}} \right) \cdot \frac{\text{day}}{24\ \text{hr}}$$

$$= 5.6 \times 10^{6}\ \text{ml/hr}$$

4.3 Determine the X/Q values for each point of interest downwind.

If no points have been requested, use the 1, 2, 5 and 10 mile values.

4.3.1 Locate the relative two-hour downwind concentration value (CH) for each point from Enclosure 5.3 and record onto Enclosure 5.1.

4.3.2 Convert these values to X/Q by,

$$X/Q = \frac{CH\ (MPH\text{-}Sec/m^3)}{Wind\ Speed\ (MPH)}$$

Record X/Q values onto Enclosure 5.1.

4.4 Determine the potential whole body dose from submersion in a cloud of noble gas.

4.4.1 Calculate the whole body two (2) hour dose commitment,

$$D_{WB} = DR_M \cdot DC \cdot LR \cdot X/Q \cdot U_{NG}$$

Where,

D_{WB} = Whole body two (2) hour dose commitment

DR_M = Monitor dose rate (see Encl. 5.2)

DC = Average Decay constant for noble gases =

$$1.5448E\text{-}2\ \frac{\mu Ci \cdot MeV \cdot hr^2}{ml \cdot d \cdot R} \qquad \text{(see Encl. 5.4)}$$

LR = containment leakage rate in ml/hr

X/Q = dispersion factor in sec/m^3

$$U_{NG} = \frac{(3.74d/sec \cdot \mu Ci)(1.6E\text{-}6ergs/MeV)}{2\ (100\ ergs/g\text{-}rad)(1.2E\text{-}3g/cm^3)(1E6cm^3/m^3)} =$$

$$2.5E\text{-}7\ \frac{d \cdot m^3 \cdot rad}{sec \cdot \mu Ci \cdot MeV}$$

Record results on Enclosure 5.1

4.5 Determine the potential thyroid dose from uptake of radioiodine.

4.5.1 Locate the time plus one (1) hour after trip on Enclosure 5.5 and record the corresponding Decay Constant on Enclosure 5.1

4.5.2 Calculate a child's thyroid two (2) hour dose commitment using time plus one (1) hour,

$$DR_T = DR_M \cdot DC \cdot LR \cdot X/Q \cdot UI$$

Where,

DR_T = thyroid two (2) hour dose commitment

DR_M = monitor dose rate (see Encl. 5.2)

DC = Decay Constant in $\frac{\mu Ci \cdot mrem \cdot hr^2}{ml \cdot pCi \cdot R}$ for time plus one (1) hour (see Enclosure 5.5)

LR = Leak rate in ml/hr

X/Q = dispersion in sec/m^3

UI = breathing rate for child

$$(1.17E\text{-}4 m^3/sec)(1E3 \frac{pCi\text{-}rem}{\mu Ci\text{-}mrem}) = 1.17E\text{-}1$$

Record results on Enclosure 5.1

4.6 Calculate an adult's thyroid dose by dividing the child's dose by two (2). Report results of all calculations on Enclosure 5.7.

4.7 Determine the potentially affected area using Enclosure 5.6. Record sectors on Enclosure 5.7.

4.8 Complete Enclosure 5.7 with information from Enclosure 5.1 and submit it to the Offsite Radiological Coordinator or his designee. Include any comments pertinent to the evaluation of offsite hazards.

5.0 <u>Enclosures</u>

5.1 Projected Offsite Dose Released from Containment

5.2 Survey Instrument Correlation

5.3 Table of Two Hour Relative Concentration Factors

5.4 Table of Noble Decay Constant (DC)

5.5 Table of Iodine and Noble Decay Constant (DC)

5.6 Evaluation of Plume Location

5.7 Dose Assessment Report

ENCLOSURE 5.1
HP/0/B/1009/14 Proposed
PROJECTED OFFSITE DOSE RELEASED FROM CONTAINMENT

Date/Time Now ______________________/__________

Unit ____________ Date/Time of Incident ______________/__________

METEOROLOGICAL DATA
(All data is 15 min. average, except NWS)

A. Daytime - 1000-1600 hrs. (Circle source of data for each point)

- 15 min. period ending time

________ ________ ________ ________

- Wind Direction (degrees)
  Sources 1) Tower (T)
  2) River (R)
  3) NWS (N)

T R N ________; T R N ________; T R N ________; T R N ________

- ΔT (°F)
  Sources 1) Tower (T)
  2) Assume (A) -0.4°F

T A ________

- Wind Speed (mph)
  Sources 1) Tower (T)
  2) River (R)
  3) NWS (N)

T R N ________; T R N ________; T R N ________; T R N ________

B. Nightime - 1600-1000 hrs. (Circle source of data for each point)

- 15 min. period ending time

________ ________ ________ ________

River Wind Direction (If river wind direction is unavailable assume 70° - 210°)

________ ________ ________ ________

Using the river wind direction above, complete #1 or #2 below.

ENCLOSURE 5.1
HP/0/B/1009/14 Proposed
PROJECTED OFFSITE DOSE RELEASED FROM CONTAINMENT

1. River Wind Direction is between 210° - 70°

- Wind Direction (degrees)
  Sources 1) Tower (T)
  2) Assume (A) between 0 - 360°

T
A ________; T
A ________; T
A ________; T
A________

- ΔT (°F)
  Sources 1) Tower (T)
  2) Assume (A) +1.0°F

T
A ________

- Wind Speed (mph)
  Sources 1) Tower (T)
  2) Assume (A) - 1 mph

T
A ________; T
A ________; T
A ________; T
A________

2. River wind direction is between 70° - 210° (Sources below are based on experiment)

- Wind Direction (degrees)
  Source 1) Between 0° - 360° (E)

E ________; E ________; E ________; E ________

- ΔT (°F)
  Source 1) +1.0°F (E)

E ________

- Wind Speed (mph)
  Source 1) 1 mph (E)

E ________; E ________; E ________; E ________

BUILDING DOSE RATE

1) Determine DR_m by completing either step a or b.

A) Containment high range monitor - RIA # ____

DR_m = ________________________ R/hr

B) Survey instrument # ________________________

a) reading ________________________ R/hr
b) correlation value ______________ (Enclosure 5.2)
c) DR_m = ________________________ R/hr

C) Date/time of sample ____________ / ____________

ENCLOSURE 5.1
HP/0/B/1009/14 Proposed
PROJECTED OFFSITE DOSE RELEASED FROM CONTAINMENT

DOSE CALCULATION

1) LR ____________________ ml/hr [Design basis LR = 5.6E6 ml/hr]

2) CH @ _____mi. = ___________, X/Q = __________ sec/m^3

CH @ _____mi. = ___________, X/Q = __________ sec/m^3

CH @ _____mi. = ___________, X/Q = __________ sec/m^3

CH @ _____mi. = ___________, X/Q = __________ sec/m^3

A. Whole Body 2 hr. dose projection from noble gases:

by $D_{WB} = DR_M \cdot 1.5448E\text{-}2 \cdot LR \cdot X/Q \cdot 2.5E\text{-}7$,

Miles Out	D_{WB} 2 hr Dose Commitment
________	____________________
________	____________________
________	____________________
________	____________________

B. Thyroid 2 hr. dose projection from iodine:

DC (for t + 1 hr.) ____________________

by $DR_T = DR_M \cdot DC \cdot LR \cdot X/Q \cdot (1.17E\text{-}1)$,

Miles Out	DR_T 2 hr Dose Commitment
________	____________________
________	____________________
________	____________________
________	____________________

ENCLOSURE 5.1
HP/0/B/1009/14 Proposed
PROJECTED OFFSITE DOSE RELEASED FROM CONTAINMENT

DEFINITIONS

D_{WB} - whole body 2 hour dose commitment

DR_T - thyroid 2 hr dose commitment from iodine

LR - containment leakage rate

LR_{DLR} - Design leak rate (5.6 E6ml/hr)

X/Q - "Chi over Q" is downwind concentration correction factor

CH - 2 hr. relative downwind concentration - MPH (X/Q · MPH)

DC - Decay constant

ENCLOSURE 5.2

HP/0/B/1009/14 Proposed

SURVEY INSTRUMENT CORRELATION

Presently, Oconee does not have a high range monitor installed to evaluate the conditions of an airborne release inside the containment. Therefore, the following equation should be used to determine the dose rate:

$$DR_{monitor} = DR_{survey} \cdot \text{Correlation Value}$$

where:

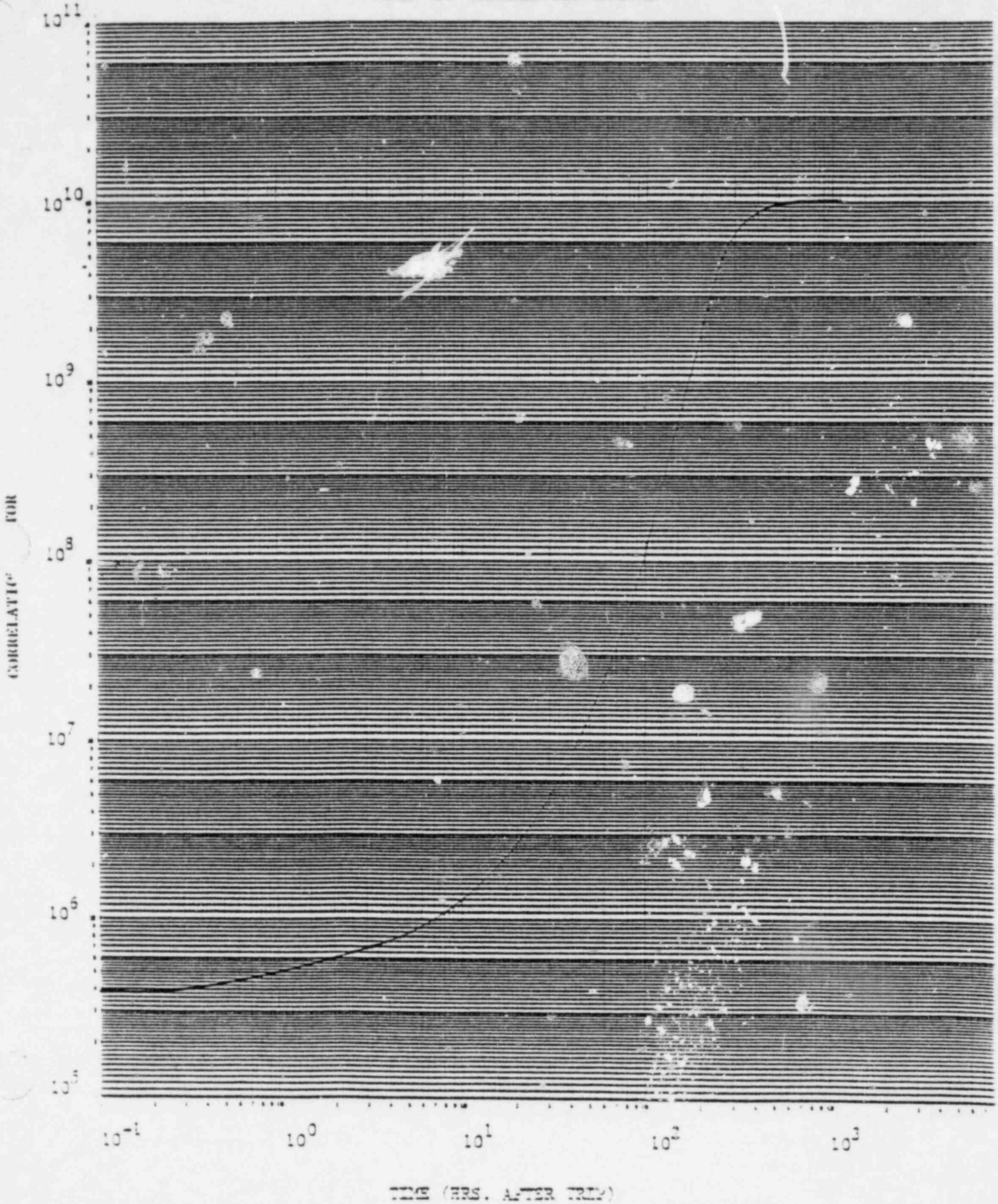
The correlation value is determined by using the graph on the following page.

DR_{survey} is taken from the 6th floor inside the Auxiliary Building, 1 foot from the reactor wall and 4 feet from the floor.

ENCLOSURE 5.2

SURVEY INSTRUMENT CORRELATION CURVE

TIME VS. CORRELATION FACTOR



Enclos. 5.3

Table of Two-Hour Relative Concentration Factors

Temperature Difference ΔT°F	Distance (Miles)									
	1	2	3	4	5	6	7	8	9	10
-25.0 to -1.3	1.5E-6	9.4E-7	5.4E-7	4.0E-7	3.4E-7	2.9E-7	2.5E-7	2.2E-7	2.0E-7	1.8E-7
-1.2 to -1.0	5.8E-5	1.6E-5	8.1E-6	4.9E-6	3.4E-6	2.5E-6	1.9E-6	1.5E-6	1.2E-6	1.0E-6
-0.9 to -0.4	1.5E-4	5.6E-5	3.1E-5	2.1E-5	1.5E-5	1.2E-5	7.6E-6	7.8E-6	6.7E-6	5.8E-6
-0.3 to +0.9	2.9E-4	1.2E-4	6.7E-5	4.9E-5	3.4E-5	2.7E-5	2.2E-5	1.9E-5	1.6E-5	1.4E-5
+1.0 to +25.0	6.4E-4	3.1E-4	1.8E-4	1.3E-4	9.5E-5	7.3E-5	6.1E-5	5.0E-5	4.3E-5	3.6E-5

ENCLOSURE 5.4
HP/0/B/1009/14

TABLE 1
NOBLE DECAY CONSTANT (DC)
0 - 498 HRS

HOUR	DC	HOUR	DC	HOUR	DC	HOUR	DC	HOUR	DC
[illegible]	[illegible]	100	1.5471E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	102	1.5477E-02	202	[illegible]	302	[illegible]	402	[illegible]
4	1.4799E-02	104	1.5479E-02	204	[illegible]	[illegible]	[illegible]	404	[illegible]
[illegible]	[illegible]	106	1.5479E-02	206	[illegible]	[illegible]	[illegible]	406	[illegible]
8	[illegible]	108	1.5480E-02	208	[illegible]	[illegible]	[illegible]	408	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	210	[illegible]	310	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	212	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	114	[illegible]	214	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	216	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	118	1.5484E-02	[illegible]	1.5506E-02	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	120	1.5486E-02	220	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]	222	1.5507E-02	322	1.5521E-02	422	[illegible]
[illegible]	[illegible]	124	[illegible]	224	1.5507E-02	324	[illegible]	424	[illegible]
[illegible]	[illegible]	126	1.5487E-02	[illegible]	1.5507E-02	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	228	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	130	[illegible]	[illegible]	[illegible]	330	[illegible]	[illegible]	[illegible]
32	[illegible]	132	[illegible]	[illegible]	[illegible]	332	[illegible]	432	[illegible]
[illegible]	[illegible]	134	[illegible]	234	[illegible]	334	[illegible]	434	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	236	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	138	[illegible]	238	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.5491E-02	240	[illegible]	[illegible]	[illegible]	440	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	242	[illegible]	342	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	244	[illegible]	344	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	248	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	252	[illegible]	[illegible]	[illegible]	452	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	256	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	158	[illegible]	258	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	260	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	262	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	164	[illegible]	264	[illegible]	364	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	266	[illegible]	366	[illegible]	466	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	268	[illegible]	[illegible]	[illegible]	468	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	274	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
80	1.5455E-02	180	1.5499E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
82	1.5458E-02	182	1.5500E-02	282	1.5516E-02	[illegible]	[illegible]	[illegible]	[illegible]
84	1.5461E-02	184	1.5500E-02	284	1.5516E-02	[illegible]	[illegible]	484	1.5541E-02
86	1.5464E-02	186	1.5500E-02	286	1.5516E-02	386	1.5529E-02	486	1.5541E-02
88	1.5466E-02	188	1.5501E-02	288	1.5516E-02	388	1.5529E-02	488	1.5541E-02
90	1.5468E-02	190	1.5501E-02	290	1.5517E-02	390	1.5529E-02	490	1.5542E-02
92	1.5470E-02	192	1.5502E-02	292	1.5517E-02	392	1.5530E-02	492	1.5542E-02
94	1.5472E-02	194	1.5502E-02	294	1.5517E-02	394	1.5530E-02	494	1.5542E-02
96	1.5473E-02	196	1.5502E-02	296	1.5518E-02	396	1.5530E-02	496	1.5543E-02
98	1.5475E-02	198	1.5503E-02	298	1.5518E-02	398	1.5530E-02	498	1.5543E-02

Enclosure 5.5
RP/0/B/1009/14

OCONEE NUCLEAR STATION
TABLE 2
IODINE & NOBLE DECAY CONSTANT (DC)
0 - 498 HRS

HOUR	DC	HOUR	DC	HOUR	DC	HOUR	DC	HOUR	DC
0	1.3309E-05	100	6.6493E-05	200	6.7575E-05	300	6.8263E-05	400	6.880[illegible]
2	2.7292E-05	102	6.6525E-05	202	6.7591E-05	302	6.8275E-05	402	6.8815E-05
4	3.4986E-05	104	6.6557E-05	204	6.7607E-05	304	6.8287E-05	404	6.8824E-05
6	4.0606E-05	106	6.6588E-05	206	6.7622E-05	306	6.8298E-05	406	6.8834E-05
8	4.5033E-05	108	6.6619E-05	208	6.7638E-05	308	6.8310E-05	408	6.8844E-05
10	4.8522E-05	110	6.6648E-05	210	6.7653E-05	310	6.8322E-05	410	6.8853E-05
12	5.1300E-05	112	6.6677E-05	212	6.7669E-05	312	6.8334E-05	412	6.8863E-05
14	5.3531E-05	114	6.6705E-05	214	6.7684E-05	314	6.8346E-05	414	6.8872E-05
16	5.5344E-05	116	6.6732E-05	216	6.7699E-05	316	6.8357E-05	416	6.8882E-05
18	5.6834E-05	118	6.6759E-05	218	6.7714E-05	318	6.8369E-05	418	6.8891E-05
20	5.8073E-05	120	6.6786E-05	220	6.7729E-05	320	6.8381E-05	420	6.8901E-05
22	5.9115E-05	122	6.6811E-05	222	6.7744E-05	322	6.8392E-05	422	6.8910E-05
24	5.9999E-05	124	6.6837E-05	224	6.7758E-05	324	6.8403E-05	424	6.8919E-05
26	6.0754E-05	126	6.6861E-05	226	6.7773E-05	326	6.8415E-05	426	6.8929E-05
28	6.1403E-05	128	6.6886E-05	228	6.7788E-05	328	6.8426E-05	428	6.8938E-05
30	6.1963E-05	130	6.6910E-05	230	6.7802E-05	330	6.8438E-05	430	6.8947E-05
32	6.2448E-05	132	6.6933E-05	232	6.7816E-05	332	6.8449E-05	432	6.8956E-05
34	6.2871E-05	134	6.6956E-05	234	6.7831E-05	334	6.8460E-05	434	6.8965E-05
36	6.3240E-05	136	6.6979E-05	236	6.7845E-05	336	6.8471E-05	436	6.8974E-05
38	6.3563E-05	138	6.7001E-05	238	6.7859E-05	338	6.8482E-05	438	6.8983E-05
40	6.3846E-05	140	6.7023E-05	240	6.7873E-05	340	6.8493E-05	440	6.899[illegible]
42	6.4097E-05	142	6.7045E-05	242	6.7887E-05	342	6.8504E-05	442	6.9002[illegible]
44	6.4318E-05	144	6.7066E-05	244	6.7901E-05	344	6.8515E-05	444	6.9010E-05
46	6.4513E-05	146	6.7088E-05	246	6.7915E-05	346	6.8526E-05	446	6.9019E-05
48	6.4690E-05	148	6.7108E-05	248	6.7929E-05	348	6.8537E-05	448	6.9028E-05
50	6.4847E-05	150	6.7129E-05	250	6.7942E-05	350	6.8548E-05	450	6.9037E-05
52	6.4988E-05	152	6.7149E-05	252	6.7956E-05	352	6.8559E-05	452	6.9046E-05
54	6.5116E-05	154	6.7169E-05	254	6.7969E-05	354	6.8570E-05	454	6.9055E-05
56	6.5232E-05	156	6.7189E-05	256	6.7983E-05	356	6.8580E-05	456	6.9064E-05
58	6.5337E-05	158	6.7208E-05	258	6.7996E-05	358	6.8591E-05	458	6.9072E-05
60	6.5434E-05	160	6.7228E-05	260	6.8010E-05	360	6.8602E-05	460	6.9081E-05
62	6.5522E-05	162	6.7247E-05	262	6.8023E-05	362	6.8612E-05	462	6.9090E-05
64	6.5604E-05	164	6.7266E-05	264	6.8036E-05	364	6.8623E-05	464	6.9098E-05
66	6.5680E-05	166	6.7284E-05	266	6.8049E-05	366	6.8633E-05	466	6.9107E-05
68	6.5751E-05	168	6.7302E-05	268	6.8062E-05	368	6.8644E-05	468	6.9115E-05
70	6.5817E-05	170	6.7321E-05	270	6.8075E-05	370	6.8654E-05	470	6.9124E-05
72	6.5879E-05	172	6.7339E-05	272	6.8088E-05	372	6.8664E-05	472	6.9132E-05
74	6.5937E-05	174	6.7357E-05	274	6.8101E-05	374	6.8675E-05	474	6.9141E-05
76	6.5992E-05	176	6.7374E-05	276	6.8114E-05	376	6.8685E-05	476	6.9149E-05
78	6.6045E-05	178	6.7392E-05	278	6.8126E-05	378	6.8695E-05	478	6.9158E-05
80	6.6094E-05	180	6.7409E-05	280	6.8139E-05	380	6.8705E-05	480	6.9166E-05
82	6.6142E-05	182	6.7426E-05	282	6.8152E-05	382	6.8715E-05	482	6.9174E-05
84	6.6187E-05	184	6.7444E-05	284	6.8164E-05	384	6.8726E-05	484	6.9183E-05
86	6.6230E-05	186	6.7460E-05	286	6.8177E-05	386	6.8736E-05	486	6.9191E-05
88	6.6272E-05	188	6.7477E-05	288	6.8189E-05	388	6.8746E-05	488	6.9199E-05
90	6.6312E-05	190	6.7494E-05	290	6.8202E-05	390	6.8756E-05	490	6.9207E-05
92	6.6351E-05	192	6.7510E-05	292	6.8214E-05	392	6.8766E-05	492	6.921[illegible]
94	6.6388E-05	194	6.7527E-05	294	6.8226E-05	394	6.8775E-05	494	6.922[illegible]
96	6.6424E-05	196	6.7543E-05	296	6.8238E-05	396	6.8785E-05	496	6.9232E-05
98	6.6459E-05	198	6.7559E-05	298	6.8250E-05	398	6.8795E-05	498	6.9240E-05

ENCLOSURE 5.6

HP/0/B/1009/14 Proposed

EVALUATION OF PLUME LOCATION

1. Acquire the following information from Enclosure 5.1 and record on Enclosure 5.7.

   a) Meteorological Data - identify for each point whether data is assumed (A), experiment (E), or measured (T, R or N).

   b) Thyroid and whole body dose

2. Protective action guides submitted to the Offsite Radiological Coordinator are to be made based on the calculated dose on Enclosure 5.1 and the following information.

   A) For doses:

      > 5 Rem Whole Body or,

      > 25 Rem Thyroid

      Recommend Evacuation of Population in Affected Area.

   B) For doses:

      1-5 Rem Whole Body or,

      5-25 Rem Thyroid

      Recommend evacuation of children and pregnant women, and sheltering of remainder of personnel in the affected area.

   C) For doses:

      < 1 Rem Whole Body or,

      < 5 Rem Thyroid

      Recommend no action.

3. To determine sectors affected, complete one of the options under A or B using meterological data from Enclosure 5.1. Record the sectors affected on Enclosure 5.7.

   A. Daytime (1000-1600 hrs.)

      1) Wind speed ≥ 5 mph for tower or river wind direction, use Table 1.

ENCLOSURE 5.6

HP/0/B/1009/14 Proposed

EVALUATION OF PLUME LOCATION

2) Wind speed ≥ 5 mph for NWS wind direction, use Table 2.

3) Wind speed < 5 mph for tower or river wind direction, assume sectors A1, B1, C1, D1, E1, and F1 are affected. Then use Table 1 to determine additional sectors affected.

4. Wind speed < 5 mph for NWS wind direction, assume all sectors are affected (A1 through F1, A2 through F2).

B. Nighttime (1600 - 1000 hrs.)

(If river wind direction is unavailable, assume 70° - 210°).

1) If river wind direction is between 210° - 70°, use Option A (Daytime).

2) If river wind direction is between 70° - 210°, assume all sectors affected (A1 through F1, A2 through F2).

ENCLOSURE 5.6

HP/0/B/1009/14 Proposed

EVALUATION OF PLUME LOCATION

TABLE 1

Wind Direction	Sectors Affected
14°-27°	C1, C2, D1, D2, E1, E2
27°-42°	C1, D1, D2, E1, E2
42°-66°	D1, D2, E1, E2
66°-85°	D1, D2, E1, E2, F2
85°-104°	D1, D2, E1, E2, F1, F2
104°-129°	E1, E2, F1, F2
129°-156°	A1, A2, E1, E2, F1, F2
156°-175°	A1, A2, E1, F1, F2
175°-181°	A1, A2, F1, F2
181°-219°	A1, A2, B1, B2, F1, F2
219°-255°	A1, A2, B1, B2
255°-271°	A1, A2, B1, B2, C1, C2
271°-297°	B1, B2, C1, C2
297°-312°	B1, B2, C1, C2, D2
312°-345°	B1, B2, C1, C2, D1, D2
345°-14°	C1, C2, D1, D2

ENCLOSURE 5.6

HP/0/B/1009/14 Proposed

EVALUATION OF PLUME LOCATION

TABLE 2

Wind Direction	Sectors Affected
1°-39°	B1, B2, C1, C2, E1, E2, F1, F2
39°-75°	A1 through F1, A2 through F2
75°-91°	A1, A2, C1, C2, D1, D2, E1, E2, F1, F2
91°-117°	A1 through F1, A2 through F2
117°-132°	A1, A2, B1, B2, C1, D1, D2, E1, E2, F1, F2
132°-165°	A1, A2, B1, B2, D1, D2, E1, E2, F1, F2
165°-194°	A1 through F1, A2 through F2
194°-207°	A1, A2, B1, B2, C1, C2, E1, E2, F1, F2
207°-222°	A1, A2, B1, B2, C1, C2, D2, E1, E2, F1, F2
222°-246°	A1 through F1, A2 through F2
246°-265°	A1, A2, B1, B2, C1, C2, D1, D2, E1, F1, F2
265°-284°	A1, A2, B1, B2, C1, C2, D1, D2, F1, F2
284°-309°	A1 through F1, A2 through F2
309°-336°	A1, A2, B1, B2, C1, C2, D1, D2, E1, E2
336°-355°	A1, A2, B1, B2, C1, C2, D1, D2, E1, E2, F2
355°-1°	A1 through F1, A2 through F2

ENCLOSURE 5.6

HP/0/B/1009/14 Proposed

EVALUATION OF PLUME LOCATION

4. Determine Stability Class by completing step (a) below and record on Enclosure 5.7.

a)

ΔT	Stability Class
-8 to-1.3	A
-1.2 to -1.0	C
-0.9 to -0.4	D
-0.3 to +0.9	E
+1.0 to +8	F

ENCLOSURE 5.7

DOSE ASSESSMENT REPORT

HP/0/B/1009/14 Proposed

DATE: ____________

TIME: ____________

DOSE ASSESSOR: ____________

WIND DIRECTION ____________ SOURCE ____________

WIND SPEED ____________ MPH SOURCE ____________

ΔT ____________ °F/120 ft SOURCE ____________

STABILITY CLASS ____________

DISTANCE	THYROID/ADULT	THYROID/CHILD	WHOLE BODY	COMMENTS
.5 mi.				
1 mi.				
2 mi.				
3 mi.				
4 mi.				
5 mi.				
6 mi.				
7 mi.				
8 mi.				
9 mi.				
10 mi.				

Sectors Affected ____________

Form SPD-1002-1

DUKE POWER COMPANY
PROCEDURE PREPARATION
PROCESS RECORD

(1) ID No: HP/0/B/1009/11
Change(s) 3 to
N/A Incorporated

(2) STATION: Oconee

(3) PROCEDURE TITLE: Projection of Offsite Dose from the Uncontrolled Release of Radioactive Materials Through a Unit Vent

(4) PREPARED BY: Sarah A Coy DATE: 12-15-82

(5) REVIEWED BY: CT Yongue /DLD DATE: 12-15-82

Cross-Disciplinary Review By: ____________ N/R: ______

(6) TEMPORARY APPROVAL (IF NECESSARY):

By: ____________ (SRO) Date: ____________

By: ____________ Date: ____________

(7) APPROVED BY: Tony B Owen Date: 12/23/82

(8) MISCELLANEOUS:

Reviewed/Approved By: ____________ Date: ____________

Reviewed/Approved By: ____________ Date: ____________

DUKE POWER COMPANY

OCONEE NUCLEAR STATION

PROJECTION OF OFFSITE DOSE FROM THE UNCONTROLLED

RELEASE OF RADIOACTIVE MATERIALS THROUGH A UNIT VENT

1.0 Purpose

This procedure describes the method for calculating the potential offsite dose following an uncontrolled release of radioactive materials through the unit vent.

2.0 References

2.1 EPA-520/1-75-001, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents

2.2 PT/0/A/230/01, Radiation Monitor Check

3.0 Limits and Precautions

3.1 Use actual sample data when possible. Radiation monitor readings are susceptible to several sources of error. When radiation monitor readings are used for downwind concentrations, note this in the report of offsite dose assessment.

3.2 Environmental data should be collected and analyzed to verify these calculations. This procedure considers all releases to be ground level releases.

3.3 Use the computer code ODCAR2 when possible. It is faster, applies a more accurate conversion factor when changing count rate to concentration, and it generates a more concise report. ODCAR2 integrates dose from the initial release and makes two-hour projections from the time of latest data entry.

3.4 Use the manual calculations for times when ODCAR2 is unavailable and if more than one unit is affected.

3.5 This procedure applies to releases made from Oconee Nuclear Station only. Many of the values contained in this procedure are site specific.

3.6 Enclosure 5.7 should be done in conjunction with the Field Monitoring Coordinator.

3.7 Vent releases can occur through more than one unit at a time. Check unit vent monitors on all 3 units during a vent release.

3.8 When using this procedure in conjunction with HP/0/B/1009/10, "Procedure for Quantifying Gaseous Releases through Steam Relief Valves and Post-Accident Conditions", ensure that the correct time is used in Steps 4.4.3 and 4.4.4.

3.9 Meteorology data needed to calculate offsite dose should be obtained as required by Enclosure 5.1. Data not available from the primary source should be obtained from the back up source. The order of preference for each data point is listed each place meteorological data is required. All meteorology data obtained from the tower or river must be a 15 minute average. National Weather Service (NWS) data is a standard observation and is not a 15 minute average.

3.9.1 Every 15 minutes the wind direction and wind speed will be rechecked in accordance with Enclosure 5.1 to ensure additional sectors have not been affected. Once a sector has been determined to be affected it cannot be removed from the list of affected sectors.

3.9.2 The following are conversion formulas for the meterological data obtained from the National Weather Service.

mph = 1.15 (Knots)

°F = (9/5 °C) + 32

4.0 Procedure

4.1 Obtain the following meteorological information from one of the designated sources and record it on Enclosure 5.1. The sources of data are listed in order of preference on Enclosure 5.1.

4.1.1 Time of reactor trip.

4.1.2 Wind speed in MPH.

4.1.3 Direction from which the wind is blowing in degrees from North.

4.1.4 Temperature gradient (ΔT°F).

4.1.5 Time meteorology data taken.

4.2 Obtain results of vent sample analysis and vent flow rate in cfm and record on Enclosure 5.1 for each affected unit.

4.2.1 Date/time of sample.

4.2.2 Gross gas concentration in μCi/ml.

4.2.3 Iodine equivalent concentration (or data for calculation).

4.2.4 Gamma E-bar value in mev/dis (or data for calculation).

NOTE: Actual sample results may not be available due to adverse plant conditions. If sample results are not available, obtain vent radiation monitor readings from the gas and iodine monitors on the unit involved. Record the date/time of data collection and the monitor readings on Enclosure 5.1 Calculate discharge concentration as shown on Enclosure 5.1.

NOTE: The iodine monitor response is time dependent. Allow sufficient time to elapse between readings in order to obtain adequate change in monitor response.

4.3 Project the impact of the release on the downwind population by using the computer code ODCAR2.

NOTE: In the event that ODCAR2 cannot be used, manually calculate the potential dose by the methods outlined in Steps 4.4 thru 4.6.

NOTE: ODCAR will only calculate for one unit at a time.

4.3.1 Using Enclosures 5.1 and 5.2, run ODCAR2 for the unit on which the highest activity is found and obtain a printout of the downwind dose assessment. Then manually calculate potential dose (Step 4.4) from any other affected unit. Add these results onto the printout from ODCAR.

4.3.2 Complete Steps 4.5 thru 4.6 of this procedure.

4.4 Project the impact of the release on the downwind population by using the manual calculations outlined below.

4.4.1 Determine the X/Q values for each point of interest downwind.

NOTE: If no points have been requested, use the 1, 2, 5 and 10 mile values.

4.4.1.1 Locate the relative two hour concentration value (CH) for each point from Enclosure 5.3 and record onto Enclosure 5.4.

4.4.1.2 Convert these values to X/Q by,

$$X/Q = \frac{CH(MPH\text{-}Sec/M^3)}{Wind\ Speed\ (MPH)}$$

Record results on Enclosure 5.4.

4.4.2 Calculate the downwind concentrations for gas and iodine at 1, 2, 5 and 10 mile points by completing Steps 4.4.2.1 and 4.4.2.2.

4.4.2.1 $Conc_T$ = Unit 1 ($Conc_V \cdot F_V$) + Unit 2 ($Conc_V \cdot F_V$) + Unit 3 ($Conc_V \cdot F_V$)

where,

$Conc_T$ = total concentration in unit vents (μCi/ml · cfm)

$Conc_V$ = vent discharge concentration (μCi/ml)

F_V = vent discharge flow rate (CFM)

4.4.2.2 $Conc_{DW} = Conc_T \cdot X/Q \cdot U_{DWC}$

where,

$Conc_{DW}$ = downwind concentration (μCi/ml)

$Conc_T$ = total concentration in unit vents (μCi/ml · cfm)

X/Q = dispersion factor in sec/m^3

U_{DWC} = unit conversions derived from (2.832E-2m^3/ft^3), (0.017 min/sec) = 4.7E-4

Enclosure 5.4 provides work space for this calculation.

4.4.3 Determine the potential whole body gamma dose downwind using the gas concentrations calculated above and the equation,

$D_{WB} = U_G \cdot \bar{E} \cdot Conc_{DW} \cdot Time$

where,

D_{WB} = whole body gamma dose due to submersion in a cloud of radioactive gas (rem)

U_G = unit conversion derived from,

(2.22E6/dis/μCi min), (cc/1.293E-3g),

(60 min/hr.), (1.602E-6 erg/mev),

(g · rem/100 ergs),

$(1.1? P_t/P_a) \cdot 1/2 = 9.00E2 \frac{dis\text{-}rem\text{-}cc}{\mu Ci\text{-}hr\text{-}Mev}$

$Conc_{DW}$ = downwind concentration (µCi/ml)

Time = projected duration of exposure (hrs); use 2 hours unless calculating a release from a steam relief valve.

$\bar{E}$ = average gamma energy per disintegration (Mev/dis)

NOTE: If $\bar{E}$ cannot be obtained from the sample results, the following values can be used:

Hours from Trip	$\bar{E}$ (Mev/dis)
0-12	0.40
12-48	0.20
48-∞	0.10

Record results on Enclosure 5.4.

4.4.3.1 Use Enclosure 5.5 as an alternate means of whole body exposure approximation.

4.4.4 Determine the potential thyroid dose downwind using the iodine concentrations calculated above and the equation.

$D_{THY} = U_I \cdot Conc_{DW} \cdot Time$

where.

D_{THY} = thyroid dose due to uptake of radioactive iodine (rem)

U_I = constants derived from a child's breathing rate (1.17E2 cc/sec.), I-131 dose conversion factor (4.39 E-3 mrem/pCi), and conversion of pCi to µCi(10^6), mrem to rem (10^{-3}), and hrs. to sec (3600 sec/hr) = 1.86 E6 $\frac{cc \cdot Rem}{\mu ci \cdot hr}$

$Conc_{DW}$ = downwind concentration of iodine (µCi/ml)

Time = projected exposure time (hrs); use 2 hours unless calculating a release from a steam relief valve.

Record results on Enclosure 5.4.

4.4.4.1 Use Enclosure 5.6 as an alternate means of thyroid exposure approximation.

4.5 Calculate an adult's thyroid dose by dividing the child's dose by two (2). Record results of all calculations on Enclosure 5.8.

4.6 Determine the potentially affected area using the method outlined in Enclosure 5.7. Record sectors on Enclosure 5.8.

4.7 Complete Enclosure 5.8 with information from Enclosure 5.1 and submit it to the Offsite Radiological Coodinator or his designee. Include any comments and information pertinent to the evaluation of offsite hazards.

NOTE: Maintain a file of all worksheets and printouts used in dose calculations.

5.0 Enclosures

5.1 Vent Release Data Sheet

5.2 ODCAR2 User's Guide

Appendix A: Sample Run of ODCAR

5.3 Table of Two Hour Relative Concentration Factors

5.4 Manual Calculation Worksheet

5.5 Graph of Noble Gas Concentration vs. Whole Body Dose

5.6 Graph of I-131 Concentration vs. Thyroid Dose

5.7 Evaluation of Plume Location

5.8 Dose Assessment Report

ENCLOSURE 5.1
HP/0/B/1009/11
VENT RELEASE DATA SHEET

Date/time __________/__________

Unit __________ Date/time of Rx trip __________/__________

METEOROLOGICAL DATA

(All data is 15 min average except NWS)

A) Daytime-1000-1600 hrs (Circle source of data for each point)

-15 min. period ending time

__________ __________ __________ __________

-wind direction (degrees)
Sources 1) Tower (T)
2) River (R)
3) NWS (N)

T R N__________; T R N__________; T R N__________; T R N__________

-ΔT (°F)
Sources 1) Tower (T)
2) Assume (A) - -0.4°F

T A__________

-wind speed (mph)
Sources 1) Tower (T)
2) River (R)
3) NWS (N)

T R N__________; T R N__________; T R N__________; T R N__________

B) Nighttime-1600-1000 hrs (circle source of data for each point)

-15 min. period ending time

__________ __________ __________ __________

River Wind Direction (If river wind direction is unavailable assume 70°-210°)

Using the river wind direction above complete #1 or #2 below

ENCLOSURE 5.1
HP/0/B/1009/11

1) River wind direction is between 210°-70°

-wind direction (degrees)
Sources 1) Tower (T)
2) Assume (A) - between 0-360°

T ; T ; T ; T
A__________; A__________; A__________; A__________

-ΔT (°F)
Sources 1) Tower (T)
2) Assume (A) - +1.0°F

T
A__________;

-wind speed (mph)
Sources 1) Tower (T)
2) Assume (A) -1 mph

T ; T ; T ; T
A__________; A__________; A__________; A__________

2) River wind direction is between 70°-210° (Sources below are based on experiment)

-wind direction (degrees)

Source 1) Between 0-360° (E)

E__________; E__________; E__________; E__________

-ΔT (°F)
Source 1) +1.0°F (E)

E__________

-wind speed (mph)
Source 1) 1 mph (E)

E__________; E__________; E__________; E__________

VENT SAMPLE ANALYSIS

1) Total Gas __________ μCi/ml - Unit 1

__________ μCi/ml - Unit 2

__________ μCi/ml - Unit 3

ENCLOSURE 5.1
HP/0/B/1009/11

2) I-131 Equiv. ____________ μCi/ml - Unit 1 $I_E = \frac{\Sigma A_i \cdot HL_i}{HL_{I-131}}$

____________ μCi/ml - Unit 2

____________ μCi/ml - Unit 3

3) Gas $\bar{E}$ ____________ Mev/dis (Gamma) - Unit 1

____________ Mev/dis (Gamma) - Unit 2

____________ Mev/dis (Gamma) - Unit 3

Sample Results

$$\bar{E} = \frac{[\Sigma \bar{E}_i \cdot A_i]}{A_t}$$

Calculated

Hours from Trip/	$\bar{E}$
0-12	.4
12-48	.2
48-∞	.1

VENT MONITOR DATA

1) RIA 45 (Lo range) ____________ CPM - Unit 1

____________ CPM - Unit 2

____________ CPM - Unit 3

2) RIA 46 (hi range) ____________ CPM - Unit 1

____________ CPM - Unit 2

____________ CPM - Unit 3

3) ΔRIA 44 (iodine) ____________ CPM; Δt ____________ min - Unit 1

____________ CPM; Δt ____________ min - Unit 2

____________ CPM; Δt ____________ min - Unit 3

4) RIA 56 (hi range) ____________ mr/hr - Unit 1

____________ mr/hr - Unit 2

____________ mr/hr - Unit 3

ENCLOSURE 5.2
HP/0/B/1009/11
ODCAR2 USER GUIDE

1.0 Introduction

The complete code ODCAR2 was designed to calculate offsite dose from gaseous releases through the unit vent. This guide is to aid the user in running ODCAR2 on VAX. In this guide, computer responses will be shown inside double bold lines. User responses will be shown underlined. The mark signifies a carriage return.

ODCAR will only calculate for one unit at a time. If more than one unit is affected, use ODCAR for the unit showing the highest activity. Any other unit will be calculated manually and added to the ODCAR results.

2.0 Procedure

2.1 Complete VAX LOGON procedure outlined below.

2.1.1 Depress parity and duplex keys.

2.1.2 Pick up receiver and dial ________. When tone is heard, depress data key and return to phone cradle.

2.1.3 Type in a carriage return ( ).

2.1.4 The computer will request: user name:

Answer with: ODC7310

2.1.5 The computer will then request: Password:

Respond by typing: DOSE

2.2 Computer will hesitate for a few seconds to load program and read the initial data file.

2.3 Computer will then respond with: INITIALIZE (YES OR NO)

Answer YES for first run of the program to initialize data files and history files.

Answer NO for subsequent runs of the program to allow the computer to account for past history of the release.

2.3.1 If initialized, computer will type: ENTER TIME OF TRIP

Enter the date and time of the reactor trip.

ENCLOSURE 5.1
HP/0/B/1009/11

CALCULATED DISCHARGE CONCENTRATION

1) Gas - (Use RIA 56 if on scale; if not on scale, use RIA 45 or RIA 46. RIA-46 is considered on scale at > 10 cpm)

$Conc_V = \frac{(\text{RIA-56 mr/hr})}{3.2E-2}$ = __________μCi/ml, Unit 1
__________μCi/ml, Unit 2
__________μCi/ml, Unit 3

$Conc_V = \frac{(\text{RIA-45 cpm})}{1E7}$ = __________μCi/ml, Unit 1
__________μCi/ml, Unit 2
__________μCi/ml, Unit 3

$Conc_V = \frac{(\text{RIA-46 cpm})}{5E3}$ = __________μCi/ml, Unit 1
__________μCi/ml, Unit 2
__________μCi/ml, Unit 3

2) Iodine

$Conc_{V-I} = \frac{(\Delta\text{RIA 44 CPM})(1.0E-9)}{\Delta t}$ = __________μCi/ml, Unit 1

__________μCi/ml, Unit 2

__________μCi/ml, Unit 3

ENCLOSURE 5.2
HP/0/B/1009/11

Format: month, day, year, time

Example: 11,10,80,0945

2.4 Computer will type: ENTER WIND SPEED (MPH)

Enter the wind speed in miles per hour.
Example: 12.0

2.5 Computer will type: ENTER WIND DIRECTION (°FROM NORTH)

Enter wind direction

Example: 127.0

NOTE: At night when wind direction is 0°-360°, enter 360° into the computer.

2.6 Computer will type: ENTER TEMP DIFFERENTIAL (DEG.F)

Enter the temperature differential using degrees Fahrenheit.
Example: -1.6

2.7 Computer will type: INPUT RELEASE RATE IN CFM

Enter the release flow rate (unit vent flow rate) in cubic feet per minute.

Example: 1.3E3

NOTE: Exponential notation may be used, but does not have to be.

2.8 Computer will type: ENTER TIME DATA WAS TAKEN

Enter the time of day (approximately) that all of the data being entered was collected.

Example: 11,10,80,0945

2.9 Computer will type: RELEASE CONC. IS KNOWN (K) OR UNKNOWN (U)

If release concentration is known, use case (A) below. If the release concentration is not known, skip down to Case (B).

(A) Enter a K if the release concentration is known (such as from unit vent sample results.)

ENCLOSURE 5.2
HP/0/B/1009/11

2.9.1 Computer will type: ENTER GROSS NOBLE GAS CONC.

Example: 1.3 E-2

Use units of microcuries per cubic centimeter.

2.9.2 Computer will type: ENTER I-131 EQUIV. CONC.

Example: Same as 2.9.1

2.9.3 Computer will type: ENTER GAS E-BAR

Example: 0.27

NOTE: This E-Bar number can be obtained from sample results.

(B) Enter a U if the release concentration is unknown (processs monitor information).

2.9.4 Computer will type: ENTER GAS LOW RANGE CPM (RIA-45)

Enter the counts per minute reading from the RIA-45 display.
Example: 1.2 E 4

NOTE: RIA 45 goes offscale at 1E6 cpm. Enter 1E6 if RIA-46 is > 100 cpm.

2.9.5 Computer will type: ENTER GAS HI-RANGE CPM (RIA-46)

Enter counts per minute from RIA-46.
Example: 1.2 E 3

NOTE: ODCAR does not consider RIA-46 on scale until > 100 cpm.

2.9.6 Computer will type: ENTER IODINE CHANGE IN CPM (RIA-44)

Enter the change in counts per minute observed on RIA-44 over a measured period of time.
Example: 1.4 E 4

2.9.7 Computer will type: ENTER TIME (MINUTES) OF CHANGE

Enter the time in minutes over which the change in RIA-44 took place.
Example: 10.0

ENCLOSURE 5.2
HP/0/B/1009/11

2.10 Computer will now calculate, and update history files:
Computer will type:

WHEN READY FOR PRINTOUT, ADVANCE TO TOP OF PAGE AND ENTER NUMBER 9

Example: 9

2.11 Computer will print, program will end, and the computer logs off.

2.12 When computer has signed off, hang up the phone or start at Step 2.1.3 and continue data entry. Release the phone line at the end of the session (when logged off) by depressing the LOCAL/TALK key.

ENCLOSURE 5.2, APPENDIX A

HP/0/B/1009/11

SAMPLE RUN OF ODCAR2

```
Username: ODC7310
Password:

        Welcome to VAX/VMS Version V2.3 on node _OCO::
INITIALIZE? (YES OR NO)
YES
ENTER TIME OF TRIP
11 12 80 0900
ENTER TOWER WIND SPEED (MPH)
2.2
ENTER TOWER WIND DIRECTION (DEGREES FROM NORTH)
148
ENTER TEMP DIFFERENTIAL (DEG F)
-1.6
INPUT RELEASE FLOW RATE (CFM)
12000
ENTER TIME DATA WAS TAKEN
11 12 80 1000
RELEASE CONC. IS KNOWN(K) OF UNKNOWN(U)
U
ENTER GAS LOW RANGE CPM (RIA-45)
1.3E6
ENTER GAS HI RANGE CPM (RIA-46)
1.2E4
ENTER IODINE CHANGE IN CPM (RIA-44)
1.5E5
ENTER TIME (MINUTES) OF CHANGE
2.0

                WHEN READY FOR PRINTOUT,
                 ADVANCE TO TOP OF PAGE
                  AND ENTER NUMBER 9.
```

ENCLOSURE 5.2, APPENDIX A

HP/0/B/1009/11

SAMPLE RUN OF ODCAR2

PLUME DIRECTION: 3.28E+02 DEGREES RELEASE FLOW RATE: 1.20E+04 CFM
WINDSPEED: 2.2 MPH
DELTA TEMP: -1.6 DEG F NOBLE GAS RELEASE CONC: 2.82E+01 UCL/ML
IODINE RELEASE CONC.: 3.62E-04 UCI/ML

TIME OF TRIP: 11/12/80 900
TIME OF SAMPLE: 11/12/80 1000

EMERGENCY LEVEL
SITE EMERGENCY

DISTANCE DOWNWIND (MILES)	SUBMERSION DOSE RATE (REM/HR)	SUBMERSION DOSE-TOTAL (REM)	SUBMERSION DOSE-TOTAL + 2 HOURS (REM)	PRESENT CONCENTRATION (UCI/ML)
1	4.081E-01	4.081E-01	1.224E+00	9.388E-04
2	2.951E-02	2.951E-02	8.853E-02	6.788E-05
3	1.695E-02	1.695E-02	5.085E-02	3.900E-05
4	1.256E-02	1.256E-02	3.767E-02	2.889E-05
5	1.067E-02	1.067E-02	3.202E-02	2.455E-05
6	9.104E-03	9.104E-03	2.731E-02	2.094E-05
7	7.848E-03	7.848E-03	2.354E-02	1.805E-05
8	6.906E-03	6.906E-03	2.072E-02	1.589E-05
9	6.278E-03	6.278E-03	1.884E-02	1.444E-05
10	5.651E-03	5.651E-03	1.695E-02	1.300E-05

	THYROID DOSE-TOTAL (REM)	THYROID DOSE-TOTAL + 2 HOURS (REM)	PRESENT CONCENTRATION (UCI/ML)
1	2.244E-02	6.733E-02	1.206E-08
2	1.623E-03	4.868E-03	8.719E-10
3	9.323E-04	2.797E-03	5.009E-10
4	6.906E-04	2.072E-03	3.710E-10
5	5.870E-04	1.761E-03	3.154E-10
6	5.007E-04	1.502E-03	2.690E-10
7	4.316E-04	1.295E-03	2.319E-10
8	3.798E-04	1.139E-03	2.041E-10
9	3.453E-04	1.036E-03	1.855E-10
10	3.108E-04	9.323E-04	1.670E-10

FORTRAN STOP
ODC7310 logged out at 18-AUG-1981 07:59:40.80

Enclosure 5.3

Table of Two-Hour Relative Concentration Factors

Temperature Difference ΔT°F	Distance (Miles)									
	1	2	3	4	5	6	7	8	9	10
-25.0 to -1.3	1.5E-6	9.4E-7	5.4E-7	4.0E-7	3.4E-7	2.9E-7	2.5E-7	2.2E-7	2.0E-7	1.8E-7
-1.2 to -1.0	5.8E-5	1.6E-5	8.1E-6	4.9E-6	3.4E-6	2.5E-6	1.9E-6	1.5E-6	1.2E-6	1.0E-6
-0.9 to -0.4	1.5E-4	5.6E-5	3.1E-5	2.1E-5	1.5E-5	1.2E-5	7.6E-6	7.8E-6	6.7E-6	5.8E-6
-0.3 to +0.9	2.9E-4	1.2E-4	6.7E-5	4.9E-5	3.4E-5	2.7E-5	2.2E-5	1.9E-5	1.6E-5	1.4E-5
+1.0 to +25.0	6.4E-4	[illegible].1E-4	1.8E-4	1.3E-4	9.5E-5	7.3E-5	6.1E-5	5.0E-5	4.3E-5	3.6E-5

ENCLOSURE 5.4
HP/0/B/1009/11
MANUAL CALCULATION WORKSHEET

1) Discharge Concentration ($Conc_V$):

Gas = ________ μCi/ml U-1; ________ μCi/ml U-2; ________ μCi/ml U-3

Iodine = ________ μCi/ml U-1; ________ μCi/ml U-2; ________ μCi/ml U-3

2) Vent Discharge Flow Rate:

F_V = ________ CFM U-1; ________ CFM U-2; ________ CFM U-3

3) Wind Speed

________ MPH (Enclosure 5.1)

4) Total Concentration: $Conc_T$ = U-1 ($Conc_V \cdot F_V$) + U-2 ($Conc_V \cdot F_V$) + U-3 ($Conc_V \cdot F_V$)

Gas = ________ μCi/ml · cfm

Iodine = ________ μCi/ml · cfm

5) Two Hour Relative Conc. Factors (CH) = sec-mph/m^3 X/Q - CH/mph = sec/m^3)

CH @ ________ Mi = ____________; X/Q = ____________ Sec/m^3

CH @ ________ Mi = ____________; X/Q = ____________ Sec/m^3

CH @ ________ Mi = ____________; X/Q = ____________ Sec/m^3

CH @ ________ Mi = ____________; X/Q = ____________ Sec/m^3

6) Downwind Concenctrations: $Conc_{DW} = Conc_T \cdot X/Q \cdot (4.7E-4)$

A) Gas

$Conc_{DW}$ = ____________ μCi/ml @ ________ Mi

$Conc_{DW}$ = ____________ μCi/ml @ ________ Mi

$Conc_{DW}$ = ____________ μCi/ml @ ________ Mi

$Conc_{DW}$ = ____________ μCi/ml @ ________ Mi

ENCLOSURE 5.4
HP/0/B/1009/11
MANUAL CALCULATION WORKSHEET

B) Iodine

$Conc_{DW}$ = ______________ μCi/ml @ __________ Mi

$Conc_{DW}$ = ______________ μCi/ml @ __________ Mi

$Conc_{DW}$ = ______________ μCi/ml @ __________ Mi

$Conc_{DW}$ = ______________ μCi/ml @ __________ Mi

7) Potential Whole Body Gamma Dose: $D_{WB} = (9.00\ E2) \cdot Conc_{DW} \cdot \bar{E} \cdot Time$

$\bar{E}$ = ______________ Mev/dis Time = __________ hours*

D_{WB} ______________ Rem @ ______________ Mi

D_{WB} ______________ Rem @ ______________ Mi

D_{WB} ______________ Rem @ ______________ Mi

D_{WB} ______________ Rem @ ______________ Mi

8) Potential Thyroid Dose: $D_{THY} = (1.36E6) \cdot Conc_{DW} \cdot Time$

Time = __________ hours*

D_{THY} ______________ Rem @ ______________ Mi

D_{THY} ______________ Rem @ ______________ Mi

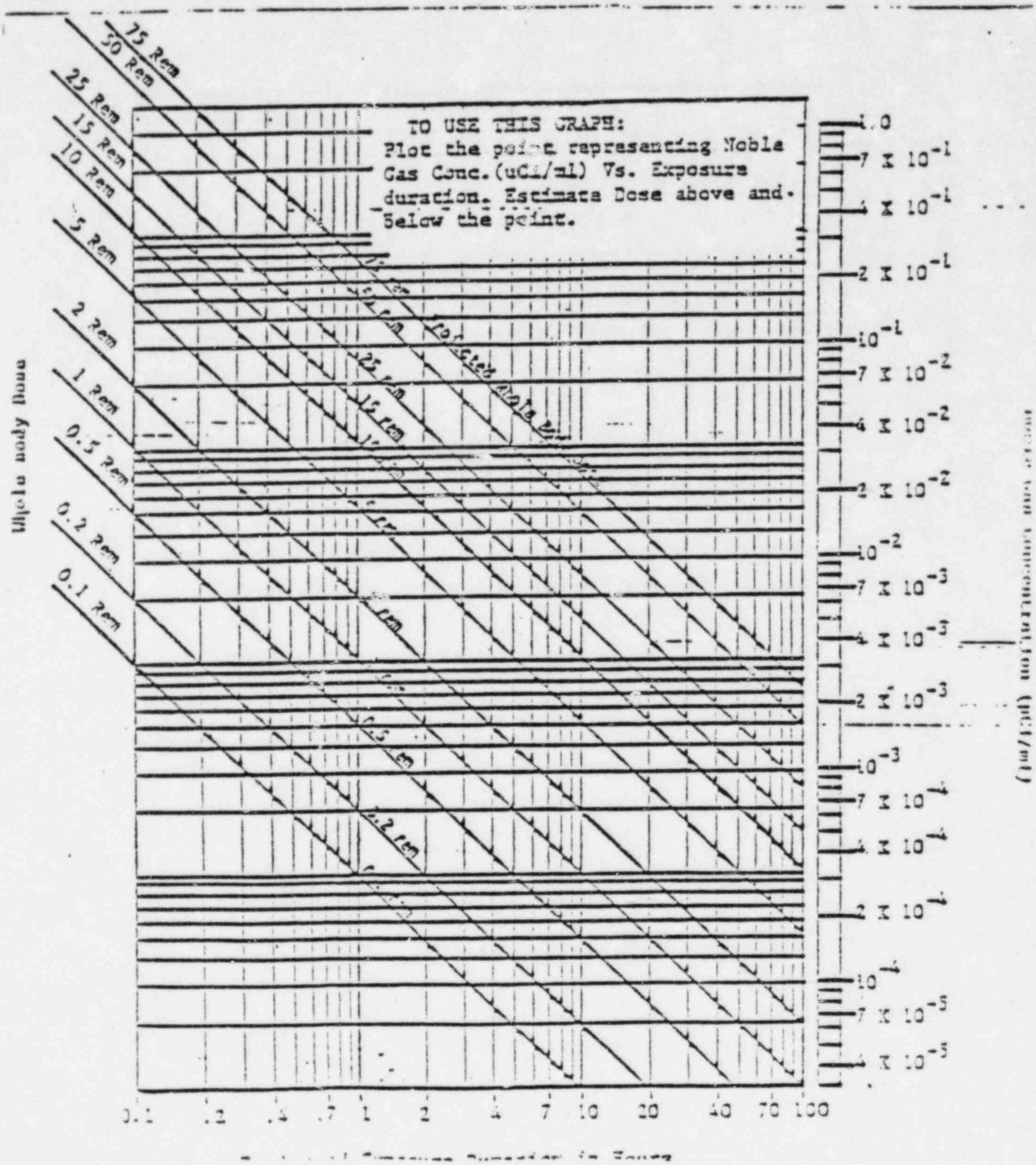
D_{THY} ______________ Rem @ ______________ Mi

D_{THY} ______________ Rem @ ______________ Mi

*Ensure correct time is used for steam relief valve release.

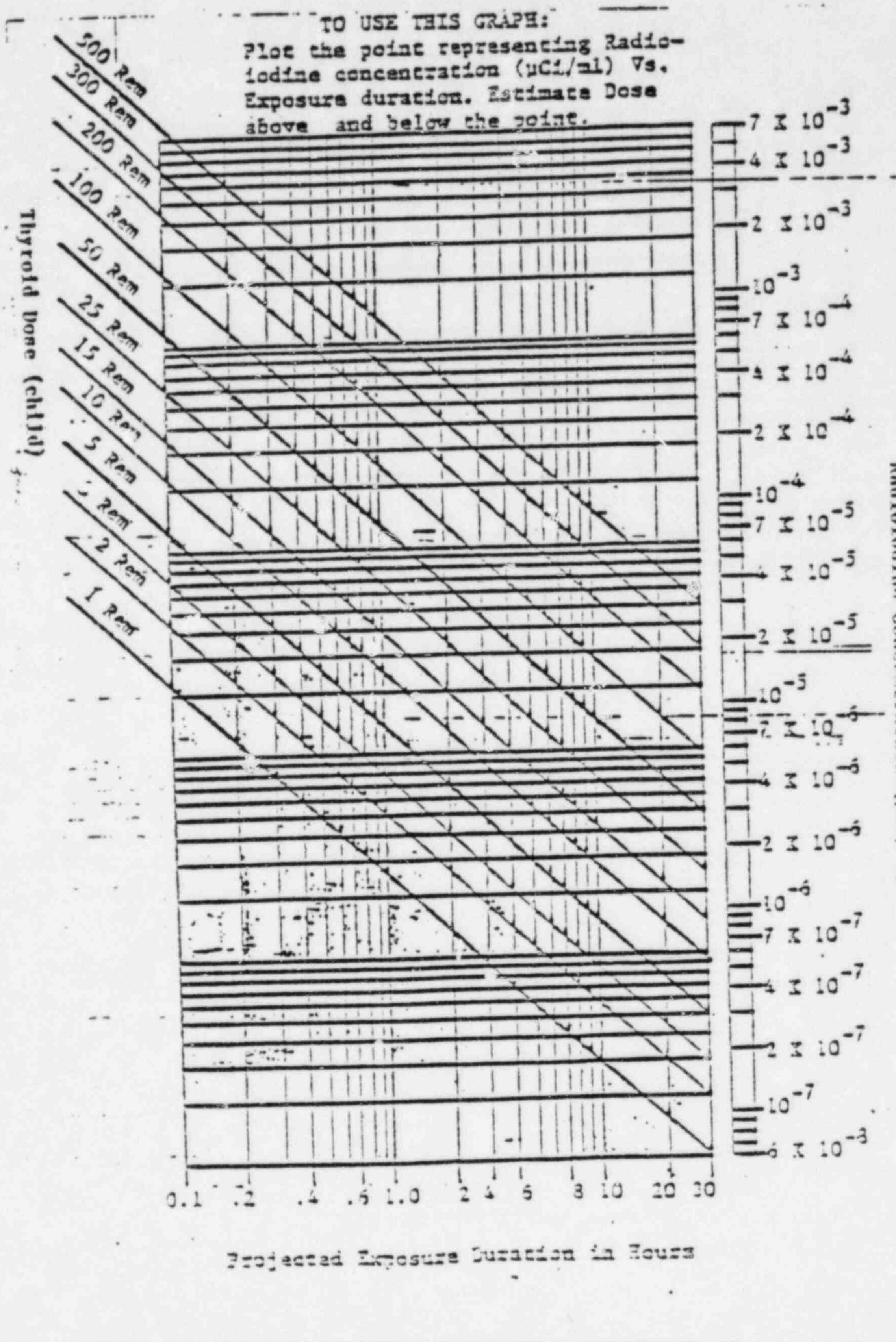
ENCLOSURE 5.5

NOBLE GAS CONCENTRATION VS. WHOLE BODY DOSE



ENCLOSURE 5.6

IODINE CONCENTRATION VS. THYROID DOSE



ENCLOSURE 5.7
HP/0/B/1009/11
EVALUATION OF PLUME LOCATION

1. Acquire the following information from Enclosure 5.1 and record on Enclosure 5.8.

   a) Meteorological Data - identify for each point whether data is assumed (A), experiment (E) or measured (T, R or N).

   b) thyroid and whole body doses

2. Protective action guides submitted to the Offsite Radiological Coordinator are to be made based on the calculated dose on Enclosure 5.1 and the following information.

   a) For doses:

      > 5 Rem Whole Body or,

      >25 Rem Thyroid

      Recommend Evacuation of Population in Affected Area.

   b) For doses:

      1-5 Rem Whole Body or,

      5-25 Rem Thyroid

      Recommend evacuation of children and pregnant women, and sheltering of remainder of personnel in the affected area.

   c) For doses:

      < 1 Rem Whole Body or,

      < 5 Rem Thyroid

      Recommend no action.

3. Determine Stability Class by completing step a below and record on Enclosure 5.8.

ENCLOSURE 5.7
HP/0/B/1009/11
EVALUATION OF PLUME LOCATION

a)

ΔT	Stability Class
-8 to-1.3	A
-1.2 to -1.0	C
-0.9 to -0.4	D
-0.3 to +0.9	E
+1.0 to +8	F

4. To determine the sectors affected, complete one of the options under A or B. Record the sectors affected on Enclosure 5.8.

A) Daytime (1000-1600 hrs)

1) wind speed ≥ 5 mph for tower or river wind direction, use Table 1.
2) wind speed ≥ 5 mph for NWS wind direction, use Table 2.
3) wind speed < 5 mph for tower or river wind direction, assume sectors A1, B1, C1, D1, E1, and F1 are affected. Then use Table 1 to determine additional sectors affected.
4) wind speed < 5 mph NWS wind direction, assume all sectors affected (A1 through F1, A2 through F2).

TABLE 1

Wind Direction	Sectors Affected
14°-27°	C1, C2, D1, D2, E1, E2
27°-42°	C1, D1, D2, E1, E2
42°-66°	D1, D2, E1, E2
66°-85°	D1, D2, E1, E2, F2
85°-104°	D1, D2, E1, E2, F1, F2
104°-129°	E1, E2, F1, F2
129°-156°	A1, A2, E1, E2, F1, F2
156°-175°	A1, A2, E1, F1, F2
175°-181°	A1, A2, F1, F2
181°-219°	A1, A2, B1, B2, F1, F2
219°-255°	A1, A2, B1, B2
255°-271°	A1, A2, B1, B2, C1, C2
271°-297°	B1, B2, C1, C2
297°-312°	B1, B2, C1, C2, D2
312°-345°	B1, B2, C1, C2, D1, D2
345°-14°	C1, C2, D1, D2

ENCLOSURE 5.7
HP/0/B/1009/11
EVALUATION OF PLUME LOCATION

EVALUATION OF PLUME LOCATION

TABLE 2

Wind Direction	Sectors Affected
1°-39°	B1, B2, C1, C2, E1, E2, F1, F2
39°-75°	A1 through F1, A2 through F2
75°-91°	A1, A2, C1, C2, D1, D2, E1, E2, F1, F2
91°-117°	A1 through F1, A2 through F2
117°-132°	A1, A2, B1, B2, C1, D1, D2, E1, E2, F1, F2
132°-165°	A1, A2, B1, B2, D1, D2, E1, E2, F1, F2
165°-194°	A1 through F1, A2 through F2
194°-207°	A1, A2, B1, B2, C1, C2, E1, E2, F1, F2
207°-222°	A1, A2, B1, B2, C1, C2, D2, E1, E2, F1, F2
222°-246°	A1 through F1, A2 through F2
246°-265°	A1, A2, B1, B2, C1, C2, D1, D2, E1, F1, F2
265°-284°	A1, A2, B1, B2, C1, C2, D1, D2, F1, F2
284°-309°	A1 through F1, A2 through F2
309°-336°	A1, A2, B1, B2, C1, C2, D1, D2, E1, E2
336°-355°	A1, A2, B1, B2, C1, C2, D1, D2, E1, E2, F2
355°-1°	A1 through F1, A2 through F2

4. B) Nighttime (1600-1000 hrs)

(If river wind direction is unavailable, assume 70°-210°.)

1) If river wind direction is between 210°-70°, use Option A (Daytime).

2) If river wind direction is between 70°-210°, assume all sectors affected (A1 through F1, A2 through F2).

ENCLOSURE 5.8

DOSE ASSESSMENT REPORT

HP/0/B/1009/11

DATE: ____________________

TIME: ____________________

DOSE ASSESSOR: __________________________

WIND DIRECTION _________________________ SOURCE ____________________

WIND SPEED _______________ MPH SOURCE __________

ΔT _______________ °F/120ft SOURCE __________

STABILITY CLASS _______________

DISTANCE	THYROID/ADULT	THYROID/CHILD	WHOLE BODY	COMMENTS
.5 mi.				
1 mi.				
2 mi.				
3 mi.				
4 mi.				
5 mi.				
6 mi.				
7 mi.				
8 mi.				
9 mi.				
10 mi.				

Sectors Affected ____