EMERGENCY PLAN PROCEDURES CONTENTS

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EMERGENCY PLAN PROCEDURES INDEX REV. 21 (PAGE 1)

Procedure #	Procedure Title	Rev. #	Date
Dose Assessment			
IP-1001	Discussion of the DMR	4	10/83
IP-1002	Determination of the Magnitude of Release	5	12/83 |
IP-1003	Obtaining Meteorological Data	4	11/82
IP-1004	Midas Computer System-Dose Assessment Models	3	11/82
IP-1005	Planned Disch. of Cont. Atmos. During Accident Conditions	2	1/82
Environmental Monitoring			
IP-1010	In-Plant/Site Perimeter Surveys	4	8/83
IP-1011	Offsite Monitoring	5	12/83 |
IP-1017	Rec. Protective Actions for Offsite Population	2	1/82
IP-1018	Post Accident Environmental Sampling and Counting	2	11/82
Personnel Injury			
IP-1021	Radiological Medical Emergency	8	10/83
IP-1022	Transport of Contam. Injured Personnel Between Unit 3 & 1	1	11/82
IP-1023	Use and Set-up of Unit 3 Personnel Decon Suite	0	11/82
Damage Assessment			
IP-1025	Repair and Corrective Action Teams	3	8/83
IP-1027	Emergency Personnel Exposure	2	8/83
IP-1028	Core Damage Assessment	0	11/83 |
Notification and Communication			
IP-1030	Control Room Emergency Notif., Communication & Staffing	9	10/83
IP-1031	Procedure for EOF Emergency Notification & Communications	1	10/83
IP-1038	Use of the Emergency Communications Systems	5	8/83
Emergency Operation Facilities			
IP-1040	Habitability of the Emergency Facilities	5	12/82
IP-1041	Personnel Monitoring of EOF, TSC and OSC Personnel	4	7/82
IP-1045	Technical Support Center	5	8/83
IP-1047	Operations Support Center	6	10/83
Accountability and Evacuation			
IP-1050	Accountability	6	8/83
IP-1053	Evacuation of Site	2	10/83
IP-1054	Search and Rescue Teams	2	8/83
Non-Radiological Emergencies			
IP-1055	Fire Emergency	2	2/83

Procedure #	Procedure Title	Rev. #	Date
IP-1056	Directing Fire Fighting Personnel in Controlled Areas	1	1/82
IP-1057	Tornado (Hurricane) Emergency	1	10/83
IP-1058	Earthquake Emergency	5	5/83
IP-1059	Air Raid Alert	1	10/83
HP Release Surveys and Decontamination			
IP-1060	Personnel Radiological Check and Decontamination	2	1/82
IP-1063	Vehicle/Equipment Radiological Check and Decontamination	2	1/82
Emergency Equipment and Maintenance			
IP-1070	Periodic Check of Emergency Preparedness Equipment	8	7/83
IP-1076	Beepers	4	10/83
Exercises, Drills and Training			
IP-1080	Conduct of Emergency Exercises and Drills	5	5/83
IP-1085	Emergency Response Training	3	11/82

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EMERGENCY PLAN PROCEDURES

PROCEDURE NO IP- 1002 REV. 5

TITLE" DETERMINATION OF THE MAGNITUDE OF RELEASE "

WRITTEN BY: Gerald O. Ford

REVIEWED BY: [signature]

PORC REVIEW: [signature] DATE 1[illegible]

APPROVED BY: John C. Brons DATE 12/9/83

EFFECTIVE DATE: 12/12/83

DETERMINATION OF THE MAGNITUDE OF RELEASE

1.0 INTENT:

To describe various methods of estimating the whole body dose due to radioactive noble gas and the thyroid dose due to radioactive Iodine for the offsite population.

2.0 DISCUSSION:

There are two primary methods of estimating offsite dose. One method is to use plant instrumentation to determine a release rate, and using dispersion factors based on meteorology, project offsite dose.

The second method involves taking radiation readings and samples offsite, then using ratios of dispersion factors to estimate the dose at various offsite locations. The offsite readings would be taken by mobile survey teams and by installed offsite instrumentation (Reuter Stokes monitors). Both of these methods should be used to verify accuracy.

When thyroid doses are calculated in this procedure (including flowchart), the child thyroid dose is conservatively used, since the child thyroid dose is approximately two times the adult thyroid dose for iodine inhalation. This is appropriate for offsite dose projections, but onsite dose projections should use the adult thyroid dose (Adult thyroid dose = child thyroid dose divided by 2)

3.0 PROCEDURE

3.1 Follow the flow charts, EP-Flowchart #'s 1a & 1b keeping in mind these basic steps:

1. determine the release rate
2. determine the site boundary concentration
3. determine the site boundary dose
4. determine the point of interest dose

3.2 Use graphs and tables on pages 6 - 8 in conjunction with the flow charts, (EP-Flowchart #'s 1a & 1b) as well as IP-1001, (section 7 & Figure 1) on the choice and placement of the meteorological overlays to determine the site boundary dose projections and the point of interest dose projections.

3.3 Along with these calculations,

a) The on site monitoring team is to be sent to the site boundary (IP-1010) for actual radiological readings.

b) The offsite team is to be called in and sent to areas the plume is expected to pass over. (The overlays are to be used as guidance for plume path and IP-1011 as guidance for the offsite team).

c) The chem. tech. shall be directed to take a sample of the activity in the Plant Vent if the radiological conditions prove safe to do so.

- The chemist should be instructed to remove and count the normal weekly iodine plant charcoal cartridge. (This will determine how much iodine has been released)
  NOTE: Total Iodines

- Sample the Noble Gases currently in the Plant Vent by taking a gaseous Marinelli sample.

(Until the chem sample is obtained and analyzed, a total Iodine to Noble gas ratio of 10^{-4} is assumed. This may prove to be overly conservative, or an underestimate, all dependent on plant conditions. Therefore, it is necessary to have a chem sample as soon as possible and use the new value (Total I/NG) in the dose projection calculations when making any decisions on protective actions.)

If initial dose projections are done using the estimated (Total I/NG) ratio of 10^{-4}, one should state to offsite authorities it is only a rough estimate, and we will be providing more accurate information by direct sampling shortly. This should be considered when taking or recommending protective actions based on projected thyroid exposure.

3.4 When an actual chemistry sample is available, the dose projections are corrected by the following:

$$\frac{\text{(Total I/NG) chem sample}}{10^{-4}} \times \text{estimated Iodine dose} = \text{corrected Iodine dose}$$

3.5 An estimate of the duration of the release should be obtained from the Emergency Director. If it is unknown, use 4 hours as a first estimate.

3.6 Implementation Procedure IP-1017 offers assistance on the recommendations which can be made to offsite authorities regarding offsite protective actions for the public.

3.7 Table 3 includes the projected thyroid dose as a function of the individual iodine isotope concentrations in air and the projected exposure time. This can be used to more exactly convert radioiodine concentration field measurement to exposure if the isotopic mix is known.

3.8 If on or offsite sampling teams have reported a gamma mR/hr reading, an initial estimate of thyroid exposure can be obtained by multiplying the gamma dose rate (mR/hr) by .15.

$$\text{gamma dose rate} \times .15 = \text{thyroid dose rate}$$

Multiplying the thyroid dose rate by hours breathed will give you the approximate iodine dose to an individual at that location.

NOTE: The direct gamma reading (mR/hr) is primarily the dose rate from the Noble Gases in the plume.

3.9 All offsite dose projections should be considered estimates until verification from measurements in the field are obtained.

4.0 ATTACHMENTS

4.1 Flow Chart for Determining Release Rate

4.2 Flow Chart for Determining Dose

4.3 Conversion Factors

4.4 Site Boundary Isopleth Values by Wind Direction and Pasquill Stability Category

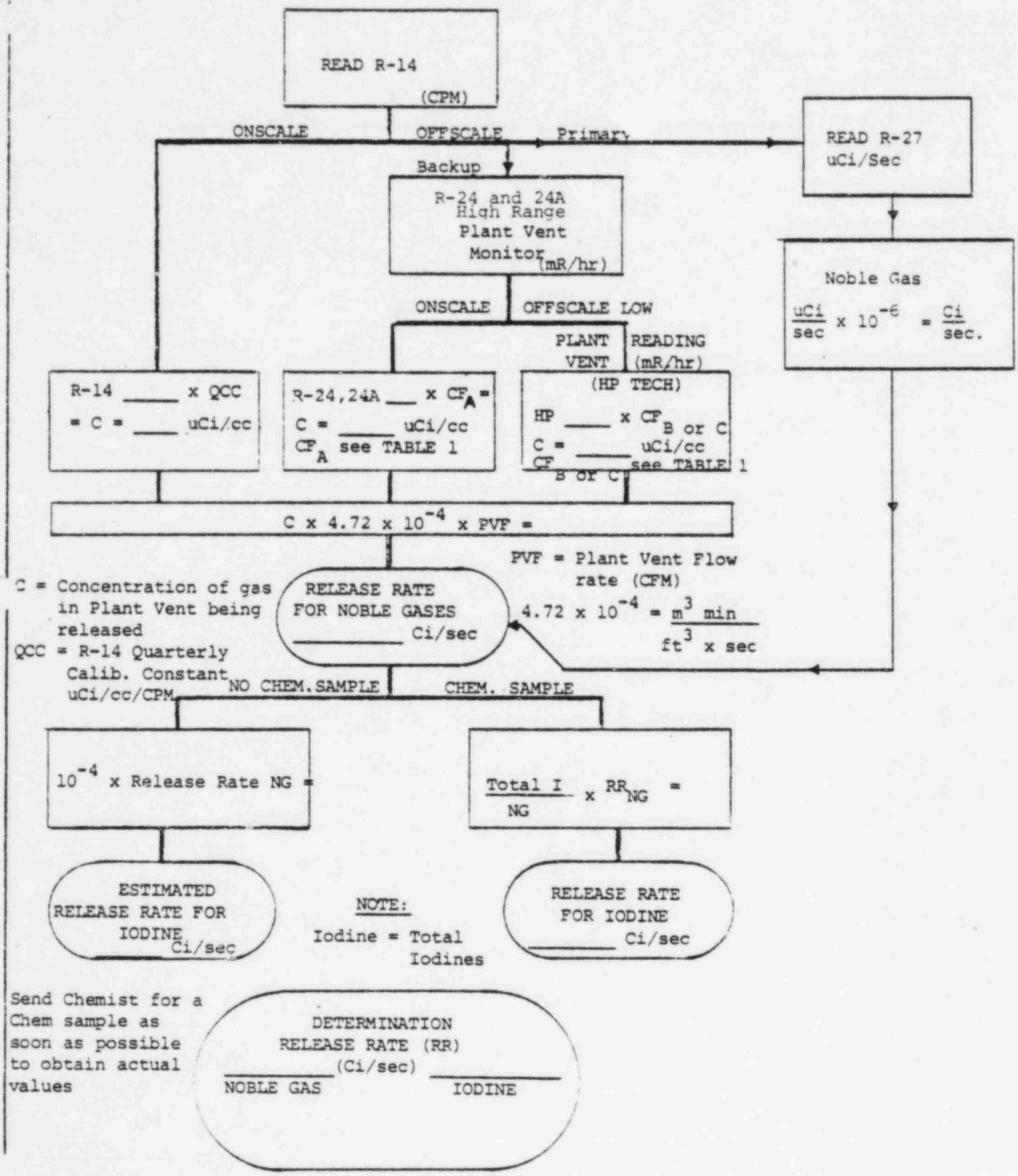
4.5 Total Inhalation Dose Conversion Factors

5

EP Flowchart #1a

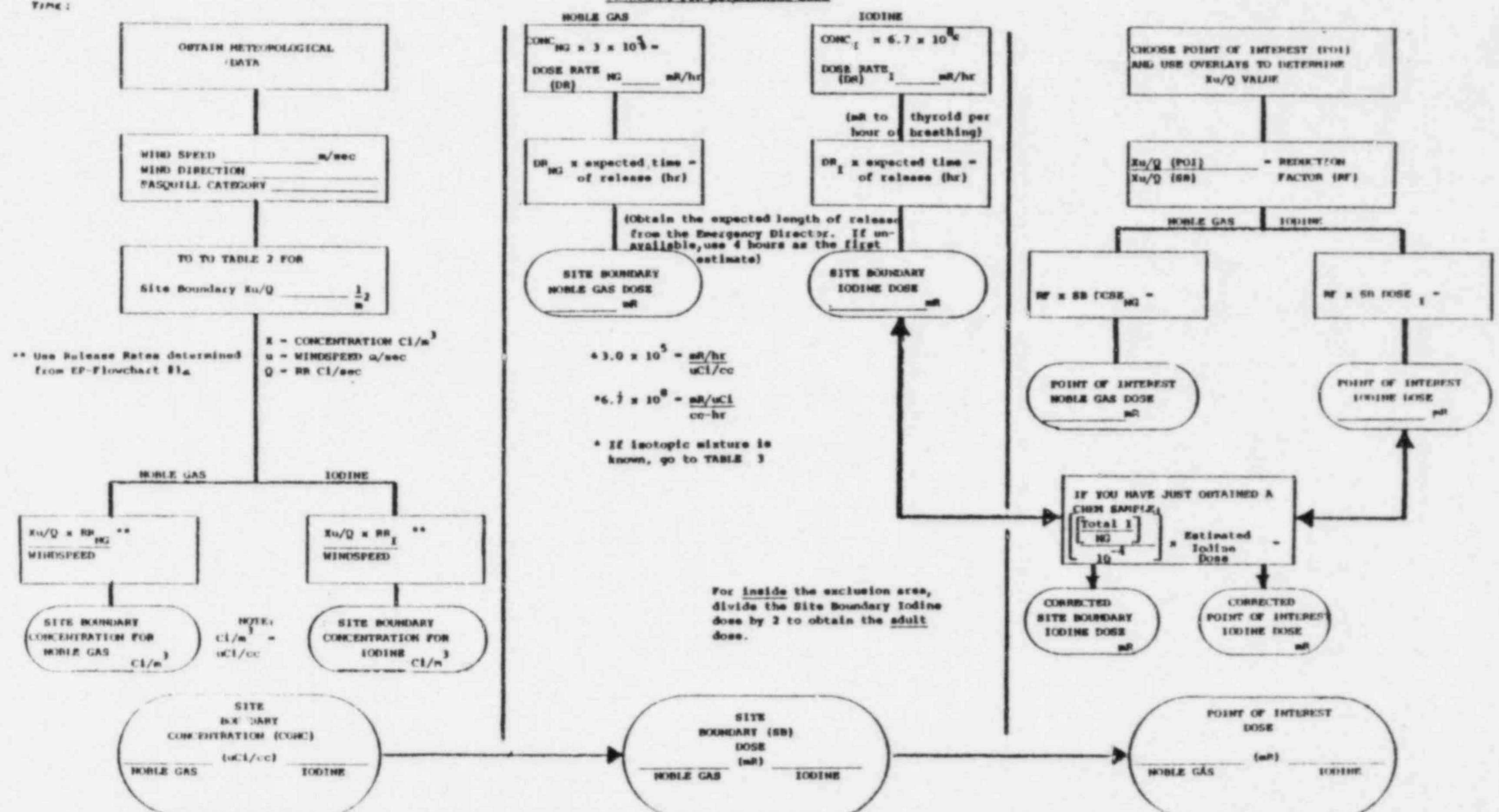
FLOWCHART FOR DETERMINING RELEASE RATE

Date:
Time:



DATE:
TIME:

EP-FLOWCHART #1b
FLOWCHART FOR DETERMINING DOSE



NOTE: If 10^{-4} (I/NG) was used, it should be stated to offsite authorities that the thyroid dose value is only a rough estimate, and we will be providing more accurate information by direct sampling shortly. This rough estimate value should be reviewed accordingly when taking or recommending protective actions based on projected thyroid exposure.

TABLE 1

CONVERSION FACTORS

$\frac{uCi/cc}{mR/hr}$

Time After Reactor Shutdown	Column A R-24,24A High Range Plant Vent Monitor	Column B Contact With Plant Vent	Column C 6 Ft. From Plant Vent
0-2 hr.	0.487	6×10^{-4}	2.5×10^{-3}
2-4 hr.	0.830	1.2×10^{-3}	3.8×10^{-3}
4-6 hr.	1.2	1.6×10^{-3}	5.5×10^{-3}
6-12 hrs.	1.95	2.8×10^{-3}	9.5×10^{-3}
12 - 24 hrs.	3.5	5.5×10^{-3}	1.6×10^{-2}
24 hrs.-2 wks.	4.7	6.5×10^{-3}	2.0×10^{-2}
more than 2 wks.	5.3	7.3×10^{-3}	2.3×10^{-2}

TABLE 2

SITE BOUNDARY ISOPLETH VALUES BY WIND DIRECTION AND PASQUILL STABILITY CATEGORY

Pasquill		A	B	C	D	E	F	G
Wind Direction (from)*	Boundary Sample Point	Boundary X u/Q	Boundary X u/Q	Boundary X u/Q	Boundary X u/Q	Boundary X u/Q	Boundary X u/Q	Boundary X u/Q
0°	10 → 12	2.2 E-6	3.4 E-6	2.8 E-5	1.7 E-4	1.2 E-4	4.0 E-4	1.2 E-3
10°	12 → 13	2.1 E-6	2.7 E-6	2.5 E-5	8.5 E-5	1.0 E-4	3.6 E-4	1.1 E-3
20°	13 → 14	2.2 E-6	3.4 E-6	2.8 E-5	1.7 E-4	1.2 E-4	4.0 E-4	1.2 E-3
30°	14 → 17	5.8 E-6	7.4 E-6	6.1 E-5	1.8 E-5	2.3 E-4	7.6 E-4	2.3 E-3
40°	18	1.3 E-5	1.6 E-5	1.1 E-4	3.9 E-4	4.4 E-4	1.5 E-3	4.5 E-3
50°	18 → 19	1.5 E-5	1.8 E-5	1.3 E-4	4.3 E-4	4.8 E-4	1.6 E-3	4.8 E-3
60°	19	1.8 E-5	2.1 E-5	1.5 E-5	5.1 E-4	5.3 E-4	1.8 E-3	5.4 E-3
70°	19 → 20	3.1 E-5	3.5 E-5	2.5 E-4	7.5 E-4	8.0 E-4	2.9 E-3	8.7 E-3
80°	20 → 21	5.7 E-5	6.2 E-5	4.0 E-4	1.1 E-3	1.3 E-3	4.8 E-3	1.4 E-2
90°	21	8.0 E-5	8.5 E-5	5.1 E-4	1.5 E-3	1.8 E-3	6.3 E-3	1.9 E-2
100°	21	9.7 E-5	1.0 E-4	6.0 E-4	1.7 E-3	2.1 E-3	7.4 E-3	2.2 E-2
110°	22	1.1 E-4	1.1 E-4	6.5 E-4	1.9 E-3	2.3 E-3	8.0 E-3	2.4 E-2
120°	22	1.4 E-4	1.4 E-4	8.0 E-4	2.3 E-3	2.8 E-3	9.9 E-3	3.0 E-2
130°	22	1.4 E-4	1.4 E-4	8.0 E-4	2.3 E-3	2.8 E-3	9.9 E-3	3.0 E-2
140°	22	1.4 E-4	1.4 E-4	8.0 E-4	2.3 E-3	2.8 E-3	9.9 E-3	3.0 E-2
150°	22	1.0 E-4	1.1 E-4	6.3 E-4	1.8 E-3	2.2 E-3	7.8 E-3	2.3 E-2
160°	22	8.6 E-5	9.2 E-5	5.5 E-4	1.6 E-3	1.9 E-3	6.7 E-3	2.0 E-2
170°	Water	9.0 E-5	9.5 E-5	5.6 E-4	1.6 E-3	2.0 E-3	6.9 E-3	2.1 E-2
180°	Water	6.0 E-5	6.5 E-5	4.1 E-4	1.2 E-3	1.4 E-3	5.0 E-3	1.5 E-2
190°	Water	3.6 E-5	4.0 E-5	2.8 E-4	8.1 E-4	9.0 E-4	3.3 E-3	1.0 E-2
200°	Water	2.0 E-6	2.4 E-6	1.8 E-4	5.8 E-4	5.8 E-4	2.0 E-3	6.0 E-3
210°	Water	9.4 E-6	1.2 E-5	8.4 E-5	2.8 E-4	3.3 E-4	1.1 E-3	3.3 E-3
220°	Water	5.4 E-6	7.0 E-6	5.8 E-5	1.8 E-4	2.2 E-4	7.3 E-4	2.2 E-3
230°	1	5.0 E-6	6.4 E-6	5.4 E-5	1.7 E-4	2.1 E-4	6.8 E-4	7.0 E-3
240°	1 → 2	5.9 E-6	7.4 E-6	6.2 E-5	1.8 E-4	2.3 E-4	7.7 E-4	2.3 E-3
250°	2 → 3	6.5 E-6	8.3 E-6	6.6 E-5	2.0 E-4	2.5 E-4	8.3 E-4	2.5 E-3
260°	3 → 4	5.1 E-6	6.6 E-6	5.5 E-5	1.7 E-4	2.1 E-4	7.0 E-4	2.1 E-3
270°	4 → 5	5.7 E-6	7.3 E-6	6.0 E-5	1.8 E-4	2.3 E-4	7.6 E-4	2.3 E-3
280°	5	7.5 E-6	9.7 E-6	7.2 E-5	2.3 E-4	2.8 E-4	9.2 E-4	2.8 E-3
290°	5 → 6	8.6 E-6	1.1 E-5	7.8 E-5	2.6 E-4	3.1 E-4	1.0 E-3	3.0 E-3
300°	6	9.6 E-6	1.2 E-5	8.6 E-5	2.9 E-4	3.4 E-4	1.1 E-3	3.3 E-3
310°	6 → 7	9.6 E-6	1.2 E-5	8.6 E-5	2.9 E-4	3.4 E-4	1.1 E-3	3.3 E-3
320°	7	8.9 E-6	1.2 E-5	8.1 E-5	2.7 E-4	3.2 E-4	1.1 E-3	3.3 E-3
330°	7 → 8	7.5 E-6	1.0 E-5	7.4 E-5	2.4 E-4	2.9 E-4	9.6 E-4	2.9 E-3
340°	8 → 9	6.1 E-6	7.7 E-6	6.3 E-5	1.9 E-4	2.4 E-4	7.9 E-4	2.4 E-3
350°	9 → 10	4.5 E-6	5.9 E-6	5.0 E-5	1.6 E-4	1.9 E-4	6.3 E-4	1.9 E-3

* The wind direction is ± 5° of table value (i.e.: 5° - <u>10°</u> - 15°)

TABLE 3

TOTAL INHALATION DOSE CONVERSION FACTORS

ISOTOPES	DOSE CONVERSION FACTOR $\frac{mRem}{hr} / \frac{uCi}{cc}$
I-131	1.6×10^9
I-132	7.9×10^7
I-133	5.4×10^8
I-134	4.0×10^7
I-135	1.6×10^8
Iodine Mix (post accident)	6.7×10^8

NOTE: If the Iodine mix is not known and it is within 24 hours of shutdown, use the Post Accident Iodine Mix dose conversion factor (6.7×10^8). After 24 hours, use the I-131 dose conversion factor.

* Concentration x Dose Conversion Factor = Dose Rate

$$(uCi/cc) \times \frac{mRem}{hr} / \frac{uCi}{cc} = mRem/hr$$

* Concentration can be determined by calculation or by field samples.

Field Samples: SAM - use I-131 DCF (1.6×10^9)
HP-210 - use Iodine Mix DCF (6.7×10^8)

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EMERGENCY PLAN PROCEDURES

PROCEDURE NO IP- 1011 REV. 5

TITLE" OFFSITE MONITORING "

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PORC REVIEW: [signature] DATE

APPROVED BY: John C Brons DATE 12/9/83

EFFECTIVE DATE: 12/12/83

OFFSITE MONITORING

1.0 INTENT

This procedure addresses the various methods of offsite monitoring which are available within the plume exposure pathway.

2.0 DISCUSSION

A combination of these methods of offsite monitoring should give an idea of the radiological conditions of the environment within a 10 mile radius of Indian Point.

Various methods of offsite monitoring are:

2.1 Offsite monitoring teams:

A. Beta and Gamma surveys:

1. Survey results
2. TLD's

B. Air Sampling (Iodine & Particulate):

1. Continuous Sampling
2. Emergency Locations

2.2 Reuter Stokes:

A. Gamma monitoring
B. Meteorological monitoring (wind speed & direction)

3.0 PROCEDURE FOR OFFSITE MONITORING TEAM MONITORING

3.1 Offsite monitoring locations have been predetermined and locations are listed on Attachment 6.1 of this procedure. To determine which locations should be monitored, use the overlays, 10 mile sector map and Attachment 6.1. The types of monitoring would include:

A. Iodine Sampling:

1. From fixed sample locations (continuous air sampling)
2. Emergency Sampling Sites

B. Whole Body dose:

1. TLD's at Fixed Locations

3.2 Members of the offsite monitoring teams are Con Edison NEM personnel.

3.3 CONTROL ROOM ACTIONS:

A. Control Room personnel should request offsite monitoring team assistance immediately upon declaration of a Site Area or General Emergency, and in certain cases during an Alert (radiological in nature).

B. The IP-3 Control Room personnel should telephone the Unit No. 2 Watch Foreman:

1. Request offsite monitoring team assistance
2. Direct the teams to the Emergency Operation Facility (EOF)

C. Ready yourselves to receive information via the Con Edison frequency radio, using EP-Form #4 and EP-Form #5.

3.4 OFFSITE MONITORING TEAM:

A. Are made up from Con Edison NEM personnel

B. Are to follow the Con Edison Procedure IP-1015

3.5 RADIOLOGICAL ASSESSMENT TEAM:

A. Determine which offsite monitoring locations the offsite teams should be sent to.

1. Using overlays
2. Using Table 1 of this procedure

B. Instruct the offsite monitoring team(s) to appropriate sample locations:

1. Predetermined Emergency Sampling Locations
2. Continuous Air Sampling Locations
3. TLD sites

C. Discuss the need for KI with the Emergency Director and Monitoring Teams. Issue if appropriate.

D. Receive information via the radio:

1. Monitoring team location(s)
2. Sampling results (Using forms EP-Form #4, and EP-Form #5)

   a) Beta and gamma field readings obtained while proceeding to the site.

   b) Beta-gamma field readings obtained at the sample point.

   c) Concentration of radioactivity on the particulate filters. Also report the sample CPM, the instrument background CPM, the sample volume in ft^3, and the counter efficiency.

d) Concentration of Iodines on the charcoal or silver zeolite filter. Also report the sample CPM, the instrument background CPM and the sample volume in ft^3, and the counter efficiency.

4.0 PROCEDURE FOR REUTER STOKES INTERPRETATION

4.1 Reuter Stokes monitors are located in each of the 16 sectors within a 3 mile radius of Indian Point. Real time Whole body dose rates, integrated dose, (Gamma) and meteorological (wind speed & direction) information can be remotely interrogated usir the Reuter Stokes Sentrii 1011 System and the MIDAS computer.

4.2 RADIOLOGICAL ASSESSMENT TEAM:

A. Using MIDAS, obtain Reuter Stokes data.

5.0 RECORD RENTENTION

5.1 The Radiological Communicator is responsible for retaining all data sheets, forms, and plots pertaining to offsite Radiological Assessment.

6.0 ATTACHMENTS

6.1 Offsite Monitoring Locations

6.2 Monitoring Team Field Survey

6.3 Environmental TLD and Air Sample Readout 5

OFFSITE MONITORING LOCATIONS

LOCATION NAME	SECT	MILE	CAS	EAS	R/S	TLD
Roa Hook Rd. - Sanatation Garage (Cortlandt)	1	2	CAS	EAS		TLD
Bear Mtn. Rd. near Old Stone on Hudson	1	2			R/S	
Rte. 9D Garrison	1	5				TLD
Rte. 9D St. Francis Retreat (Garrison)	1	7		EAS		
St. Basils Academy	1	9				TLD
Rte. 9D Derham Cross Rd. (Cold Spring)	1	10		EAS		
Old Pemart Ave. (Peekskill)	2	2		EAS		TLD
Annsville Circle, Texaco Station	2	2.5			R/S	
Highland Ave. & Sprout Brook Rd.	2	3		EAS		
Gallows Hill Rd.	2	6				TLD
Canopus Hollow Rd. & Old Albany Post Rd	2	6		EAS		
Canopus Hollow Rd. & Bell Hollow Rd.	2	10		EAS		TLD
North East Corner (site)	3	.5				TLD
Louisa St. & R.R. Bridge	3	1		EAS		
Lower Scuth St. & Bay St.	3	1.5				TLD
Peekskill Gas Holder	3	2	CAS			
Hudson St. & RR Street (Peekskill) (Carbones Rest.)	3	2			R/S	
Hamilton St.	3	3				TLD
Hillcrest School (Peekskill)	3	3		EAS		
Oregon Road Substation	3	4	CAS			
Westbrook Dr.	3	6				TLD
Oregon Corners (Putnam Valley)	3	6		EAS		
Peekskill Hollow Rd. & Tinker Hill Rd.	3	10		EAS		TLD
Lents Cove	4	.5				TLD
Standard Brands	4	1	CAS			TLD
Old Dump	4	1				TLD
Lower South St., Merle Corp.(Peekskill)	4	1		EAS		
Lower South St. near West. Iron	4	1			R/S	
Lower South St. & Louisa St.	4	1.5				TLD
Maple Ave. Entrance to Mt. Florence School	4	3		EAS		
Pine Rd.	4	5				TLD
Lexington Ave. & Townsend Rd. (Cortlandt)	4	6		EAS		
Somerston Rd. & Carol Ct. (Yorktown)	4	10		EAS		TLD
Bleakley & Broadway	5	.5	CAS			TLD
Lower S. St. near By Pass Diner	5	1			R/S	
Welcher Ave. & McKinely School Playground	5	1.5				TLD
McKinley St. & Welcher Ave.(Peekskill)	5	2		EAS		
Maple Ave. & Furnace Woods Rd. (Cortlandt)	5	4		EAS		
Croton Ave.	5	6				TLD
Hunterbrook Rd. @ CoAx Sta. #571 (Yorktown)	5	7		EAS		
Moseman Rd. & St. Patricks School (Yorktown)	5	10		EAS		TLD

LOCATION NAME	SECT	MILE	CAS	EAS	R/S	TLD
Simulator Building	6	.5				TLD
Broadway, between Bleakley & Service Center	6	.5			R/S	
Tensolite Corp. Rt. 9A (Buchanan)	6	1		EAS		
Factory St.	6	1.5				TLD
Watch Hill Rd & Mt. Side Trail (Cortlandt)	6	3		EAS		
Colabaugh Pond Rd.	6	6				TLD
Rte. 129 @ Hunterbrook Bridge(Yorktown)	6	7		EAS		
Rte. 100 & Rte. 134	6	10		EAS		TLD
Water Meter House	7	.5				TLD
Broadway, at Service Center Gate	7	.5			R/S	
Buchanan Village Hall	7	1	CAS			TLD
Westchester Ave. & First St. (Buchanan)	7	1		EAS		
Furnace Dock	7	4	CAS			TLD
Watch Hill Rd. & Westminister Dr. (Cortlandt)	7	4		EAS		
Mt. Airy & Winsor Rd	7	5				TLD
Cleveland Dr. & Hughes St. (Croton)	7	6		EAS		
North State Rd. & Ryder Ave.	7	10		EAS		TLD
Environmental Lab	8	.5	CAS			TLD
Service Building	8	.5	CAS			TLD
Broadway, S.W. of Sub Station	8	.5			R/S	
Westchester Ave. & School Exit (Buchanan)	8	1		EAS		
Tate Ave.	8	1.5				TLD
Crugers R.R. Station (Cortlandt)	8	3		EAS		
Croton Point & Sample Site	8	7	CAS	EAS		TLD
Liberty St. & Hudson St. (Ossining)	8	10		EAS		TLD
South East Corner (site)	9	1				TLD
14th St. Between Broadway & Wes . Ave.	9	1		EAS		
Broadway at St. Mary's Cemetary	9	1			R/S	
Montrose Marina	9	2				TLD
Montrose Pt. Rd. (Cortlandt)	9	3		EAS		
Warren Ave. Haverstraw	9	5				TLD
Rte. 9W & So.Mt.Rd. (Short Cove) (Clarkstown)	9	7		EAS		
Kings Highway & Old Mill Rd. (Clarkstown)	9	10		EAS		TLD

LOCATION NAME	SECT	MILE	CAS	EAS	R/S	TLD
Onsite Pole	10	.5				TLD
N.Y.U. Tower	10	1	CAS			TLD
11th St. & Highland Ave. (Verplanck)	10	1		EAS		
11th St. & Highland (Con Ed Property)	10	1			R/S	
Verplanck	10	1.5				TLD
Grassy Point	10	4	CAS			TLD
Beach Rd. & Grassy Pt. Rd. (Stony Pt.)	10	4		EAS		
Railroad Ave. & Rte. 9W	10	5				TLD
Little Tor Rd. & South Mt. Rd. (Clarkstown)	10	7		EAS		
West Clarkstown Rd. & Palisades Pkwy. Overpass (Clarkstown)	10	10		EAS		TLD
White Beach Texas Inst. (Verplanck)	11	1		EAS		
Algonquin Gas Line Crossing	11	1	CAS			TLD
Trap Rock at end of 9th Ave. (White Beach)	11	1			R/S	
Gilmore Dr. & Adams Dr. (Stony Pt.)	11	3		EAS		
Willow Grove Rd. & Birch Dr.	11	5				TLD
Willow Grove Rd. & Knapp Rd.(Haverstraw)	11	6		EAS		
Haverstraw Rd. (Rte. 202) & Wilder Rd.	11	10		EAS		TLD
Gays Hill Rd. (south end) & Rte. 9W	12	2		EAS	R/S	TLD
Lovett Plant	12	2	CAS			
Frank Rd. & Bulson Town Rd.(Stony Pt.)	12	4		EAS		
Palisades Pkwy. (sign going So.,NY&NJ)	12	5				TLD
Lake Welch Pkwy. & Sewage Plant (Harrison)	12	7		EAS		
Lake Welch Pkwy. & 7 Lakes Pkwy. (Harrison)	12	10		EAS		TLD
Gays Hill Rd. (north end) & Rte. 9W	13	2		EAS	R/S	TLD
Mott Farm Rd. @ Entrance to Camp Addison Boyce (Tuxedo)	13	3		EAS		
Palisades Pkwy. (So. of Gas Station)	13	5				TLD
Arden Valley & Lake Cohasset	13	9		EAS		TLD
Dock (Onsite)	14	.5				TLD
Rte. 9W at Pirates Cove Rest.(Stony Pt.)	14	2		EAS	R/S	TLD
Anthony Wayne Park	14	5				TLD
Rte. 6, 1 mi. West of Palisades Pkwy.	14	6		EAS		
County Rte. 9 @ Thruway (Woodbury)	14	10		EAS		TLD
Rte. 9W & Anchor Monument (Stony Pt.)	15	1		EAS		
Rte. 9W So. of Ayers Rd.	15	1				TLD
9W & 202 (Pole # NYT #225)	15	1			R/S	
Front Entrance Bear Mt. Inn	15	4		EAS		
Palisades Pkwy. (Lake Welch Exit going South)	15	5				TLD
Mine Rd. & Weynants Rd. (Highland)	15	6		EAS		
Mineral Springs Rd. & County Rte. 34	15	10		EAS		TLD

LOCATION NAME	SECT	MILE	CAS	EAS	R/S	TLD
Ayers Rd., Jones Point (Stony Pt.)	16	1		EAS	R/S	TLD
Bear Mt. Bridge West End	16	4		EAS		
Fort Montgomery	16	5				TLD
0.4 mi West. Junction Rts. 9W & 218	16	6		EAS		
Rte. 9W & Rte. 293 (Highland)	16	9		EAS		TLD

SECT: Sector

CAS: Continuous Air Sampling Site (Green dots)

EAS: Emergency Air Sampling Site (Yellow dots)

R/S: Reuter Stokes (Blue dots)

TLD: TLD (Red dots)

Mile determinations are made in this manner:
Miles are determined by the mile sector which encompasses it.

Example: If site is between sector 1 & 2, it will be referred to as mile 2.

EP-Form #4

MONITORING TEAM FIELD SURVEY

Instrument Model No. ______________ Serial Number ______________

Individuals Name ______________ Date ______________

Survey Location or Site Perimeter Sector Number	Time	B + γ mR/hr	γ mR/hr	[(B + γ)-γ]4 mrad/hr	Remarks

ENVIRONMENTAL TLD AND AIR SAMPLE READOUT

Prior to Discharge ☐ After Discharge ☐
Sample Pickup - Date__________Time____________Indiv.__________________
Sample Process - Date_________Time____________Indiv.__________________

TLD		AIR SAMPLE			
Sector Mile Zone	mRem	Sector Mile Zone	Iodine uCi Part.	Iodine uCi Char.	Thy. Rem*

*Note: 1 uCi of Iodine on filter (Part. or char.) is approximately equal to 1 Rem exposure to the adult thyroid.

Indian Point 3
Nuclear Power Plant
P.O. Box 215
Buchanan, New York 10511
914 739.8200

New York Power Authority

EMERGENCY PLAN PROCEDURES

PROCEDURE NO IP- 1028 REV. 0

TITLE" Core Damage Assessment "

WRITTEN BY: Dennis Quinn 11-29-83

REVIEWED BY: [signature] 11-29-83

PORC REVIEW: [signature] DATE 12/1/83

APPROVED BY: John C Brons DATE 12/1/83

EFFECTIVE DATE:

CORE DAMAGE ASSESSMENT PROCEDURE

1.0 PURPOSE

To provide a methodology to determine the extent of core damage following a postulated accident based on radionuclide concentrations in reactor coolant (RCS) and containment atmosphere (VC) samples as well as other plant indications and parameters.

2.0 DATA PREREQUISITES

The information described in the following paragraphs will be utilized in assessing the core damage condition. Where information (other than measured concentrations) is not fully available and cannot be obtained in a timely manner, attempts should be made to conservatively estimate those values, with the use of such estimates noted in all discussions and evaluations of results.

2.1 RCS and VC samples have been taken and analyzed (with appropriate isotopic breakdown) in accordance with established post accident sampling procedures. The appropriate source of the liquid sample will depend on the particular accident scenario.

2.2 The following additional information has been obtained:

2.2.1 The reactor coolant temperature at the time the sample is taken.

2.2.2 Temperature of the RCS sample.

2.2.3 Pressure and temperature of both the containment atmosphere (at time of sampling) and the corresponding sample.

2.2.4 The volume of emergency core cooling water injected into the primary system.

2.2.5 The amount of dilution performed by the chemist during the sampling process.

2.2.6 The elapsed time from reactor shutdown to sample analysis.

2.2.7 Power history data for current cycle and Effective Full Power Days (EFPD) for two previous cycles.

3.0 QUALITATIVE ASSESSMENT OF CORE DAMAGE

Where plant parameters indicate an abnormal plant shutdown has occurred with core cooling jeopardized or interrupted and possible core damage, a preliminary determination of the extent of core damage can be made by qualitatively reviewing the analyzed sample and evaluating it together with other plant parameters and operating data. Based on the following indicators, a general core damage assessment can be made:

3.1 Cladding Damage Indicators

3.1.1 The appearance of noble gases (xenons, kryptons), iodines and possibly small amounts of cesium in the reactor coolant without the presence of other fission products is a fair indication that damage is limited to clad failure and possibly, a limited degree of fuel overheat.

3.1.2 Additional indicators of clad damage include:

3.1.2.1 Core exit thermocouple temperature readings higher than 650° (for LOCA with normal Engineered Safeguards response, the maximum expected core exit temperatures with natural circulation should be about 620 - 650°F).

NOTE: Thermocouple readings as confirmatory information for core conditions beyond clad damage must be used with caution since coolant conditions (i.e., steaming) can significantly affect thermocouple accuracy. Those readings should therefore be evaluated carefully before use. A review of any available thermocouple trends (log, computer, etc.) will be useful in this evaluation.

3.1.2.2 High Range Containment Monitors (when conditions indicate release to containment)

100% clad damage may indicate up to 2.7×10^4 rad/hr on R-25 and R-26

3.2 Overtemperature Indicators

3.2.1 The presence of an appreciable cesium concentration will be indicative of at least a fuel overheat situation since no substantial quantity of cesiums should be found if core temperatures remain below 2370°F or if the core has not been at least partially uncovered for some extended period of time. In addition, strontium and barium may be present.

3.2.2 High Range Containment Monitors: (When conditions indicate release to containment) R25/R26 would read up to 3.0×10^6 rad/hr for 100% overheat/melt.

3.2.3 Reactor Vessel Level Indicating System (if available) indicates core uncovery for an extended period of time.

3.2.4 Significant releases (e.g. greater than 100 uCi/cc) of tellurium, ruthenium and more refractory materials will occur only if the temperature approaches the fuel melting point (~4500 - 5000°F). The presence of ruthenium and tellurium does not "prove" melting, but <u>their absence is a good indicator that melt has not occurred.</u>

3.3 Fuel Melt Indicators

3.3.1 Presence of cerium and lanthanum in fluid samples are generally indicative of fuel melt. Ruthenium and tellurium must also be present (although as stated in 3.2.4, their presence does not prove melt).

3.3.2 High Range Containment Monitors: (when conditions indicate release to containment) R25/R26 would read up to 3.0×10^6 rad/hr for 100% fuel overheat/melt.

4.0 <u>ASSESSMENT OF CLAD DAMAGE FROM HYDROGEN GENERATION FROM ZIRCONIUM WATER REACTION</u>

The percent of the zirconium cladding reacting with water can be estimated using the graph in Figure 1. This assumes that there has been no substantial loss of Hydrogen due to Hydrogen recombiner use.

5.0 <u>ASSESSMENT OF THE CORE DAMAGE FROM SAMPLE ANALYSIS</u>

The following procedural steps address more detailed characterization of core damage based on results of sampling and analysis of RCS and VC samples. The calculations are based on characteristics of a reference sample corrected for actual sampling conditions. Containment atmosphere sampling is of importance only for "line-break" type accidents.

5.1 Application and Determination of Correction Factors

The "reference sample" assumes the following characteristics:

- o A core average burnup of 1050 effective full power days (EFPD) - EOL conditions.
- o Dilution of the liquid source term in Reactor Coolant System volume only (non-line break accident).
- o No additional dilution during the sampling and analysis process.
- o The RCS sample at RCS temperature and pressure (and therefore density)
- o The VC sample at containment temperature and pressure
- o Samples taken at time of shutdown

To correct for deviations from the above assumptions under specific sampling conditions, the following correction factors should be applied as appropriate to the measured activity. The correction factors should be used for both the RCS and VC samples unless otherwise indicated.

5.1.1 Operating Time Correction Factor (P)

Long Lived Isotopes (See Table 2)

This correction factor is applied to correct long lived nuclides for operation for less than EOL conditions assumed in the formulation of the reference "maximum concentration" (MX) values shown in Table 2.

$$P = \frac{1 - e^{-1050\lambda_i}}{(1-e^{-\lambda_i T_0}) + N_1/193\left[e^{-\lambda_i t_1}(1-e^{-\lambda_i T_1})\right] + N_2/193\left[e^{-\lambda_i t_2}(1-e^{-\lambda_i T_2})\right]}$$

where:
- T_o = operating time for current cycle (EFPD)
- t_1 = time since end of last cycle (days)
- T_1 = operating time for last cycle (EFPD)
- t_2 = time since end of cycle before last (days)
- T_2 = operating time for cycle before last (EFPD)
- λ_i = decay constant for isotope "i" (days^{-1})
- N_1 = Number of assemblies from the last cycle currently in core
- N_2 = Number of assemblies from cycle before last cycle currently in core.

Short Lived Isotopes

For short lived isotopes (See Table 2), the operating time correction factor (P) must be calculated for each isotope i:

$$P = \frac{100}{\sum P_j \ (1-e^{-\lambda_i T_j}) \ e^{-\lambda_i t_j}}$$

where:

P_j = steady reactor power in period j (percent)

T_j = duration of period j (days)

t_j = time from end of period j to reactor shutdown (days)

NOTE: This calculation should be made over a period starting from at least five half-lives prior to the present shutdown and ending at the time of the present shutdown.

Table 3 is included as a worksheet, if necessary. One sheet should be used for each short-lived isotope.

5.1.2 Correction for Additional Dilution Provided by Emergency Core Cooling System (ECCS) Volume (ED)
For accidents involving injection of emergency core cooling water into the primary system, the assumed dilution volume for the RCS sample must be corrected. The volumes which may need to be added will depend on the specific accident scenario and may typically include the accumulators, boron injection tank and Refueling Water Storage Tank. The actual volumes can be determined from appropriate level and flow instrumentation.

$$ED = \frac{91{,}600 + \text{ECCS Volume Injected (gallons)}}{91{,}600}$$

5.1.3 Correction for Dilution During Sampling Process (SD)

The "reference sample" is an undiluted sample. A Sampling Dilution (SD) correction factor must be applied if the chemist further dilutes the drawn sample.

SD = Dilution Ratio
(e.g., SD = 1000 for a 1000: 1 dilution)

5.1.4 Density Correction Factor (R)

This a straightforward correction if the density of the sample differs from that of the RCS or Containment. The correction factor (R) is taken from Table 1 for the RCS sample. Temperature of the RCS Sample is assumed to be 80° F.

For the Containment atmosphere sample this factor can be determined by:

$$R = \frac{(Pvc)\ Ts}{Ps\ (Tvc)}$$

where: Pvc = Containment Pressure (psia)
Ps = Sample pressure (psia) during analysis
Tvc = Containment temperature ($^{\circ}$R)
Ts = Sample temperature ($^{\circ}$R) during analysis

Sample temperature is assumed to be equal to the VC temperature. Sample pressure is assumed to be atmospheric.

5.1.5 Decay Correction Factor

This corrects the measured fission product concentration (MC) to account for decay from reactor shutdown to the time of analysis. This calculation must be performed for each appropriate isotope.

$$MC_o = MC\ (e^{.0417\ \lambda t})$$

where: MC_o = decay corrected measured concentration
MC = uncorrected measured concentration
t = time (hrs) from shutdown to analysis
λ = decay constant (See Table 2)(days^{-1})
.0417 = conversion factor (hours to days)

NOTE: The gamma spectrometry computer may be used to back calculate these values.

5.2 Determination of "Adjusted" Measured Concentration

Having determined and calculated all appropriate correction factors, the "adjusted" measured concentration AC is given by:

$$AC_i = (MC_o \cdot P \cdot ED \cdot SD \cdot R)_{RCS} + (MC_o \cdot P \cdot SD \cdot R)_{VC} \frac{(VC\ volume)}{(RCS\ volume)}$$

where: AC_i = Adjusted total measured concentration for isotope i. This includes both RCS and VC concentration and will be compared to the "reference" sample concentrations (MX's)

RCS = Adjusted Reactor Coolant System concentration

VC = Adjusted Containment atmosphere concentration

$\frac{(VC\ volume)}{(RCS\ volume)}$ = This term adjusts the containment atmosphere concentration to allow it to be directly added to the RCS concentration.

This concentration should be determined for each of the isotopes Table 2 (or as many as possible). These adjusted concentrations should then be compared to the reference concentrations (MX values) given in Table 2 as follows:

NOTE: A different calculation must be performed for each isotope, and it is expected that different fractions will be calculated. Engineering judgement must be used on the aggregate results to resolve any discrepancies.

5.3 Clad Damage Estimate

To estimate the fraction of clad failure damage:

5.3.1 Determine the maximum clad failure concentration, MX_{CFi} from Table 2, Column I for each selected isotope "i".

5.3.2 Calculate a Clad Failure Fraction (CFF for each appropriate isotope)

$$CFF = \frac{ACi}{MX_{CFi}}$$

where Ac_i = adjusted concentration for isotope "i"

5.3.3 Criterion for Cladding Failure

If CFF $<$ .01 there is little or no cladding damage. Verify that MC is within normal concentration measurements.

If .01 $\leq$ CFF $\leq$ 1.0 there is some degree of clad damage. To estimate percentage of damage, multiply CFF by 100.

If CFF $>$ 1.0 proceed to next paragraph to estimate damage.

5.4 Fuel Overtemperature Estimate

To estimate the degree of fuel overtemperature:

5.4.1 Determine the maximum fuel overtemperature concentration, MX_{FOi}, from Table 2, Column II for each selected isotope "i".

5.4.2 Calculate a Fuel Overtemperature Fraction (FOF):

$$FOF = \frac{ACi}{MX_{FOi}}$$

where AC_i = adjusted concentration for isotope "i"

5.4.3 To estimate the percentage of the core in an overtemperature conditions, multiply FOF by 100. If FOF is greater than 1.0, proceed to the next paragraph to evaluate for fuel melt.

5.5 Fuel Melt Estimate

To estimate the fraction of the core which may have experienced core melt:

5.5.1 Determine the maximum fuel melt concentration, MX_{FMi} from Table 2, Column III for each selected isotope "i".

5.5.2 Calculate f Fuel Melt Fraction (FMF):

$$FMF = \frac{ACi}{MX_{FMi}}$$

where AC_i adjusted concentration for isotope "i"

5.5.3 To estimate the percentage of fuel melt, multiply FMF by 100. Note the presence of ruthenium and tellurium as per 3.3.1.

6.0 CAUTIONS AND RECOMMENDATIONS

If conflicting data exists based on criteria guidance given in Sections 3 and 4, reanalyze all indications. For example; the analysis yields results which indicate core melt. The core thermocouple readings show the core is not hot enough to have melted. The sample analysis should therefore be re-examined to determine if the isotopics chosen are appropriate.

It should also be noted that the above evaluations address an assumed uniform distribution of core damage. Since the degree of damage is likely to vary within the core, calculations for CFF, FOF and FMF should all be performed to provide a better understanding and perspective with regard to the potential existence of a mixture of fuel damage conditions. Variations in core exit thermocouple readings may supply additional supporting information.

Finally it should also be noted that the results determined using this procedure are subject to inaccuracies related to physical processes occurring in the RCS and VC in the post accident condition. These processes, including among others, adsorption, sedimentation and plateout, may remove a significant amount of source term from both the atmosphere and fluid from which the sample is drawn. Although inclusion of these processes is beyond the scope of this evaluation, their potential effect should be borne in mind.

7.0 REFERENCES

7.1 Reactor Safety Study (WASH-1400)

7.2 Three Mile Island - Report to the Commissioners and to the Public ("Rogovin Report")

7.3 W Mitigating Core Damage Training Manual, Sections 6 & 8

7.4 Westinghouse Radiation Analysis Design Manual

7.5 ORIGEN (Isotope generation and depletion code)

TABLE 1

DENSITY CORRECTION FACTORS (R)

RCS Temperature at time of sample (°F)	RCS Sample Temperature (°F): 70	80	90	100
100	.995	.996	.998	1.0
150	.982	.983	.985	.987
200	.965	.966	.968	.970
250	.944	.945	.947	.949
300	.920	.921	.923	.924
350	.892	.894	.895	.897
400	.861	.862	.864	.865
450	.826	.827	.828	.830
500	.787	.788	.789	.791
550	.737	.738	.739	.742
560	.726	.727	.728	.730
570	.716	.717	.718	.720
580	.704	.705	.706	.707
590	.692	.693	.694	.695
600	.680	.681	.682	.683
620	.650	.651	.652	.653
640	.617	.618	.619	.620
660	.579	.580	.582	.582
680	.528	.529	.530	.531
700	.438	.438	.439	.441

TABLE 2

Short Lived Isotopes

Isotope	Halflife	λ(day^{-1})	I MX-CF (Ci/cc)	II MX-FO (Ci/cc)	III MX-FM (Ci/cc)
Mo-99	66.0h	.252	N/A	4.8E-3	1.4E-2
I-131	8.04d	.0862	4.7E-3	1.4E-1	2.5E-1
I-133	20.8h	.800	8.6E-3	2.5E-1	4.5E-1
Xe-133	5.25d	.132	1.5E-2	2.5E-1	4.5E-1
Te-132	78.2h	.213	N/A	1.9E-2	5.7E-2
Ru-105	4.44h	3.75	N/A	3.3E-5	1.0E-3
Ba-140	12.79d	.0542	N/A	9.0E-3	4.5E-2
La-140	40.22h	.414	N/A	N/A	1.4E-3

Long Lived Isotopes

Isotope	Halflife	λ(day^{-1})	I MX-CF (Ci/cc)	II MX-FO (Ci/cc)	III MX-FM (Ci/cc)
Kr-85	10.72y	1.77E-4	9.3E-5	1.5E-3	2.8E-3
Cs-137	30.17y	6.09E-5	1.6E-3	1.3E-2	2.6E-2
Ce-141	32.5d	2.13E-2	N/A	N/A	1.2E-3
Sr-89	50.6d	1.37E-2	N/A	3.6E-3	1.8E-2
Sr-90	28.6y	6.64E-5	N/A	4.2E-4	2.1E-3
Ru-103	39.4d	1.76E-2	N/A	3.7E-5	1.1E-3
Ru-106	368d	1.88E-3	N/A	1.9E-5	5.5E-4
Ce-144	284d	2.44E-3	N/A	N/A	9.3E-4

N/A = Not Applicable

TABLE 3

CALCULATION OPERATING HISTORY CORRECTION FOR ISOTOPE i

Isotope: ____________

Half Life: ____________

λ = ____________ day^{-1}

Period	Power Level (%)	Duration (days)	(Days) Decay Time	$(1-e^{-\lambda_i T_j})$	$(e^{-\lambda t_j})$	$P_j(1-e^{-\lambda_i T_j})(e^{-\lambda t_j})$
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Σ =

$$\frac{100\%}{P_j(1-e^{-\lambda_i T_j})(e^{-\lambda t_j})} =$$

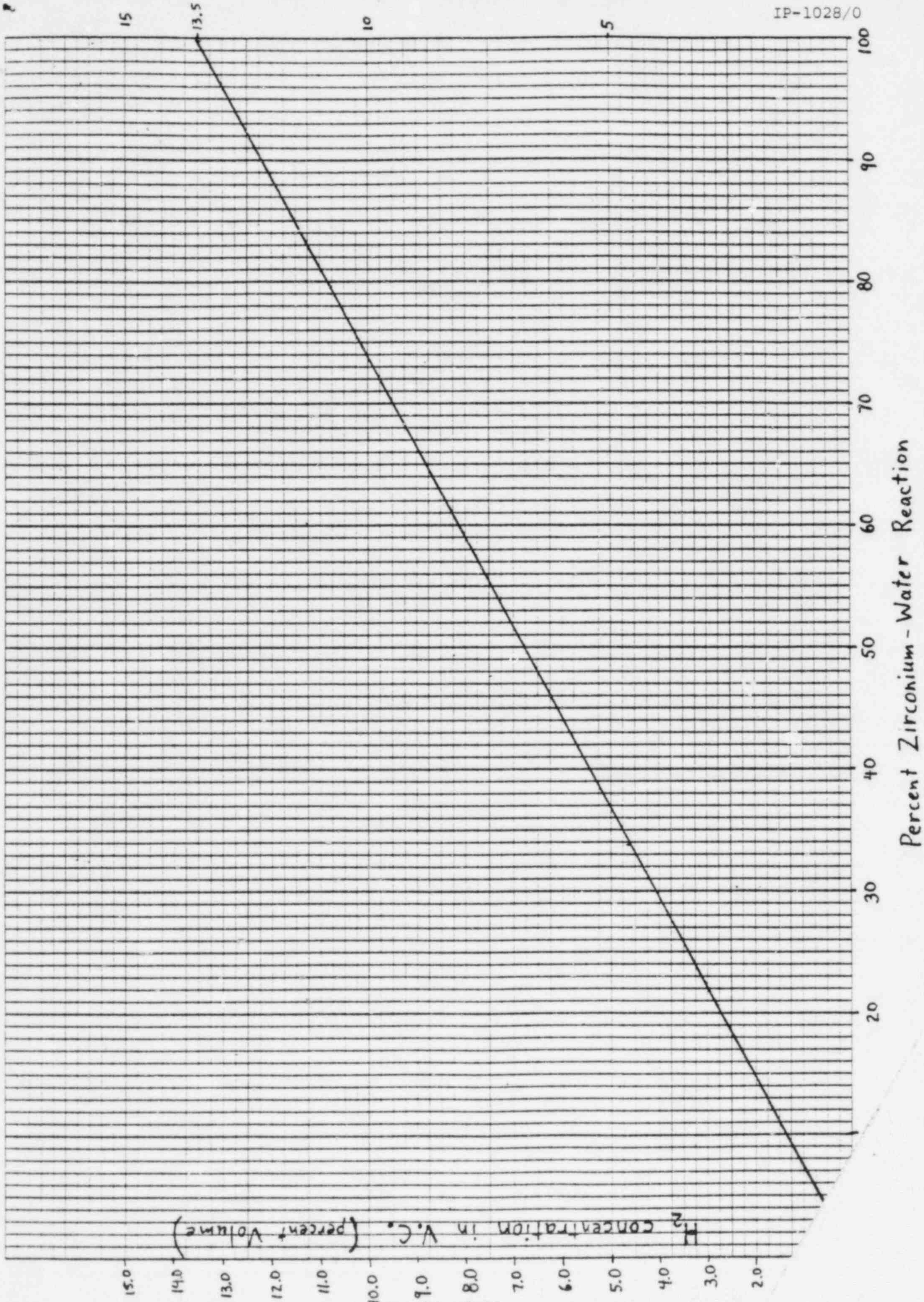
P_j = steady reactor power level (percent)

λ_i = decay constant for isotope i (day^{-1})

T_j = time at power level P_j (days)

tj = time since end of T_j to reactor shutdown (days)

Figure 1


Percent Zirconium-Water Reaction
H_2 Concentration in V.C. (percent Volume)
15
13.5
10
5
100
90
80
70
60
50
40
30
20
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0