ENCLOSURE

DIABLO CANYON POWER PLANT

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

JANUARY 1, 1989 - JUNE 30, 1989

PACIFIC GAS AND ELECTRIC COMPANY

2829S/0071K

DIABLO CANYON POWER PLANT

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

JANUARY 1, 1989 THROUGH JUNE 30, 1989

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INTRODUCTION

This Semiannual Radioactive Effluent Release Report summarizes the gaseous
and liquid effluent releases made from Diablo Canyon Power Plant's Units 1
and 2 for the first and second quarters of 1989. This report also includes
the doses due to the release of radioactive liquid and gaseous effluents and
a summary of solid radwaste shipments. This report contains the information
required by Unit 1 and 2 Technical Specification 6.9.1.6 and is generally
presented in the format of Regulatory Guide 1.21, Appendix B.

In all cases, the plant effluent releases were well below Technical
Specifications for the report period.

The Unit 1 reactor operated continuously throughout the report period. The
Unit 2 reactor was at full power throughout the report period except for a
brief outage in April.

I. SUPPLEMENTAL INFORMATION

A. Regulatory Limits

1. Gaseous Effluents

a. Noble Gas Dose Rate Limit

The dose rate in unrestricted areas due to radioactive noble gases released in gaseous effluents is limited to less than or equal to 500 millirem per year to the total body and less than or equal to 3000 millirem per year to the skin. (Technical Specification 3.11.2.1.a.)

b. Particulate and Iodine Dose Rate Limit

The dose rate in unrestricted areas due to iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half lives greater than 8 days in gaseous effluents is limited to less than or equal to 1500 millirem per year to any organ. (Technical Specification 3.11.2.1.b.)

c. Noble Gas Dose Limit

The air dose due to noble gases released in gaseous effluents, from each reactor unit, from the site, is limited to the following:

	CALENDAR QUARTER	CALENDAR YEAR
Gamma radiation	5 millirad	10 millirad
Beta radiation	10 millirad	20 millirad

(Tech. Spec. 3.11.2.2)

d. Particulate and Iodine Dose Limit

The dose to an individual from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half lives greater than 8 days in gaseous effluents released, from each reactor unit, from the site, is limited to less than or equal to 7.5 millirem to any organ in any calendar quarter and less than or equal to 15 millirem to any organ during a calendar year. (Technical Specification 3.11.2.3)

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2. Liquid Effluents

   a. Concentration

   The concentration of radioactive material released from the site is limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration is limited to 2 x 10-4 microcuries/ml total activity. (Technical Specification 3.11.1.1)

   b. Dose

   The dose or dose commitment to an individual from radioactive materials in liquid effluents released, from each reactor unit, from the site, is limited to the following:

	CALENDAR QUARTER	CALENDAR YEAR
Total Body	1.5 millirem	3 millirem
Any Organ	5 millirem	10 millirem

   (Technical Specification 3.11.1.2)

B. Maximum Permissible Concentrations

   1. Gaseous Effluents

   Maximum permissible concentrations are not used in the methodology for determining allowable release rates for gaseous effluents at Diablo Canyon Power Plant.

   2. Liquid Effluents

   The concentrations listed in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases are used for determining the allowable release rate at the point of discharge from the site for liquid effluents. For dissolved or entrained noble gases, the allowable release rate concentration at the point of discharge is limited to 2 x 10-4 microcuries per milliliter total activity for liquid effluents.

C. Measurements and Approximations of Total Radioactivity

1. Gaseous Effluents

a. Fission and Activation Gases

The gaseous radioactivity released from the plant vent is monitored by a pair of off-line monitors each equipped with Geiger-Mueller detectors. These monitor readings are correlated to isotopic concentration based on laboratory isotopic analysis of grab samples using a germanium detector.

When the plant vent measurements as indicated by the process monitors are below the lower limit of detection, the results of the grab samples are used to quantify releases. In addition, the individual batch release data is used to quantify the radioactivity discharged from the gas decay tanks and containment.

A noble gas grab sample is obtained and analyzed at least weekly. The isotopic mixture is assumed to remain constant between grab sample analyses.

Containment purges, gas decay tank releases and air ejector discharge are all routed through the plant vent for release.

The gaseous radioactivity released from the steam generator blowdown tank vent is measured by analyzing grab samples with a germanium detector. The isotopic concentrations are assumed to remain constant between grab samples.

Other potential pathways for releasing gaseous radioactivity are periodically monitored by collecting grab samples and analyzing these samples with a germanium detector system.

b. Iodines

Radioiodines released from the plant vent are monitored by continuous sample collection on silver zeolite cartridges. The cartridges are changed at least weekly and analyzed with a germanium detector. The radioiodine releases are averaged over the period of cartridge sample collection.

Other potential pathways for releasing radioiodines are periodically monitored by collecting samples using charcoal cartridges and analyzing these cartridges with a germanium detector.

c. Particulates

Radioactive materials in particulate form released from the plant vent are monitored by continuous sample collection on particulate filters. The filters are changed at least weekly and analyzed with a germanium detector. The particulate radioactivity is averaged over the period of particulate filter sample collection. Each filter is analyzed for alpha emitters using an internal proportional counter.

All of the plant vent particulate filters collected during a quarter are used for the composite analysis for strontium-89 and -90 which is counted on an internal proportional counter after chemical separation.

Other potential pathways for releasing radioactive particulates are periodically monitored by collecting samples using particulate filters and analyzing these filters with a germanium detector.

d. Tritium

Tritium released from the plant vent is monitored by passing a measured volume of plant vent sample through a water column and determining the tritium increase in the water. An aliquot of the water is counted in a liquid scintillation spectrometer. Tritium is determined at a minimum sample frequency of weekly. The tritium concentration is assumed to remain constant between samples.

2. Liquid Effluents

a. Batch Releases

Each tank of liquid radwaste is analyzed for principal gamma emitters using a germanium detector prior to release. The pre-release analysis includes dissolved and entrained gases. Volume proportional monthly and quarterly composites are prepared from aliquots of each tank released. The monthly composite is analyzed for tritium using a liquid scintillation spectrometer and gross alpha radioactivity using an internal proportional counter. The quarterly composite is analyzed for iron-55 using a liquid scintillation spectrometer and for strontium-89 and -90 using an internal proportional detector following chemical separations.

b. Continuous releases

For the continuous liquid releases of steam generator blowdown tank and turbine building sump oily water separator, daily grab samples are collected and aliquots are proportioned for weekly, monthly and quarterly composites.

The oily water separator weekly composite is analyzed for gross gamma and principal gamma emitters using a germanium detector. The steam generator blowdown tank weekly composite is analyzed for principal gamma emitters and iodine 131.

The steam generator blowdown tank monthly composite is analyzed for tritium using a liquid scintillation spectrometer and for gross alpha using an internal proportional counter.

The steam generator blowdown tank quarterly composite is analyzed for iron-55 using a liquid scintillation spectrometer and for strontium-89 and -90 using an internal proportional counter following chemical separation. The results for each of the composites are averaged over the period of the composite.

In addition, one grab sample of the steam generator blowdown tank is analyzed monthly for dissolved and entrained gases using a germanium detector. The results of this analysis are assumed to remain constant over the period of one month.

D. Batch Releases

1. Liquid

   a. Number of batch releases.................... 351

   b. Total time period for batch releases........ 904 hours

   c. Maximum time period for a batch release..... 7.50 hours

   d. Average time period for a batch release..... 2.58 hours

   e. Minimum time period for a batch release..... 0.010 hours

   f. Average saltwater flow during batch releases 1.68E+6 GPM

2. Gaseous

   a. Number of batch releases.................... 44

   b. Total time period for batch releases........ 191 hours

      c.   Maximum time period for a batch release..... 24.0 hours

      d.   Average time period for a batch release..... 4.33 hours

      e.   Minimum time period for a batch release..... 1.00 hours

II. MAJOR CHANGES TO LIQUID, GASEOUS AND SOLID RADWASTE TREATMENT SYSTEMS

There were no major changes to liquid, gaseous, and solid radwaste treatment systems during the report period.

III. CHANGES TO THE PROCESS CONTROL PROGRAM (PCP)

The radioactive waste packaging Process Control Program (PCP), as promulgated in DCPP Administrative Procedures AP C-253 and AP C-253S1, was revised once during the report period. Revision 13 to AP C-253 incorporated a new vendor procedure on verification of a penetrometer. This new procedure enables a penetrometer to be used to determine the hardness of encapsulation liner plug seal. This change is within the scope of LN Technologies Topical Report. This revision was reviewed and found acceptable by the Plant Staff Review Committee (PSRC) on April 6, 1989. A copy of the changed procedure is included as Attachment 1. AP C-253S1 was not revised during the report period and is not included.

IV. CHANGES TO THE ENVIRONMENTAL RADIOLOGICAL MONITORING PROCEDURE (ERMP)

There were no changes to the DCPP Environmental Radiological Monitoring Procedure (ERMP) during the report period.

V. CHANGES TO THE OFFSITE DOSE CALCULATION PROCEDURE (ODCP)

The following changes to the ODCP were made during the report period. These revisions were reviewed and found acceptable by the Plant Staff Review Committee (PSRC) on April 7, 1989.

A. Completed the perennial update to the "5 years-running historical average" meteorological dispersion factors X/Q and D/Q. Values for 1983 were dropped and values for 1988 were added.

B. Changed the parameters in the Percent Release Rate Limits - PRRL (Appendix 2) expressions because of dependency on new "5 years history average" meteorological parameters X/Q and D/Q (see paragraph A above).

C. Changed the maximum rated flowrates for FDRTs and EDRTs from 35 and 36 to 60 gpm because a new pump was installed which has a higher flow rate.

D. Changed HASP correction factor for RE 03, 14, 18, and 22 from "0.3" to "0.375" per Instrumentation and Controls' review of the radiation monitor vendor's (Westinghouse) recommendations.

E. Incorporated On-The-Spot-Change (OTSC) dated 1/6/89 removing residence "R3" per 1988 land use census.

F. Updated the Liquid Radwaste Discharge Flow diagram.

The changes listed above maintain and in some cases improve the reliability and accuracy of the dose calculations, and do not reduce the accuracy of any setpoint determination. A copy of the changed procedure is included as Attachment 2.

VI. GASEOUS AND LIQUID EFFLUENTS
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TABLE 1
GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	Units	First Quarter	Second Quarter	Est. Total Error,%
A. Fission & activation gases				
1. Total release	Ci	2.36 E+1	1.35 E+2	5.5 E+1
2. Average release rate for period	μCi/sec	3.04 E+0	1.72 E+1	
3. Percent of technical specification limit[2]	%	1.17 E-3	5.40 E-3	
B. Iodines				
1. Total iodine-131	Ci	4.61 E-5	7.20 E-5	2.4 E+1
2. Average release rate for period	μCi/sec	5.93 E-6	9.15 E-6	
3. Percent of technical specification limit[2]	%	9.87 E-5	1.54 E-4	
C. Particulates				
1. Particulates with half-lives >8 days	Ci	MDA	MDA	2.4 E+1
2. Average release rate for period	μCi/sec	MDA	MDA	
3. Percent of technical specification limit[2]	%	MDA	MDA	
4. Gross alpha radioactivity	Ci	MDA[1]	MDA[1]	
D. Tritium				
1. Total release	Ci	1.90 E+0	4.52 E+0	1.3 E+1
2. Average release rate for period	μCi/sec	2.44 E-1	5.75 E-1	
3. Percent of technical specification limit[2]	%	8.75 E-5	2.08 E-4	

NOTE:

1 MDA = Less than the "a posteriori" minimum detectable activity (microcuries per unit mass or volume). This note applies to all tables.

2 Technical Specification 3.11.2.1 Limit

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TABLE 2
GASEOUS EFFLUENTS – GROUND-LEVEL RELEASES

		FIRST QUARTER		SECOND QUARTER	
Nuclides Released	Unit	CONTINUOUS MODE	BATCH MODE	CONTINUOUS MODE	BATCH MODE
1. Fission gases					
argon-41	Ci	MDA	4.66 E-2	1.55 E-2	6.52 E-1
krypton-85	Ci	MDA	MDA	3.34 E+1	2.30 E-1
krypton-85m	Ci	MDA	4.33 E-5	1.21 E-1	3.35 E-5
krypton-87	Ci	MDA	MDA	4.22 E-2	MDA
krypton-88	Ci	MDA	MDA	8.35 E-2	MDA
xenon-131m	Ci	MDA	MDA	2.35 E-3	MDA
xenon-133	Ci	2.04 E+1	7.49 E-1	8.66 E+1	5.89 E+0
xenon-133m	Ci	MDA	5.26 E-3	3.95 E-2	6.85 E-2
xenon-135	Ci	2.38 E+0	6.26 E-3	7.31 E+0	5.65 E-1
xenon-135m	Ci	MDA	MDA	3.07 E-2	MDA
xenon-138	Ci	MDA	MDA	7.32 E-2	MDA
TOTAL FOR PERIOD	Ci	2.28 E+1	8.07 E-1	1.28 E+2	7.41 E+0
2. Iodines					
iodine-131	Ci	4.61 E-5		7.20 E-5	
iodine-133	Ci	1.37 E-4		2.04 E-4	
iodine-135	Ci	MDA		MDA	
TOTAL FOR PERIOD	Ci	1.83 E-4		2.76 E-4	

Nuclides Released	Unit	CONTINUOUS MODE	
		First Quarter	Second Quarter
3. Particulates			
cesium–134	Ci	MDA	MDA
cesium–137	Ci	MDA	MDA
cerium–141	Ci	MDA	MDA
cerium–144	Ci	MDA	MDA
chromium–51	Ci	MDA	MDA
cobalt–58	Ci	MDA	MDA
cobalt–60	Ci	MDA	MDA
iron–59	Ci	MDA	MDA
manganese–54	Ci	MDA	MDA
molybdenum–99[1]	Ci	MDA	MDA
ruthenium–103	Ci	MDA	MDA
strontium–89	Ci	MDA	MDA
strontium–90[1]	Ci	MDA	MDA
zinc–65	Ci	MDA	MDA
zirconium–95[1]	Ci	MDA	MDA
TOTAL FOR PERIOD	Ci	MDA	MDA

·Note:

1 Includes Daughters

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TABLE 3
GASEOUS EFFLUENTS – LOWER LIMITS OF DETECTION

Nuclide	Unit	Continuous Mode	Batch Mode	
			Containment Purge	Gas Decay Tank
1. Fission gases				
krypton-85	µCi/ml	3.04 E-6	3.04 E-6	1.87 E-3
krypton-85m	µCi/ml	7.19 E-9	7.19 E-9	4.08 E-6
krypton-87	µCi/ml	2.29 E-8	2.29 E-8	1.32 E-5
krypton-88	µCi/ml	3.48 E-8	3.48 E-8	1.39 E-5
xenon-131m	µCi/ml	2.74 E-7	2.74 E-7	1.97 E-4
xenon-133	µCi/ml	2.22 E-8	2.22 E-8	1.44 E-5
xenon-133m	µCi/ml	4.24 E-8	4.24 E-8	3.25 E-5
xenon-135	µCi/ml	6.98 E-9	6.98 E-9	4.09 E-6
xenon-135m	µCi/ml	2.13 E-7	2.13 E-7	3.17 E-5
xenon-138	µCi/ml	6.14 E-7	6.14 E-7	7.97 E-5
argon-41	µCi/ml	1.77 E-8	1.77 E-8	7.63 E-6
2. Tritium				
hydrogen-3	µCi/ml	1.27 E-8	1.27 E-8	
3. Iodines				
iodine-131	µCi/ml	3.62 E-13		
iodine-133	µCi/ml	4.89 E-13		
iodine-135	µCi/ml	3.12 E-12		

Nuclide	Unit	Continuous Mode
4. Particulates		
cesium–134	μCi/ml	5.17 E–13
cesium–137	μCi/ml	4.12 E–13
cerium–141	μCi/ml	3.83 E–13
cerium–144	μCi/ml	1.48 E–12
chromium–51	μCi/ml	2.27 E–12
cobalt–58	μCi/ml	5.23 E–13
cobalt–60	μCi/ml	4.43 E–13
iron–59	μCi/ml	6.20 E–13
manganese–54	μCi/ml	4.62 E–13
molybdenum–99[1]	μCi/ml	2.10 E–12
ruthenium–103	μCi/ml	3.26 E–13
strontium–89	μCi/ml	1.04 E–14
strontium–90[1]	μCi/ml	5.61 E–15
zinc–65	μCi/ml	6.92 E–13
zirconium–95[1]	μCi/ml	6.80 E–13
gross alpha	μCi/ml	2.56 E–15

Note:

1 Includes daughters

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TABLE 4
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	Unit	First Quarter	Second Quarter	Est Total Error, %
A. Fission and activation products				
1. Total release (not including tritium, gases, alpha)	Ci	8.22 E-2	2.18 E-1	2.4 E+1
2. Average diluted concentration during period	µCi/ml	4.69 E-10	1.28 E-9	
3. Percent of applicable limit[1]	%	7.48 E-3	2.70 E-2	
B. Tritium				
1. Total release	Ci	1.26 E+2	2.24 E+2	1.3 E+1
2. Average diluted concentration during period	µCi/ml	7.19 E-7	1.32 E-6	
3. Percent of applicable limit[1]	%	2.40 E-2	4.40 E-2	
C. Dissolved and entrained gases				
1. Total release	Ci	2.59 E-2	4.04 E-2	2.4 E+1
2. Average diluted concentration during period	µCi/ml	1.48 E-10	2.38 E-10	
3. Percent of applicable limit[1]	%	7.38 E-5	1.19 E-4	
D. Gross alpha radioactivity				
1. Total release	Ci	MDA	MDA	6.1 E+1

[1] Technical Specification 3.11.1.1 Limit

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	Unit	First Quarter	Second Quarter	Est Total Error, %
E. Volume of waste released (prior to dilution)	liters	1.36 E+8	1.28 E+8	5.0 E0
F. Volume of circulating saltwater used during release	liters	1.75 E+11	1.70 E+11	6.5 E0

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TABLE 5
LIQUID EFFLUENTS

Nuclides Released	Unit	First Quarter Continuous Mode	First Quarter Batch Mode	Second Quarter Continuous Mode	Second Quarter Batch Mode
antimony-122	Ci	MDA	1.19 E-5	MDA	MDA
antimony-124	Ci	MDA	1.07 E-4	MDA	6.42 E-4
antimony-125	Ci	MDA	4.53 E-3	MDA	7.69 E-3
beryllium-7	Ci	MDA	7.63 E-5	MDA	6.03 E-5
bromine-82	Ci	MDA	MDA	MDA	3.15 E-5
cerium-144	Ci	MDA	MDA	MDA	MDA
cesium-134	Ci	MDA	1.32 E-2	MDA	3.88 E-2
cesium-136	Ci	MDA	1.84 E-7	MDA	MDA
cesium-137	Ci	MDA	1.70 E-2	MDA	4.97 E-2
chromium-51	Ci	MDA	5.50 E-4	MDA	1.15 E-3
cobalt-57	Ci	MDA	6.08 E-5	MDA	3.44 E-5
cobalt-58	Ci	MDA	1.38 E-2	MDA	6:13 E-2
cobalt-60	Ci	MDA	1.11 E-2	MDA	1.17 E-2
iron-55	Ci	MDA	1.61 E-2	MDA	3.32 E-2
iron-59	Ci	MDA	1.23 E-4	MDA	1.02 E-4
lanthanum-140[1]	Ci	MDA	1.17 E-5	MDA	4.01 E-4
manganese-54	Ci	MDA	8.37 E-4	MDA	6.15 E-4
manganese-56	Ci	MDA	MDA	MDA	2.90 E-9

.Note:

1 Includes daughters

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TABLE 5 (CONTINUED)
LIQUID EFFLUENTS

Nuclides Released	Unit	First Quarter		Second Quarter	
		Continuous Mode	Batch Mode	Continuous Mode	Batch Mode
molybdenum-99[1]	Ci	MDA	1.22 E-4	MDA	2.19 E-4
ruthenium-103	Ci	MDA	MDA	MDA	MDA
silver-110m	Ci	MDA	MDA	MDA	MDA
sodium-24	Ci	MDA	3.41 E-6	MDA	2.31 E-6
strontium-89	Ci	MDA	3.67 E-5	MDA	4.51 E-5
strontium-90[1]	Ci	MDA	MDA	MDA	MDA
strontium-91	Ci	MDA	MDA	MDA	1.25 E-5
tellurium-129m	Ci	MDA	MDA	MDA	MDA
tellurium-132	Ci	MDA	MDA	MDA	MDA
tin-1131	Ci	MDA	9.53 E-5	MDA	MDA
tin-117m	Ci	MDA	MDA	MDA	MDA
tungsten-187	Ci	MDA	2.42 E-6	MDA	4.65 E-7
zirconium-95[1]	Ci	MDA	9.67 E-4	MDA	2.32 E-5
iodine-131	Ci	MDA	2.88 E-3	MDA	1.10 E-2
iodine-132	Ci	MDA	4.12 E-7	MDA	6.24 E-8

Note:

1 Includes daughters

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TABLE 5 (CONTINUED)
LIQUID EFFLUENTS

Nuclides Released	Unit	First Quarter Continuous Mode	First Quarter Batch Mode	Second Quarter Continuous Mode	Second Quarter Batch Mode
iodine-133	Ci	MDA	5.55 E-4	MDA	1.29 E-3
iodine-134	Ci	MDA	4.59 E-9	MDA	MDA
iodine-135	Ci	MDA	1.39 E-5	MDA	1.26 E-5
TOTAL FOR PERIOD	Ci	MDA	8.22 E-2	MDA	2.18 E-1

DISSOLVED AND ENTRAINED GASES

xenon-131m	Ci	MDA	MDA	MDA	MDA
xenon-133	Ci	MDA	2.57 E-2	MDA	3.98 E-2
xenon-133m	Ci	MDA	MDA	MDA	1.41 E-4
xenon-135	Ci	MDA	1.82 E-4	MDA	4.91 E-4
krypton-85m	Ci	MDA	MDA	MDA	MDA
TOTAL FOR PERIOD	Ci	MDA	2.59 E-2	MDA	4.04 E-2

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TABLE 6
LIQUID EFFLUENTS – LOWER LIMITS OF DETECTION

Nuclide	Unit	LLD
antimony-122	μCi/ml	4.06 E-8
antimony-124	μCi/ml	9.22 E-8
antimony-125	μCi/ml	7.82 E-8
beryllium-7	μCi/ml	3.19 E-7
cerium-141	μCi/ml	3.93 E-8
cerium-144	μCi/ml	1.72 E-7
cesium-134	μCi/ml	3.94 E-8
cesium-136	μCi/ml	3.46 E-8
cesium-137	μCi/ml	4.04 E-8
chromium-51	μCi/ml	2.37 E-7
cobalt-57	μCi/ml	2.56 E-8
cobalt-58	μCi/ml	2.81 E-8
cobalt-60	μCi/ml	3.71 E-8
iron-55	μCi/ml	3.00 E-7
iron-59	μCi/ml	5.53 E-8
lanthanum-140[1]	μCi/ml	6.60 E-8
manganese-54	μCi/ml	3.51 E-8
manganese-56	μCi/ml	4.02 E-8
molybdenum-99[1]	μCi/ml	2.42 E-8

Note:

1 Includes Daughters

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TABLE 6 (CONTINUED)
LIQUID EFFLUENTS - LOWER LIMITS OF DETECTION

Nuclide	Unit	LLD
ruthenium-103	µCi/ml	3.28 E-8
silver-110m	µCi/ml	3.45 E-8
sodium-24	µCi/ml	4.74 E-8
strontium-89	µCi/ml	2.51 E-8
strontium-90	µCi/ml	1.10 E-8
strontium-91	µCi/ml	9.95 E-8
tellurium-129m	µCi/ml	9.74 E-7
tellurium-132	µCi/ml	2.64 E-8
tin-113[1]	µCi/ml	4.29 E-8
tin-117m	µCi/ml	2.42 E-8
tungsten-187	µCi/ml	7.22 E-8
zirconium-95[1]	µCi/ml	5.87 E-8
zinc-65	µCi/ml	6.23 E-8
gross alpha	µCi/ml	7.62 E-8
hydrogen-3	µCi/ml	5.59 E-6
iodine-131	µCi/ml	2.47 E-8
iodine-132	µCi/ml	4.27 E-8
iodine-133	µCi/ml	3.32 E-8
iodine-134	µCi/ml	7.59 E-8
iodine-135	µCi/ml	1.40 E-7

Note:

1 Includes Daughters

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TABLE 6 (CONTINUED)
LIQUID EFFLUENTS – LOWER LIMITS OF DETECTION

Nuclide	Unit	LLD
xenon–131m	µCi/ml	9.21 E-7
xenon–133	µCi/ml	1.05 E-7
xenon–133m	µCi/ml	2.56 E-7
xenon–135	µCi/ml	2.77 E-8
krypton–85m	µCi/ml	3.38 E-8

Note:

1 Includes Daughters

VII. SOLID RADWASTE SHIPMENTS

DIABLO CANYON POWER PLANT
SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT 1989
SOLID WASTE AND IRRADIATED FUEL SHIPMENT

A. Solid Waste Shipped Offsite for Burial or Disposal (Not irradiated fuel)

		Unit	6-Month Period	Est. Total Error, %
1.	Type of Waste			
a.	Spent Resins,	m3	7.40 E+0	N/A
	Encapsulated Cartridge	Ci	2.86 E+2	10.0
	Filters, Concentrates			
b.	Dry Compressible	m3	1.60 E+1	N/A
	Waste, Contaminated	Ci	1.55 E+0	10.0
	Equip. Etc.			
c.	Irradiated Components,	m3	0.00 E0	
	Control Rods, Etc.	Ci	0.00 E0	N/A
d.	Sand, Building Rubble,	m3	0.00 E0	
	Biological Waste	Ci	0.00 E0	N/A

2. Estimate of Major Nuclide Composition (by type of waste)

a.

Co-60	%	33
Cs-137	%	17.8
Ni-63	%	17.7
Cs-134	%	16.0

b.

Fe-55	%	83
Co-60	%	15

c.

NOT APPLICABLE	%	N/A

d.

NOT APPLICABLE	%	N/A

2829S/0071K

DIABLO CANYON POWER PLANT
SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT 1989
SOLID WASTE AND IRRADIATED FUEL SHIPMENT

A. Solid Waste Shipped Offsite for Burial or Disposal (Not irradiated fuel)
(Continued)

3. Supplemental Information Required by T.S. 6.9.1.6

Solidification Agent	Container Type	Shipping Package Type	Number of Containers	10 CFR 61 Waste Class
Cement	Strong Tight	Type B	1	B
Cement	Strong Tight	LSA>Type A	1	C
None	Strong Tight	LSA	17	A-unstable

4. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
2	Truck	Richland, WA
7	Truck	Barnwell, SC

B. Irradiated Fuel Shipments (Disposition)

Number of Shipments	Mode of Transportation	Destination
None	N/A	N/A

VIII.   RADIATION DOSE DUE TO GASEOUS AND LIQUID EFFLUENTS

RADIATION DOSES

A. Radiation doses due to radioactive liquid effluents

The radiation dose contributions due to releases of radioactive liquid effluents to the total body and each individual organ for the maximum exposed adult have been calculated in accordance with the methodology in the Offsite Dose Calculation Procedure. Since the liquid radwaste system is common to both units, no attempt has been made to segregate each unit's contribution to the total dose. For the purposes of comparison with the Plant Technical Specifications, the dose contributions conservatively have been assumed to be due to a single unit. Dose contributions, listed in Table 7, show conformance to Technical Specification 3.11.1.2.

B. Radiation doses due to radioactive gaseous effluents

The radiation dose contributions due to radioactive gaseous effluents at the site boundary for the land sectors have been calculated in accordance with the calculational methodology in the Offsite Dose Calculation Procedure. Each unit's dose contribution has been calculated separately. The meteorology conditions concurrent with the time of discharge were used in these calculations. In addition to the site boundary doses, the dose to all age groups at the nearest residence within the low population zone for each of the land sectors and a five mile infant milk dose in each of the land sectors is included. Dose contributions, listed in Table 8 for the First and Second Quarters, show conformance to Technical Specifications 3.11.2.2 and 3.11.2.3.

C. Radiation doses due to direct radiation (Line-of-Sight Plus Sky-Shine) - Closest Site Boundary (800 m)

For the First and Second Quarters of 1989, the radiation dose is evaluated to be 1.10 E-1 mrem due to the presence of radioactive waste containers outside of plant buildings.

D. Radiation Doses Due to Chemistry Laboratory Radioactive Gaseous Effluents - Closest Site Boundary (800m)

The radiation doses due to Chemistry Laboratory Radioactive Gaseous Effluents for the report period is evaluated to be 1.44 E-6 mrem.

DIABLO CANYON POWER PLANT

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT 1989

TABLE 7

RADIATION DOSE DUE TO THE RELEASE OF RADIOACTIVE LIQUID EFFLUENTS

millirem

ORGAN	First Quarter	Second Quarter
Total Body	2.79 E-4	7.99 E-4
Bone	5.50 E-4	1.34 E-3
Liver	5.50 E-4	1.44 E-3
Thyroid	1.73 E-4	6.55 E-4
Kidney	9.05 E-5	2.81 E-4
Lung	2.06 E-4	4.71 E-4
G.I. LLI	1.02 E-3	1.11 E-3

DIABLO CANYON NUCLEAR POWER PLANT

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT 1989

TABLE 8A

RADIATION DOSE[1] DUE TO THE RELEASE OF RADIOACTIVE GASEOUS EFFLUENTS (UNIT 1)

		First Quarter		Second Quarter	
		Sector[2]	Dose	Sector	Dose
Site Boundary					
Noble Gas					
Gamma air dose	mrad	NW	1.78 E-3	NNW	5.61 E-3
Beta air dose	mrad	NW	3.90 E-3	NNW	1.37 E-2
I,P,T[3]					
Child[4] (Thyroid)	mrem	NW	2.29 E-4	NNW	3.47 E-4
Residence					
Noble Gas					
Gamma air dose	mrad	NNW	2.40 E-4	NNW	7.11 E-4
Beta air dose	mrad	NNW	5.14 E-4	NNW	1.73 E-3
I,P,T[3]					
Child[5] (Thyroid)	mrem	ESE	2.20 E-4	ESE	2.50 E-4
Five Mile Dairy					
I,P,T[3]					
Infant (Thyroid)	mrem	ESE	2.64 E-4	ESE	2.49 E-4

DIABLO CANYON NUCLEAR POWER PLANT

SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT 1989

TABLE 8B

RADIATION DOSE[1] DUE TO THE RELEASE OF RADIOACTIVE GASEOUS EFFLUENTS (UNIT 2)

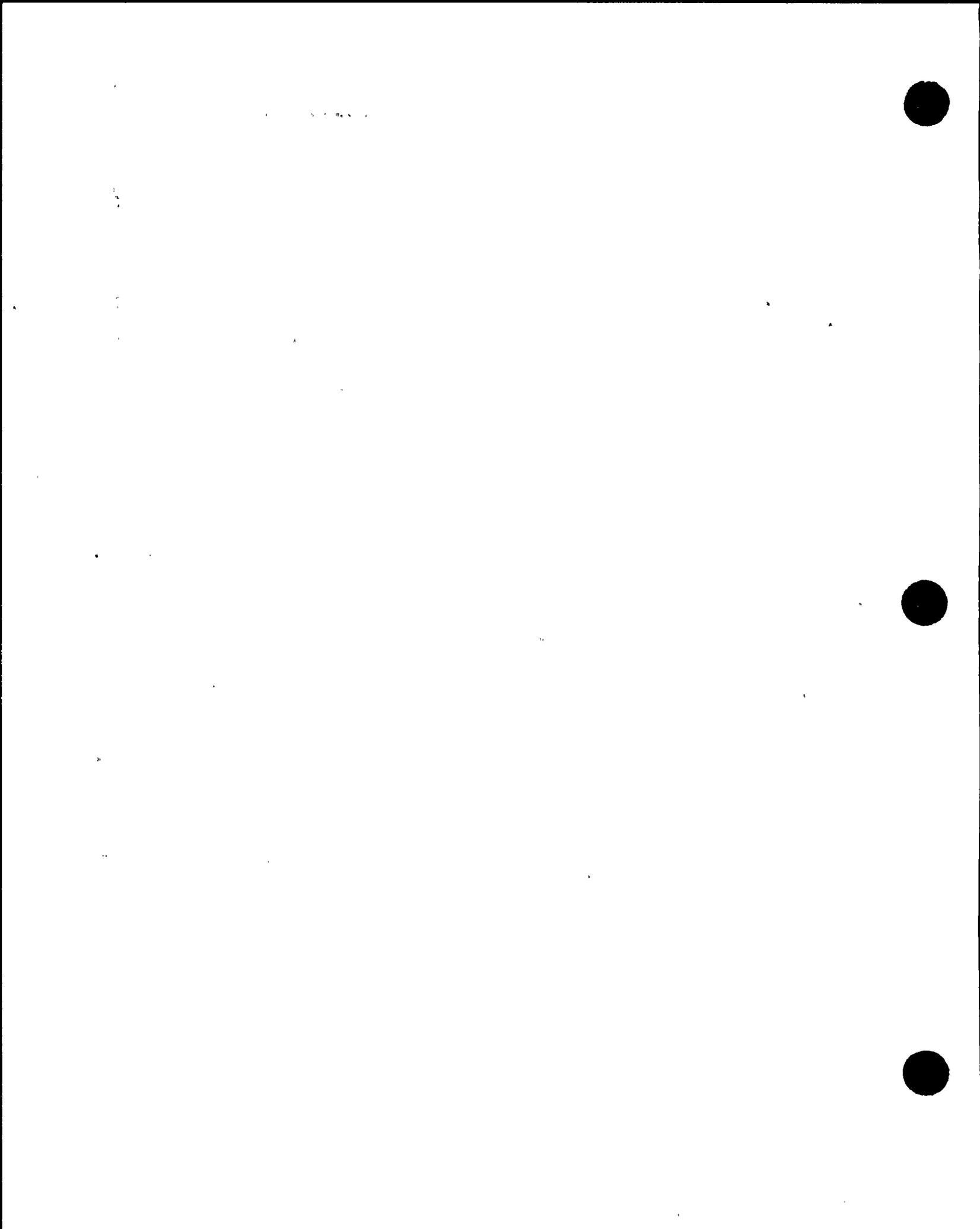|		First Quarter		Second Quarter	
		Sector[2]	Dose	Sector	Dose
Site Boundary					
Noble Gas					
Gamma air dose	mrad	N	3.05 E-5	NNE	1.87 E-2
Beta air dose	mrad	N	9.06 E-5	NNE	2.42 E-2
I,P,T[3]					
Child[4] (Thyroid)	mrem	NNW	2.71 E-4	NNE	6.45 E-3
Residence					
Noble Gas					
Gamma air dose	mrad	ESE	5.02 E-6	NNE	6.02 E-4
Beta air dose	mrad	ESE	1.49 E-5	ESE	1.90 E-3
I,P,T[3]					
Child[5] (Thyroid)	mrem	ESE	1.40 E-4	ESE	6.04 E-4
Five Mile Dairy					
I,P,T[3]					
Infant (Thyroid)	mrem	ESE	3.11 E-5	ESE	2.23 E-4

DIABLO CANYON NUCLEAR POWER PLANT
SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT 1989

TABLE 8 (Continued)

NOTES:

1. This represents the maximum dose of age groups, organs, and geographic locations for the quarter.

2. The ocean sectors SSE, S, SSW, SW, WSW, W, and WNW are not included.

3. Radioiodines, Radioactive Material in Particulate Form and Radionuclides Other Than Noble Gases With Half-lives Greater Than Eight Days.

4. The inhalation, ground plane and animal-meat pathways are included in this dose calculation.

5. The inhalation, ground plane, animal-meat and vegetable pathways are included for this location. An occupancy factor of 0.5 was used for the inhalation and ground plane pathways. The child age group had the highest calculated dose for this location.

TABLE 9

PERCENT OF TECHNICAL SPECIFICATION LIMITS[1]
FOR RADIOACTIVE LIQUID EFFLUENTS

millirem

ORGAN	First Quarter	Second Quarter
Total Body	1.86 E-2	5.33 E-2
Bone	1.10 E-2	2.68 E-2
Liver	1.10 E-2	2.88 E-2
Thyroid	3.46 E-3	1.31 E-2
Kidney	1.81 E-3	5.62 E-3
Lung	4.12 E-3	9.42 E-3
G.I. LLI	2.04 E-2	2.22 E-2

Note:

1 Technical Specification 3.11.1.2

DIABLO CANYON NUCLEAR POWER PLANT
SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT 1989
TABLE 10A
PERCENT OF TECHNICAL SPECIFICATION LIMITS[1] FOR RADIOACTIVE GASEOUS EFFLUENTS (UNIT 1)

		First Quarter		Second Quarter	
		Sector	% of T.S. Limit	Sector	% of T.S. Limit
Site Boundary					
Noble Gas					
Gamma air dose	mrad	NW	3.56 E-2	NNW	1.12 E-1
Beta air dose	mrad	NW	3.90 E-2	NNW	1.37 E-1
I,P,T					
Child (Thyroid)	mrem	NW	3.05 E-3	NNW	4.63 E-3
Residence					
Noble Gas					
Gamma air dose	mrad	NNW	4.80 E-3	NNW	1.42 E-2
Beta air dose	mrad	NNW	5.14 E-3	NNW	1.73 E-2
I,P,T					
Child (Thyroid)	mrem	ESE	2.93 E-3	ESE	3.33 E-3
Five Mile Dairy					
I,P,T					
Infant (Thyroid)	mrem	ESE	3.52 E-3	ESE	3.32 E-3

Note:

1 Technical Specification 3.11.2.2 and 3.11.2.3

DIABLO CANYON NUCLEAR POWER PLANT
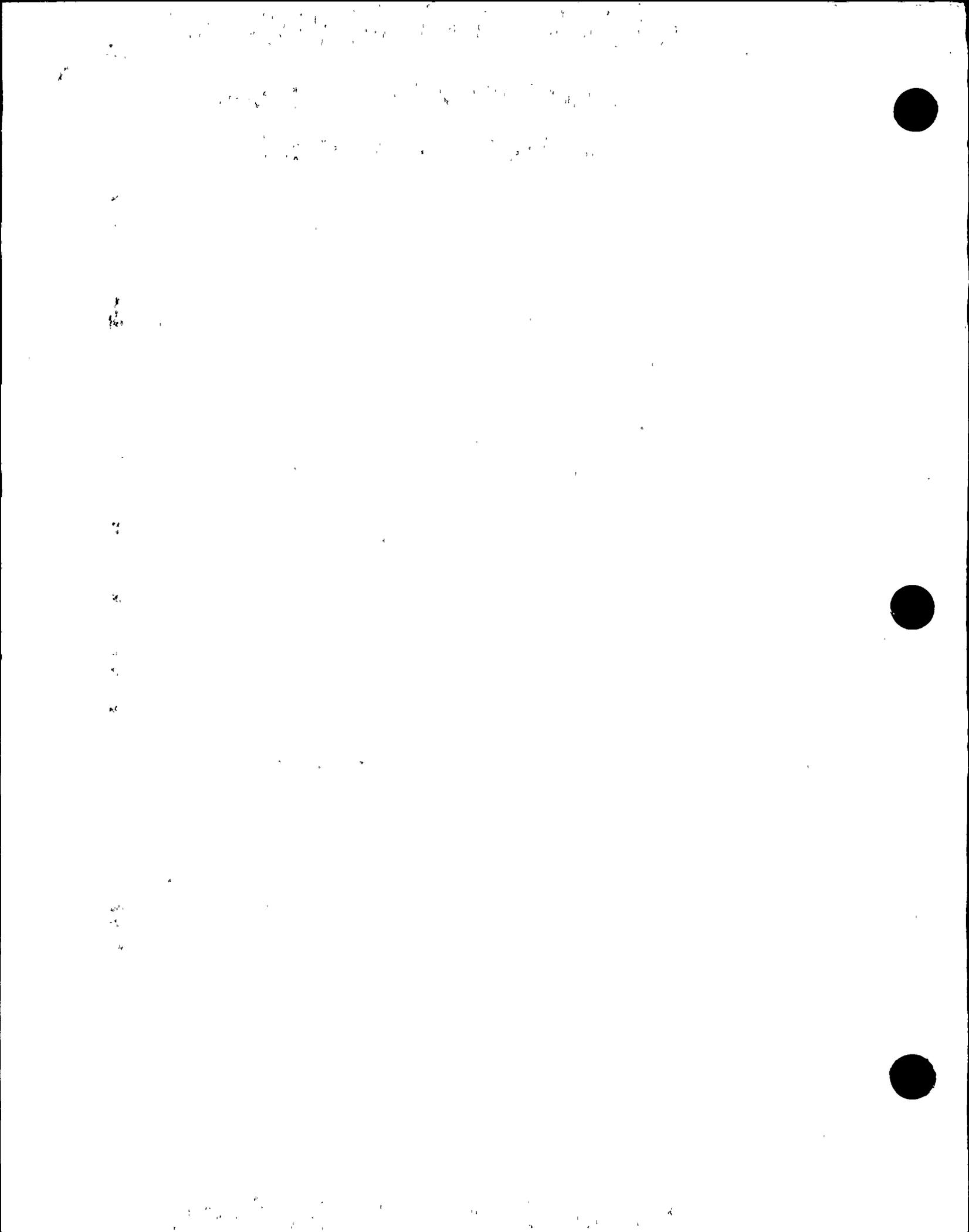## SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT 1989
TABLE 10B
PERCENT OF TECHNICAL SPECIFICATION LIMITS[1] FOR RADIOACTIVE GASEOUS EFFLUENTS (UNIT 2)

		First Quarter		Second Quarter	
		Sector	% of T.S. Limit	Sector	% of T.S. Limit
Site Boundary					
Noble Gas					
Gamma air dose	mrad	N	6.10 E-4	NNE	3.74 E-1
Beta air dose	mrad	N	9.06 E-4	NNE	2.42 E-1
I,P,T					
Teen (Thyroid)	mrem	NNW	3.61 E-3	NNE	8.60 E-2
Residence					
Noble Gas					
Gamma air dose	mrad	ESE	1.00 E-4	NNE	1.20 E-2
Beta air dose	mrad	ESE	1.49 E-4	ESE	1.90 E-2
I,P,T					
Child (Thyroid)	mrem	ESE	1.87 E-3	ESE	8.05 E-3
Five Mile Dairy					
I,P,T					
Infant (Thyroid)	mrem	ESE	4.15 E-4	ESE	2.97 E-3

Note:

1 Technical Specification 3.11.2.2 and 3.11.2.3

ATTACHMENT 1

CHANGES TO THE PROCESS CONTROL PROGRAM

PACIFIC GAS AND ELECTRIC COMPANY

DEPARTMENT OF NUCLEAR POWER GENERATION

DIABLO CANYON POWER PLANT

NUMBER   AP C-253
REVISION   13
PAGE   1 OF 6
UNITS

1 AND 2

TITLE: ADMINISTRATIVE PROCEDURE
PROCESS CONTROL PROGRAM

APPROVED: _____ 4/7/89   4-7-89
                PLANT MANAGER   DATE   EFFECTIVE DATE

1.0 SCOPE

1.1 The purpose of the Process Control Program (PCP) is to define the necessary program guidance used at DCPP to ensure that SOLID RADIOACTIVE WASTE MANAGEMENT activities, in packaging radioactive waste for disposal, conform to the Code of Federal and State Regulations and the Waste Burial Site License Criteria.

1.2 This procedure and changes thereto require PSRC review.

2.0 RESPONSIBILITIES

2.1 Plant Manager has the overall responsibility for the Solid Radioactive Waste activities at DCPP.

2.2 Manager of Radiation Protection is responsible for the implementation of the requirements of this procedure.

2.3 Radwaste Engineer is responsible for the development and review of procedures relating to the requirements of this procedure.

2.4 The Radwaste Foreman is responsible for the implementation of procedures relating to the requirements of this procedure.

2.5 QC is responsible for verification of compliance with the Quality requirements.

3.0 PREREQUISITES

3.1 This procedure with the attachments and any changes thereto requires review by the Plant Staff Review Committee and submission to the US NRC in the Semi-annual Effluent Report for the period in which the changes were made.

DIABLO CANYON POWER PLANT

TITLE: PROCESS CONTROL PROGRAM

NUMBER   AP C-253
REVISION 13
PAGE   2 OF 6

UNITS   1 AND 2

4.0 INSTRUCTIONS

4.1 GENERAL

It is the policy of Pacific Gas and Electric Company to conscientiously apply emphasis and attention to those activities associated with generation, processing, packaging, storage and disposal of radioactive waste generated at the Diablo Canyon Power Plant and to maintain a high level of assurance that radioactive waste products meet or exceed the applicable Federal and State regulations and the Radioactive Waste Burial Site License Criteria.

4.2 WET WASTE

4.2.1 LIQUID/WET WASTE

Liquid / Wet wastes at DCPP are processed to a condition meeting shipping and disposal criteria. These criteria include requirements for immobilization, stability and limits on Free Standing Water (FSW). Specific instructions on processing and required FSW limits are contained in plant procedures and/or qualified vendor procedures. These procedures are to be approved by the PSRC prior to implementation.

4.2.2 CONTAINERS, SHIPPING CASKS AND PACKAGING

Solid radioactive waste is processed, packaged and shipped in accordance with DCPP procedures and/or qualified vendor procedures which have been approved by the PSRC. These procedures provide specific instructions which ensure the container, shipping casks and packaging methods comply with the applicable Code of Federal Regulations, State Regulations and the Radioactive Waste Burial Site License Criteria.   — .

4.2.3 SHIPPING AND DISPOSAL

Solid radioactive waste is prepared, loaded and shipped to a Federal and/or State Licensed Radioactive Waste Disposal Facility (Burial Ground) in accordance with DCPP procedures and/or qualified vendor procedures which have been approved by the PSRC. These procedures provide specific instructions which ensure the shipments meet the intended Burial Site License Requirements as well as applicable Federal and State Regulations.

DIABLO CANYON POWER PLANT

TITLE: PROCESS CONTROL PROGRAM

NUMBER   AP C-253
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4.2.4   LABORATORY MIXING OF SAMPLES

Qualified vendor procedures approved by the PSRC provide written instructions on sampling, processing and handling waste for the determination of process parameters prior to the actual full scale solidification. These procedures contain the description of the laboratory mixing methods used for these samples.

4.2.5   SOLIDIFICATION PROCESS

Qualified vendors used by DCPP for radioactive waste solidification are required to provide the Process Control Program and written procedures. These procedures and changes thereto must be approved by the PSRC prior to use. Further, the vendors are required to have a topical report, as referenced, on the waste forms which will be solidified at DCPP. This topical report should demonstrate compliance with the NRC requirements for waste form. These documents should include:

a.   Description of the solidification process
b.   Type of solidification used
c.   Process control parameters
d.   Parameter boundary conditions
e.   Proper waste form properties
f.   Specific instructions to ensure the systems are operated within established process parameters.

4.2.6   SAMPLING PROGRAM FOR SOLIDIFICATION

Vendors, utilized by DCPP for radioactive waste solidification, are required to include in their approved procedures, requirements to sample at least every tenth batch of the same waste type to ensure solidification and to provide actions to be taken if a sample fails to verify solidification. After a test specimen failure, initial test specimens from three consecutive batches of that waste type must demonstrate solidification before testing requirements of every tenth batch can be resumed. Verification of such sampling is to be accomplished by completing Form 69-10350, "Processing Control Program (PCP) Verification". These forms will be maintained in the Radiation Protection Department and the Records Management System (RMS). These procedures and changes thereto must be approved by the PSRC prior to use.

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DIABLO CANYON POWER PLANT

TITLE: PROCESS CONTROL PROGRAM

NUMBER   AP C-253
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UNITS   1 AND 2

4.2.7   WASTE FORM VERIFICATION

Vendors utilized by DCPP to process wet wastes are required to include in their procedures provisions to verify that the solidification and/or FSW Criteria in the Federal and State regulations and the Burial Site License are met for the specific type of waste being processed. These procedures and changes thereto must be approved by the PSRC prior to use.

4.2.8   CORRECTIVE ACTIONS FOR FREE STANDING WATER

Vendors utilized by DCPP to process wet wastes are required to include in their approved procedures provisions for correcting processed waste in which free standing water in excess of the FSW Criteria is detected. These procedures and changes thereto must be approved by the PSRC prior to use.

4.2.9   EXOTHERMIC PROCESSES

Vendors utilized by DCPP for radioactive waste solidification that utilize an exothermic solidification method are required to include in their approved procedures:

a.   Waste/binder temperature monitoring to mitigate the consequence of adverse exothermic reactions which may occur in the full scale solidification but might not be noticeable in the specimen tests.

b.   Specific process control parameters that must be met before capping the container.

These procedures and changes thereto must be approved by the PSRC prior to use.

4.3   OILY WASTE·

Oily wastes at DCPP are processed in accordance with approved vendor procedures. These procedures specify the proper methods to treat oily wastes to comply with Federal and State regulations and applicable Burial Site License Criteria. These procedures and changes thereto must be approved by the PSRC prior to use.

DIABLO CANYON POWER PLANT

TITLE: PROCESS CONTROL PROGRAM

NUMBER   AP C-253
REVISION 13
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UNITS   1 AND 2

4.4   SPECIAL CASES

Based upon previous industry experience, DCPP foresees the potential for situations arising that may be beyond existing plant capabilities. Anticipating this possibility, provisions are made herein to accommodate such situations in a timely manner by using special techniques or processes. These special cases would be controlled as follows:

4.4.1   Implementing procedures would be developed comparable to those used for normal plant solid waste activities based on the guidance of this PCP and incorporating the applicable provisions for process control and testing.

4.4.2   The implementing procedure would receive PSRC approval prior to use.

4.4.3   Use of this provision and supporting information would be included in the next Semi-annual Effluent Report to the NRC.

4.5   REMEDIAL ACTIONS

4.5.1   For waste forms which do not meet Federal, State and burial site regulations and requirements, suspension of shipment of the inadequately processed waste and correction of the PCP, procedures or processing equipment shall be performed as necessary to prevent recurrence.

4.5.2   For waste forms not prepared in accordance with the PCP, testing of the waste to verify shipping and burial site requirements shall be performed and appropriate administrative action taken to prevent recurrence.

5.0   REFERENCES

5.1   Title 10 Code of Federal Regulations

5.2   NUREG 0472 and 0473

5.3   NUREG-0800, 11.4 US NRC Standard Review Plan Solid Waste Management Systems

5.4   AP C-253S1, "Dewatering Control Program."

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5.5   AP C-257, "Mobile Service Operating Procedure for Low-Level Radioactive Waste Processing."

5.6   NRC Information Notice 88-08, "Chemical Reactions with Radioactive Waste Solidification Agents."

6.0 ATTACHMENTS

6.1   LN Technologies, Corp. Procedure SS-042, "Process Control Program for Radwaste Solidification Service at Diablo Canyon Power Plant," Rev. B.

6.2   Topical Report TR-002, "10CFR61 Qualified Radioactive Waste Forms," Rev. 1.

6.3   LN Technologies, Corp. Procedure GS-007, "Temperature Indicating Device Comparison Test," Rev. D.

6.4   LN Technologies, Corp. Procedure GS-006, "Calibration for a Triple Beam Balance," Rev. B.

6.5   LN Technologies, Corp. Procedure SS-049, "Penetrometer Check Procedure," Rev. B.

       NOTE: The above attachments are maintained in Document Control Master File, Catalog No. TK 9400/LNT-1.

6.6   Form 69-10350, "Process Control Program (PCP) Verification", 11/85.

PACIFIC GAS AND ELECTRIC COMPANY
DIABLO CANYON POWER PLANT UNIT NOS. 1 AND 2

TITLE: PROCESS CONTROL PROGRAM (PCP) VERIFICATION

DATE	WASTE BATCH		PCP		NOTES	OPERATOR	VERIFIER
	Number	Type	Passed	Failed			

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ATTACHMENT 2

CHANGES TO THE OFFSITE DOSE CALCULATION PROCEDURE

DIABLO CANYON POWER PLANT

NUMBER   CAP A-8
REVISION 8
PAGE   74 OF 91

TITLE: OFF-SITE DOSE CALCULATION

UNITS   1 AND 2
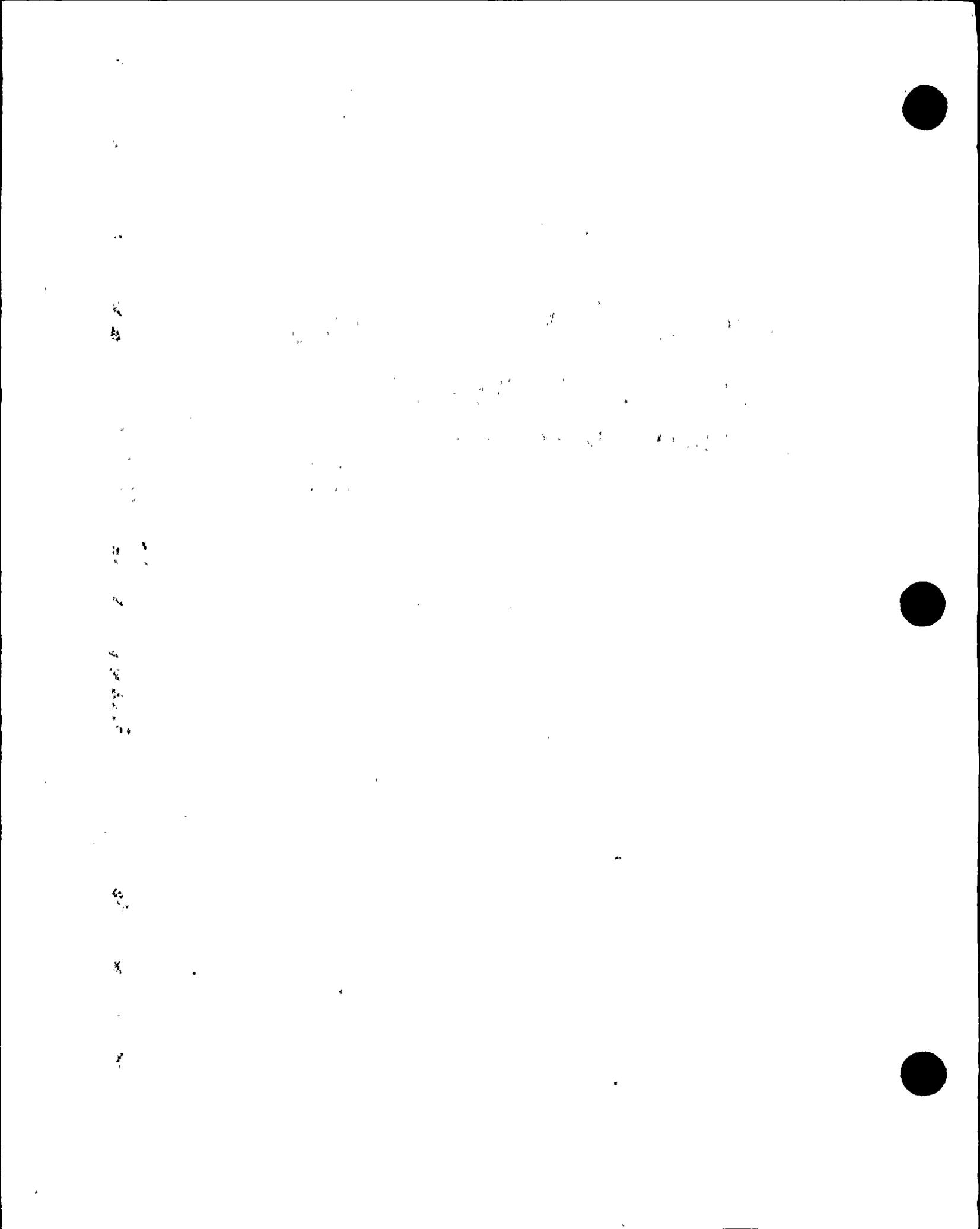
FIGURE 7.1
LIQUID DISCHARGES MONITORED FOR RADIOACTIVITY

LIQUID RADWASTE SYSTEM

CONDENSATE DEMINERALIZER
REGENERATE TANKS

STEAM GENERATOR
BLOWDOWN

SI
APERTURE
CARD

Also Available On
Aperture Card

GRAPHICS\CRP\CVS-AT

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DIABLO CANYON POWER PLANT

TITLE: OFF-SITE DOSE CALCULATION

NUMBER   CAP A-8
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UNITS   1 AND 2
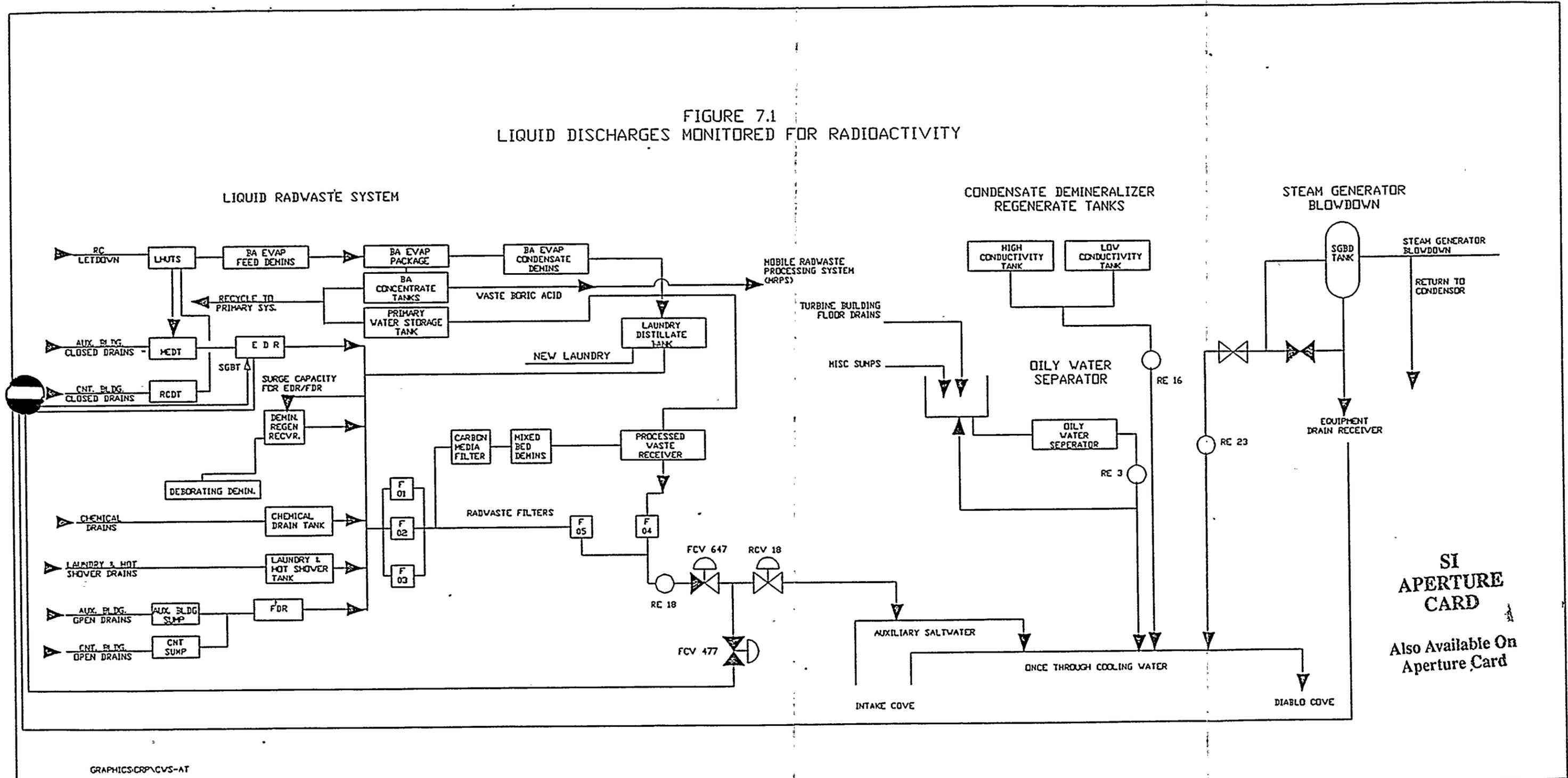
FIGURE 7.2
GASEOUS RELEASES MONITORED FOR RADIOACTIVITY
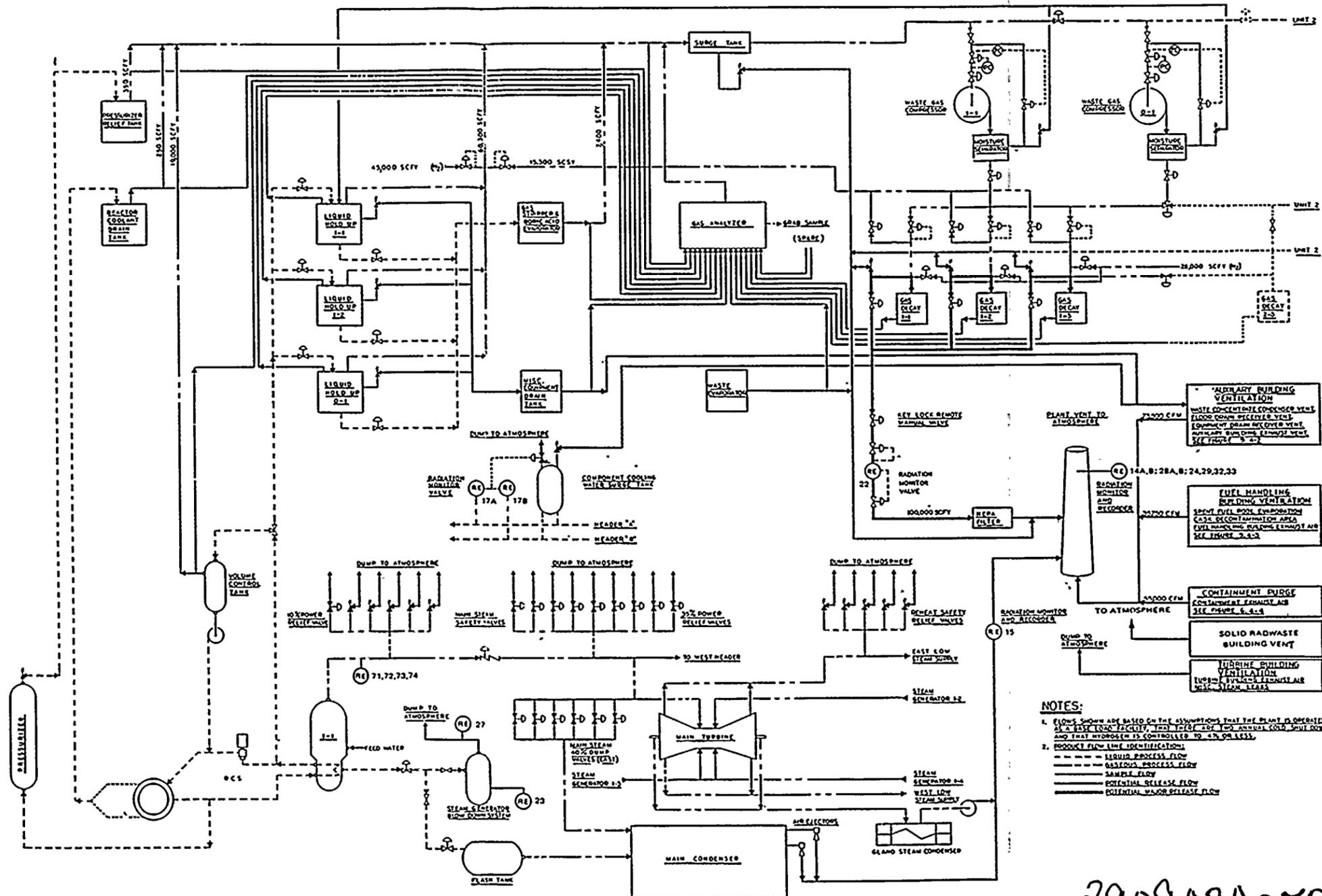
SI
APERTURE
CARD

Also Available On
Aperture Card

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DIABLO CANYON POWER PLANT

TITLE: OFF-SITE DOSE CALCULATIONS

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UNITS 1 AND 2
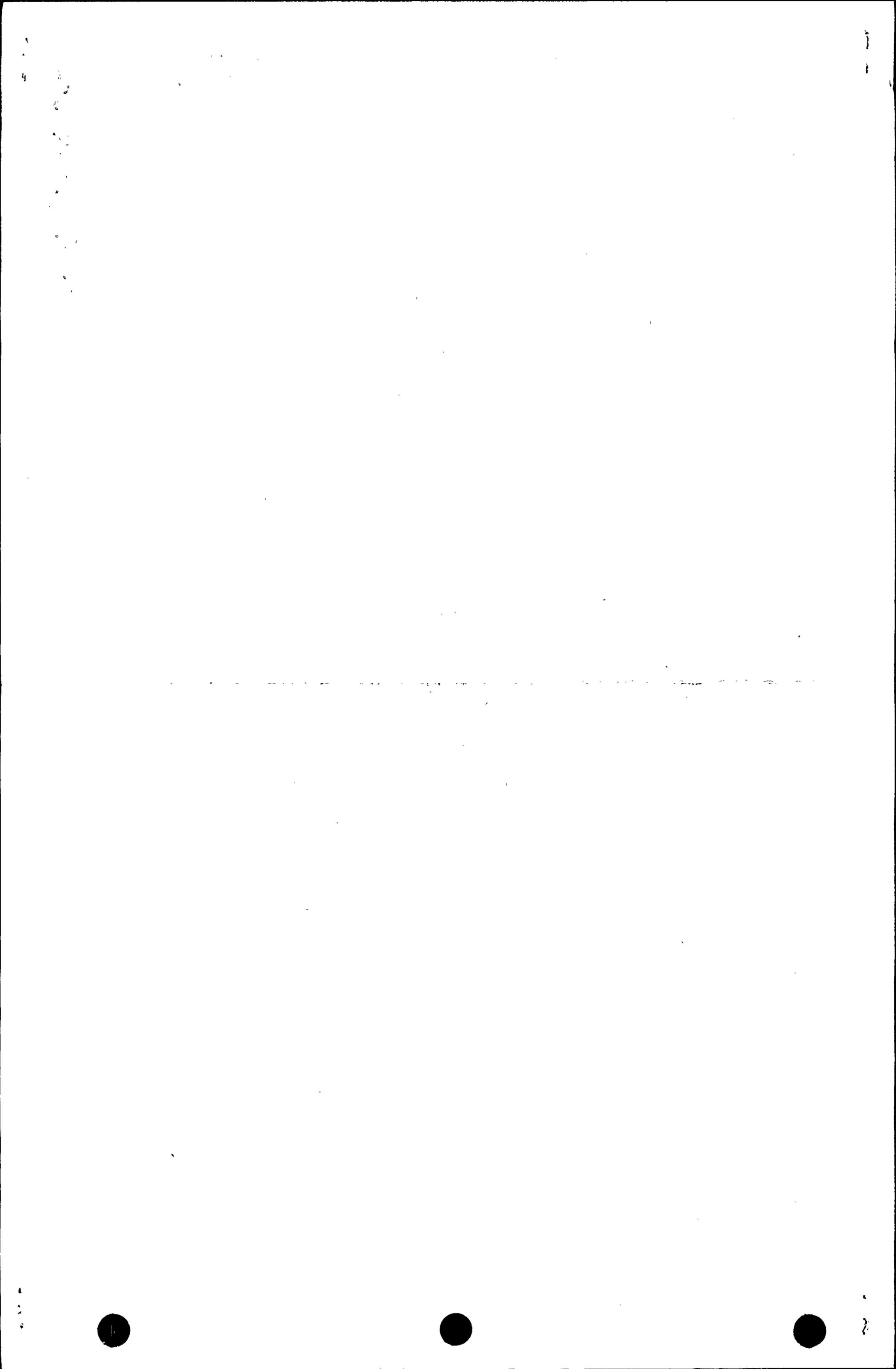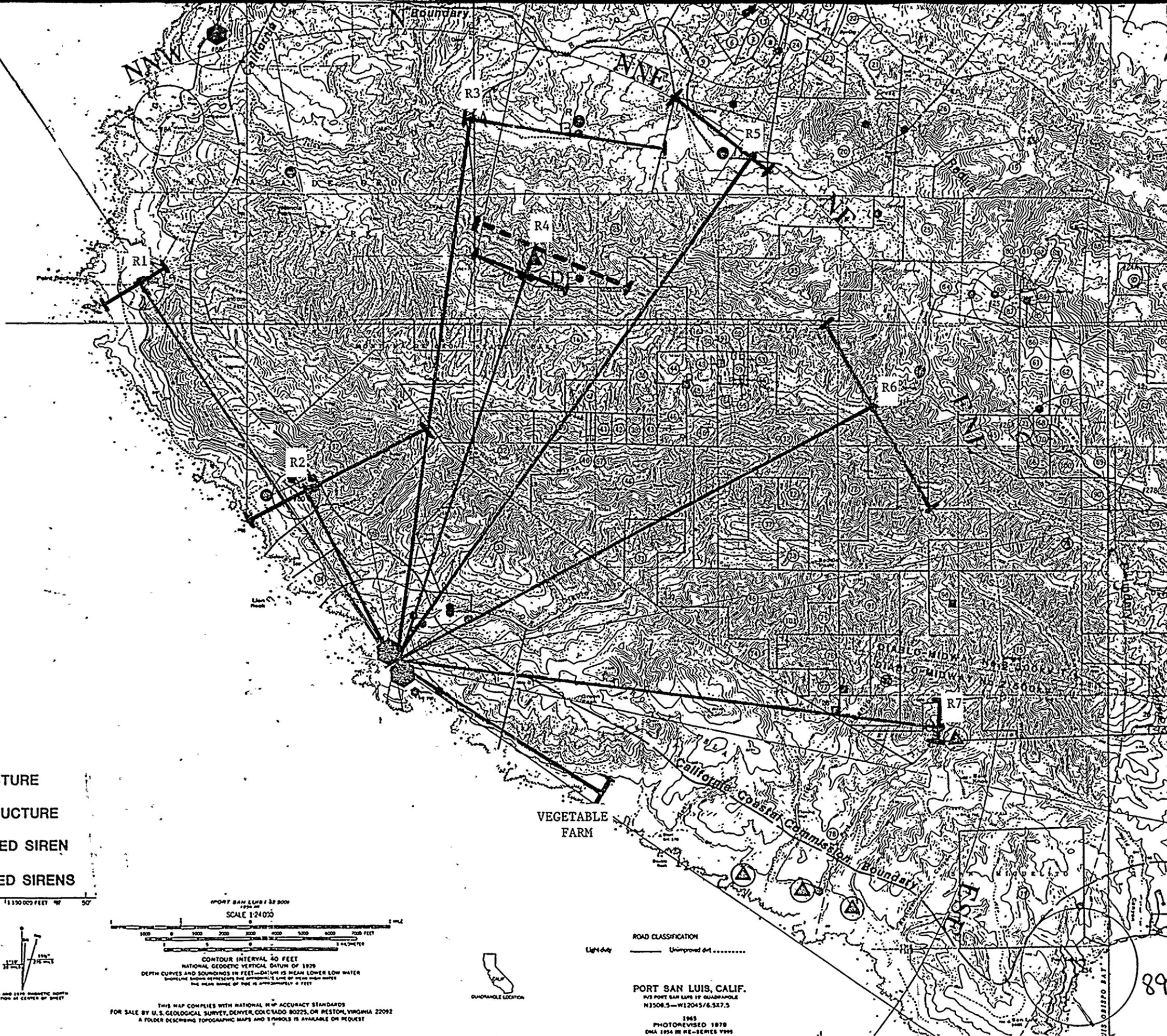
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SAN LUIS OBISPO COUNTY
DIABLO CANYON POWER PLANT
LOW POPULATION ZONE

LEGEND

◉ HABITABLE STRUCTURE

◪ UNHABITABLE STRUCTURE

◯ ELECTRIC POWERED SIREN

△ BATTERY POWERED SIRENS

VEGETABLE
FARM

SCALE 1:24000

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

ROAD CLASSIFICATION

Light duty ———   Unimproved dirt ....

PORT SAN LUIS, CALIF.

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03

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REVISION   8
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TITLE: OFF-SITE DOSE CALCULATIONS

UNITS   1 AND 2
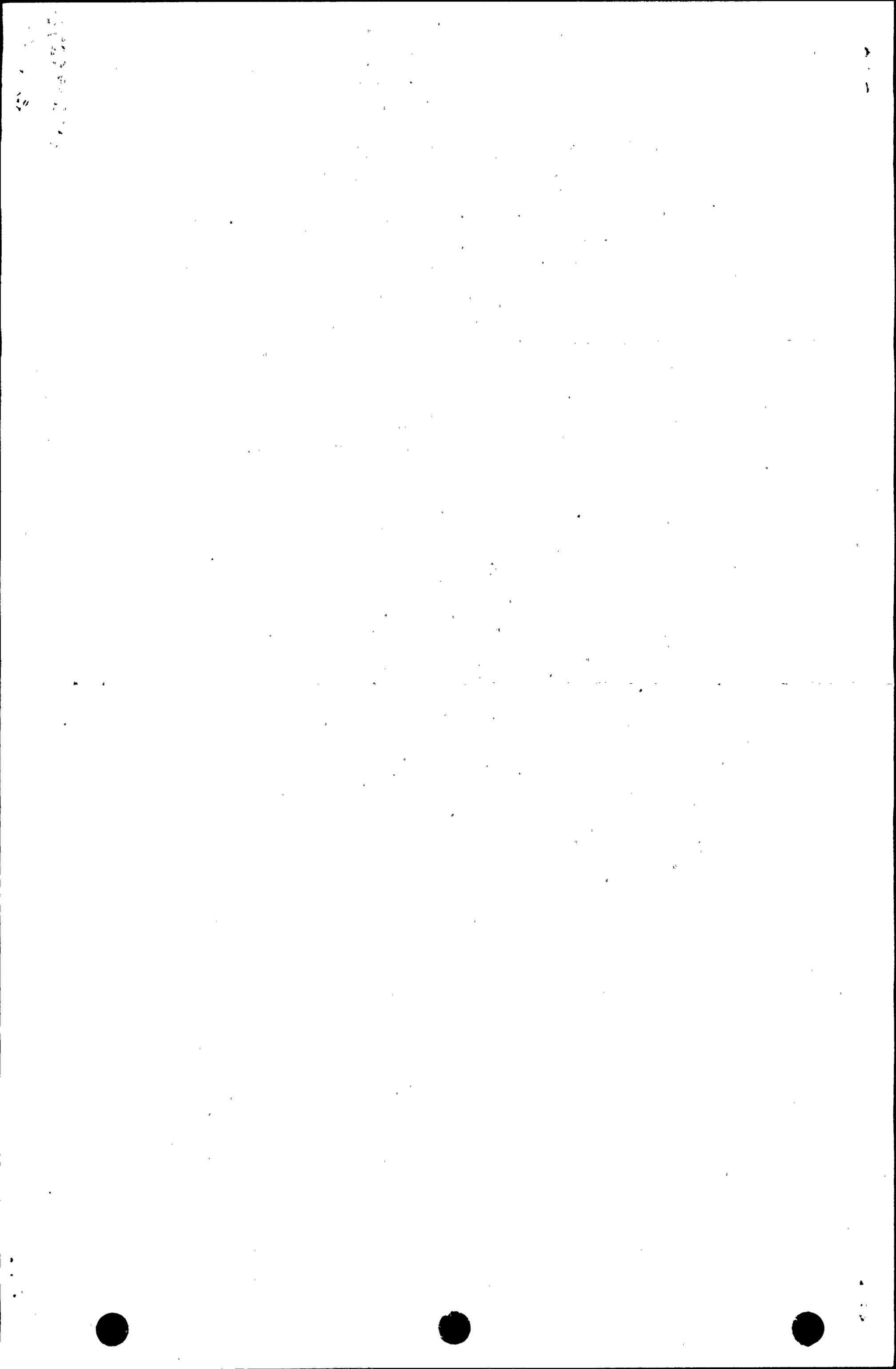
APPENDIX 8.1

Here the constituents, ΔF, to the Liquid Effluent radiation monitor high alarm set point expressions as displayed in l.c. are expounded upon in more detail. From these, it is relatively effortless to see how equations (2) through (7) were derived.

8.1.1   RE-18 (Subscript "b")

The ΔF_b term is assembled from the other sources, as,

$$\Delta F_b = \sum_{\substack{j=1 \\ j \neq b}}^{5} \frac{C_j F_j}{MPC_j}$$

The C&RP Engineer will specify the ΔF_b made up of choices on $\frac{C_j}{MPC_j}$ and F_j. The choices are as follows:

a. If there is a discharge already in progress from any (or all) of the other potential sources ($j \neq b$), then use the actual values of $\frac{C_j}{MPC_j}$ and F_j.

b. If there is a planned discharge from any of the other potential sources ($j \neq b$) which might occur during batch "b" discharge and wherein pre-release analysis data also provides a $\frac{C_j}{MPC_j}$, then use this value and the maximum

default value of F_j.

DIABLO CANYON POWER PLANT

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TITLE: OFF-SITE DOSE CALCULATIONS

UNITS   1 AND 2

APPENDIX 8.1 (Continued)

c.   In the absence of any pre-release data, yet there is possibility of a discharge from these other sources ($j{\neq}b$) occurring during batch "b's" discharge, then select a max conservative value of the $\dfrac{C_j}{MPC_j}$ from a recent history of such values also the maximum default value of F_j.

d.   With the assurance that no "jth" discharge will occur during batch "b's" discharge, then select $\dfrac{C_j}{MPC_j} = 0$ for that other "jth" potential source.

8.1.2   RE-23 (Subscript "1" for Unit 1 - Subscript "2" for Unit 2)

As in 1. (above), assemble the $\Delta F_{1(2)}$ term as:

$$\Delta F = \sum_{\substack{j=b,3,4,5,2(1) \\ j{\neq}1(2)}} \frac{C_j F_j}{MPC_j}$$

Again as in 1., the Chem. Engineer will specify the $\Delta F_{1(2)}$ makeup of the following choices on $\dfrac{C_j}{MPC_j}$ and F_j:

a.   If there is a discharge from any (or all) of the other potential sources already in progress, then use the actual values of $\dfrac{C_j}{MPC_j}$ and F_j in these discharges $j \neq b$.

For the $\dfrac{C_b}{MPC_b}$ contribution, the Chem. Engr. selects from a recent history (within 2 weeks) of such values a maximum (hence most conservative) along with F_j = max default value.

DIABLO CANYON POWER PLANT

NUMBER   CAP A-8
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TITLE: OFF-SITE DOSE CALCULATIONS

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APPENDIX 8.1 (Continued)

b. If there is a proposed "jth" discharge (j≠b) which may coincide or overlap with this discharge and for which a pre-release analysis gives the values of $\frac{C_j}{MPC_j}$, then use

these values along with the max default F_j. For the $\frac{C_b}{MPC_b}$

and F_b contributions, use the same as instructed in a. above.

c. If there are no discharges from the "jth" sources (j≠b) and no pre-release data on j≠b, then enter "0" for these contributions to the $\Delta F_{1(2)}$. For the $\frac{C_b}{MPC_b}$ and F_b contributions, use the same as instructed in a. and/or b. above.

8.1.3   RE-3 (Subscript "3")

As in 2. above, the ΔF_3 is generated by exactly the same instructions with the exception of merely permuting the subscript "3" with the subscripts "1" (or "2"), namely:

$$\Delta F_3 = \sum_{\substack{j=b,1,2,4,5 \\ j\neq 3}} \frac{C_j F_j}{MPC_j}$$

8.1.4   RE-16 (Subscript "4" for Unit 1- Subscript "5" for Unit 2)

As in 2. above, the $\Delta F_{4(5)}$ are generated by exactly the same instructions as in 2. with the exception of merely permuting the subscripts "4(5)" with the subscripts "1(2)", namely:

$$\Delta F_{4(5)} = \sum_{\substack{j=b,1,2,3,5,(4) \\ j\neq 4(5)}} \frac{C_j F_j}{MPC_j}$$

8.1.5   Allowable flowrates and/or Batch Volumes as a Liquid Radwaste Release Limiting Criteria

a. M.P.C. or Maximum Allowable Flowrate (MAF) Limiting - T.S. 3/4.11.1.1(10CFR20)

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$$^{MAF}F_j = \frac{F(j) - \Delta F_j}{C_j/MPC_j} \qquad \text{(from 1., 2., 3. or 4. above)}$$

NOTE: because F contains F_c and F_j, one can either use $F_j = F_j'$, the rated flowrate for the pump in stream of "j^{th}" release or simply $F \approx F_c(j)$ since $F_c \gg F_j$, in any case. This also applies to b. and c. below.

b. H.A.S.P. Limiting Flowrate (i.e., "turning" the procedure's main body equation (2) through (7) "inside out")

$$^{HASP}F_j = (F-\Delta F_j)\left\{ \frac{^jHASP_{calc}(existing) - {}^jBkgd}{{}_\gamma k_j} \left[\frac{1}{^{RCS}C_\gamma'} \sum_{\beta \neq H3} \frac{^{RCS}C_\beta}{^{MPC}C_\beta} + \frac{1}{^{RCS}MPC_\gamma'} \right] + \frac{^{RCS}C_{H3}}{^{MPC}H3} + \frac{C_j''}{MPC_j} \right\}^{-1}$$

Note: $^{j=b,3}HASP_{calc}(existing) = 10^{(\log_{10}Actual\ HASP\ +0.375)}$ and $^{j=1,2}HASP_{calc}(existing) = \frac{Actual\ HASP}{0.7}$

Also the bracketed "[   ]" term as well as $^{RCS}C_{H3}/MPC_{H3}$ is a slowly varying constant and at most calculated quarterly.

Here, as seen in 5.1.3 of the procedure's main body, one has

$$^{RCS}MPC_\gamma' \equiv \left(\sum {}^{RCS}f_{\gamma i}' /MPC_i \right)^{-1}, \text{ where } {}^{RCS}f_{\gamma i}' = \frac{^{RCS}C_i\ e^{-\lambda i(1\ day)}}{^{RCS}C_\gamma'} \quad (i=\gamma \text{'s only}),$$

and $^{RCS}C_\gamma' \equiv \sum_{\substack{i \neq H3 \\ i \neq \beta}} {}^{RCS}C_i\ e^{-\lambda i(1\ day)}$, ($\beta$ usually = Sr 89 and Sr 90/Y90)

c. "31-Day-Dose Projection Limiting Volume - T.S. 3./4.11.1.3.d

$$^{31DDP}_{MAX}V_j = \frac{V_j'}{(0,1,2)d_o'} \left\{ \frac{1}{31} \begin{bmatrix} 0.2mrem,(\neq w.b.) \\ or \\ 0.06mrem,(= w.b.) \end{bmatrix}(T+t) - {}^{PM}D_{o(0,1,2)} - d_o \right\}(from\ Step\ 5.1.4)$$

Note: $V_j' \equiv F_j' \Delta t_j(max)$, where F_j' is the rated flowrate of "j^{th}" release pump and

$\Delta t_j(max)$ = maximum time proposed for release, or alternately

$V_j' \equiv$ maximum capacity of tank for proposed "j^{th}" release

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APPENDIX 8.2

8.2.1   NOBLE GASES

Two important entities are generated for triggering the
effluents engineer and the attendant rad monitor's valving
automatics to allow or disallow a radioactive gaseous
batch release. Involved here are the only two gaseous
batch release sources, the Gas Decay Tanks and the
Containment Purge (or venting), which efflux through the
plant vent. The expressions controlling these decision
entities are found in the main body of this procedure as
equations (9) and (10). Equation (9) is preferentially
selected over equation (10) since, almost without
exception, the whole body dose rate calculation always
seems to predominate over the skin dose rate calculation
(i.e., with regard to the most conservative dose rate
limitation). Although the Technical specification assigns
a 500 mrem/yr (whole body dose rate) overall limitation to
both units, the calculation here will conservatively
assign a 250 mrem/yr limit per Unit in this procedure's
equation (9).

These key entities are the percent release rate limit
(P.R.R.L.) and attendant rad monitor high alarm set point
(H.A.S.P). Although the local attendant rad monitors for
noble gas releases from the gas decay tanks and
containment are respectively RE-22 and RE-12 the final
attendant effluent rad monitors are RE-14A and RE-14B of
the plant vent. Consequently for each batch release from
either containment or gas decay tank whether a projected
HASP for RE-12 or RE-22 is calculated, a projected HASP
for RE-14A and RE-14B must always be calculated. Lastly,
since the procedure partitions 99% of all gaseous releases
to the plant vent and 1% to the steam generator blowdown
tank vent (at least with regard to dose rates) then
equation (9)'s usage will have a 0.99 multiplication
factor.

The analytics implementing all of this are as follows:

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a. **% Release Rate Limit (P.R.R.L.)** and **High Alarm Set Point (H.A.S.P.)**

Define the batch flow rate F*, which adds to the existing plant vent flow rate (F_{pv}). This can be from either the containment ($F*=F_{ct}$, usually 55000cfm) or from the gas decay tanks ($F*=F_{GDT}$, usually 31 cfm). This means that during a batch release (whether from containment or gas decay tank) the new plant vent flow rate will be F_{pv} + F*.

Now looking at some other definitions needed, one has the set $C_i'(NG)$ and their total $C_T'(NG)$ where, $C_i'(NG)$ is the concentration of noble gas isotope "i" (in μCi/cc) in the plant vent just prior to discharge of the batch, (containment or gas decay tank), with $C_T'(NG) = \Sigma\ C_i'(NG)$. The C_i' s come from the last known sample analysis as scaled by RE-14 ratios. Additionally there is the set $C_i''(NG)$ and its total, $C_T''(NG) = \Sigma\ C_i''(NG)$, which define isotopic noble gas concentrations (and total) in the batch about to be released (i.e., containment or gas decay tank). The C_i'''s come from the batch's pre-release sample analysis. Companion to these are the relative isotopic fractions, namely:

$$f_i' = C_i'/C_T' \text{ and } f_i'' = C_i''/C_T'' \tag{1}$$

Now during the discharge the new plant vent concentration, $C_i(NG)$, will be the following sum, with the batch addition dilution scaled (by flowrate ratios) i.e.:

$$C_i = \left(\frac{F_{pv}}{F_{pv} + F*}\right)\ C_i'\ + \left(\frac{F*}{F_{pv} + F*}\right)\ C_i'' \qquad (\mu Ci/cc) \tag{2}$$

Similarly from this set (equation2) the new plant vent total concentration of noble gases is $C_T(NG) = \Sigma C_i$, and the relative isotopic fractions:

$$f_i(NG) = C_i/C_T = \frac{F_{pv}\ C_i' + F*C_i''}{F_{pv}\ C_T' + F*C_T''}$$

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This is easily seen, since

$$C_T = \frac{1}{F_{pv} + F^*} \left(F_{pv}\, C_T' + F^*\, C_T'' \right)$$

At this point one calls equation (9) from the main body of this procedure and rearranges it in view of the earlier (above) constraints and equation (3)

using, $\dot{Q}_i$ (μCi/sec) = 472 F (cfm) C_i(μCi/cc), namely:

$$^{MAX}C_T(NG) = \frac{0.99 \times 250 \text{ mrem/yr}}{472\ (F_{pv} + F^*)(\overline{X/Q})_{C/L\ MAX} \sum_i K_i\, f_i\ (NG)} \quad (4)$$

where: K_i is the noble gas "i" whole body dose factor and

$(\overline{X/Q})_{C/L\ MAX}$ is the maximum historical "five year" running average "controlling location's" (usually-sector-center-line-at-site boundary) meteorological diffusion dispersion factor – See Tables 6.2 and 6.5.1 of this procedure.

__NOTE:__ Since $^{MAX}C_i(NG) = {}^{MAX}C_T(NG)\, f_i(NG)$

and the fact that F_{pv} and F^* as well as $(\overline{X/Q})$ are independent of i, then they can be factored out from under the "$\sum_i$" sign.

Obviously from equation (4), $^{MAX}C_T(NG)$ sets the limit on what can be

released for all the relative isotopic mixes involved with this particular batch release. From this it is an easy matter to express simple percent for what is actually released (assuming all the f_i's, f_i's and f_i's hold steady values).

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For this, using a knowledge of C_T'', C_T', C_T and equation (4), one has:

$$P.R.R.L.* = \frac{C_T''(NG)}{{}^{MAX}C_T''(NG)} \times 100 = \frac{C_T(NG)}{{}^{MAX}C_T(NG)} \times 100 \leq 100\% \qquad (5)$$

or finally

$$P.R.R.L.* = 191(F_{pv} C_T' + F^* C_T'') (\overline{X/Q})_{C/L} \text{ MAX} \sum_i K_i f_i (NG) \qquad (6)$$

A note of clarification is in order. By examination of equation (6), the P.R.R.L.* is the percent that $\dot{C}_T$ (NG) represents out of a potential

limit $^{MAX} \dot{C}_T$ (NG), which this discharge can impose as it is -- added to an already existing and radiologically restrained effluent stream. To see that those are, indeed, release rates being compared, one only has to multiply both numerator and denominator of the R.H.S. of (5) by

$472F^*$ to get $\dot{Q}_T$ / $^{MAX}\dot{Q}_T$.

Now for the H.A.S.P. one simply has

$$H.A.S.P._{RE22 \text{ (or RE12)}} = Bkg_{RE22 \text{ (or RE12)}} + k_{RE22 \text{ (or RE12)}} {}^{MAX}C_T''(NG)$$

where:

$$k_{RE22 \text{ (or RE12)}} = \sum f_i''(NG) k_i (RE22 \text{ or RE12}),$$

and $^{MAX}C_T''(NG) = {}^{MAX}C_T(NG) C_T''(NG)/C_T(NG)$ in addition

to using equations in CAP D-19 values for k_i (RE22 or RE12)

Likewise:

$$HASP_{RE14} = Bkg_{RE14} + k_{RE14} {}^{MAX}C_T(NG)$$

Using equation (3) and again CAP D-19 values for k_i(RE14), then

$$k_{RE14} = \sum_i f_i (NG) k_i (RE14)$$

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Finally from these calculated values of the HASP (RE22, RE12, or RE14), a usable high alarm set point is needed for the actual setting or comparing with what is already physically set on the instrument (rad monitor) itself. This is called projected HASP and takes into account the I&C uncertainty factor correction. It is given as:

$$\text{proj. HASP} \leq 10^{(\log_{10} \text{HASP (calc)} -0.375)}$$

This must be entered on the release permit as called for in the procedure. This applies to RE22, RE12, RE14A and 14B.

All of the above is performed automatically by the computer software per each pre-release analysis. The software also calculates a projected reading of the radiation monitor from the known values of

C_i'' (or C_i') and $^{22}k_i$ (or $^{12}k_i$, or $^{14}k_i$).

Generally if the proj. HASP is greater than the existing setting (from previous releases) then no action is taken. That is, Operations and I&C do not have to change the HASP on the monitor unless the projected reading calculation shows that, although less than proj. HASP, it is still larger than the existing HASP. In this case the HASP should be raised to the proj. HASP so the release can be legally discharged. On the other hand should the proj. HASP be less than the existing HASP, then the release cannot be discharged until the HASP is lowered to the proj. HASP.

8.2.2   IODINES, PARTICULATES AND TRITIUM

As with noble gases in section 8.2.1 we are concerned with a similar P.R.R.L. for iodines particulates and tritium. Except here interest is only in containment. Since it was assumed above that the only significant nuclides for the gas decay tank were noble gases. Also only the P.R.R.L. will be developed here but no H.A.S.P., this is because there is no iodine rad monitor on containment nor does the plant vent iodine monitor possess any automatics to isolate containment.

Equation (13) from the main body of this procedure is the controlling expression here, which comes directly under T.S. (L.C.O.) 3.11.2.1.b. Although

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the Technical Specifications assigns a 1500 mrem/yr dose to any organ limitation to be applied to the site's both units, the calculation here will conservatively assign 750 mrem/yr limit per unit. Also to simplify the calculation and at the same time maintain conservatism, the formulae will use the so-called super-age group/critical-organ dose rate factors $\bar{P}_i$, found in table 6.4 of this procedure. This in effect selects the highest dose rate factor within the seven (7) major organs and amongst the four (4) principle age groups, for each radionuclide (I.P.T.).

Similarly, as with noble gases in 8.2.1 above, one defines F_{ct} as the containment purge (or vent) flow rate (usually 55000 cfm), and F_{pv} as the plant vent flow rate prior to containment purge.

Also $C_i'(I.P.T.)$ is the concentration of the radioparticulate isotope, or radioiodine or tritium (in $\mu Ci/cc$) found in the plant vent just prior to containment purge. The C_i''s come from the last plant vent sample analysis. Similarly $C_i''(I.P.T.)$ is that same I.P.T. isotope found in containment before the purge and comes from the pre-release analysis for I.P.T.'s in containment

As described above:

$$f_i'(IPT) = \frac{C_i'(IPT)}{C_T'(IPT)}, \text{ with } C_T'(IPT) = \sum_i C_i'(IPT) \text{ and } f_i''(IPT) = \frac{C_i''(IPT)}{C_T''(IPT)}, \text{ with } C_T''(IPT) = \sum_i C_i''(IPT)$$

Also $C_i(IPT) = \left(\dfrac{F_{pv}}{F_{pv} + F_{ct}} \right) C_i' + \left(\dfrac{F_{ct}}{F_{pv} + F_{ct}} \right) C_i'$ with $C_T(IPT) = \sum_i C_i(IPT)$

and $f_i(IPT) = C_i(IPT)/C_T(IPT)$. From this one also sees that

$$C_T(IPT) = \frac{1}{(F_{pv} + F_{ct})} \left[F_{pv}C_T'(IPT) + F_{ct} C_T''(IPT) \right]$$

and $\dfrac{C_T''(IPT)}{C_T(IPT)} = (F_{pv} + F_{ct}) \left[\dfrac{C_T''(IPT)}{F_{pv}C_T'(IPT) + F_{ct} C_T''(IPT)} \right]$

At this point, one recalls equation (13) from the main body of this procedure and rearranges it in view of the above constraints and the definition of $F_i(IPT)$ along with the fact that $Q_i(\mu Ci/sec) = 472 \, F(cfm)C_i(\mu Ci/cc)$:

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$$^{mx}C_{IPT} = {}^{mx}_{SB}C_T(IPT) = \frac{750}{472(F_{pv}+F_{ct})\left(\left[{}^{inh}\overline{p}_{H3}f_{H3} + {}^{inh}\overline{p}_{I131}f_{I131} + {}^{inh}\overline{p}_{I133}f_{I133} + \sum_p {}^{inh}\overline{p}_p f_p\right]\overline{X}/Q_{c/1SB}^{MAX} + \left[{}^{gp}\overline{p}_{I131}f_{I131} + {}^{gp}\overline{p}_{I133}f_{I133} + \sum_p {}^{gp}\overline{p}_p f_\phi\right]\overline{D}/Q_{c/1SB}\right)}$$

(7)

$$^{mx}\dot{C}_{IPT} = {}^{mx}_{VF}C_T(IPT) = \frac{750}{472(F_{pv}+F_{ct})\left\{\left(1/2\left[{}^{inh}\overline{p}_{H3}f_{H3} + {}^{inh}\overline{p}_{I131}f_{I131} + {}^{inh}\overline{p}_{I133}f_{I133} + \sum_p {}^{inh}\overline{p}_p f_p\right] + \left[\left({}^{am}\overline{p}_{H3} + {}^{v}\overline{p}_{H3}\right)f_{H3}\right]\right)\overline{X}/Q_{VF} + \left[\left({}^{am}\overline{p}_{I131} + {}^{v}\overline{p}_{I131} + 1/2\,{}^{gp}\overline{p}_{I131}\right)f_{I131} + \left({}^{am}\overline{p}_{I133} + {}^{v}\overline{p}_{I133} + 1/2\,{}^{gp}\overline{p}_{I133}\right)f_{I133} + \sum_p\left({}^{am}\overline{p}_p + {}^{v}\overline{p}_p + 1/2\,{}^{gp}\overline{p}_p\right)f_p\right]\overline{D}/Q_{vf}\right\}}$$

(8)

$$^{mx}C_{IPT} = {}^{mx}_{5MID}C_T(IPT) = \frac{750}{472(F_{pv}+F_{ct})\left({}^{cm}\overline{p}_{H3}f_{H3}\,\overline{X}/Q_{5MID}^{(MAX)} + \left[{}^{cm}\overline{p}_{I131}f_{I131} + {}^{cm}\overline{p}_{I133}f_{I133} + \sum_p {}^{cm}\overline{p}_p f_p\right]\overline{D}/Q_{5MID}\right)}$$

(9)

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From the 3 leading candidates for "controlling location" above, choose smallest $^{MX}C_T(IPT)$ and call it $^{mx}_{(MIN)}C_T(IPT)$

Then $^{MAX}C_T''(IPT) = \dfrac{C_T''(IPT)}{C_T(IPT)} \quad ^{mx}_{(MIN)}C_T(IPT)$

and $(P.R.R.L.)_{IPT} = \dfrac{C_T''(IPT)}{^{MAX}C_T''(IPT)} \; X100\%$

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$\underline{i}$	$^{inh}\bar{p}_i$	$^{cm}\bar{p}_i$	$^{gp}\bar{p}_i$	$^{a,v,g}\bar{p}_i = {}^{am}\bar{p}_i + {}^{v}\bar{p}_i + \frac{1}{2}\,{}^{gp}\bar{p}_i$
H 3	1.3E3	2.4E3	0	4.32E3
Cr 51	2.1E4	7.5E6	6.7E6	1.70E7
Mn 54	2.0E6	3.1E7	1.1E9	1.51E9
Fe 59	1.5E6	3.4E8	3.9E8	2.98E9
Co 58	1.3E6	9.1E7	5.3E8	1.19E9
Co 60	8.7E6	2.9E8	4.4E9	6.50E9
Zn 65	1.2E6	1.7E10	6.9E8	4.05E9
Rb 86	2.0E5	2.1E10	1.3E7	1.00E9
Sr 89	2.4E6	1.1E10	3.2E4	3.64E10
SR 90/Y 90	1.1E8	1.0E11	6.4E3	1.41E12
Y91m/Y91	2.9E6	5.5E6	1.7E6	3.73E9
Zr 95	2.7E6	1.0E6	3.5E8	2.98E9
Nb 95M/Nb 95	7.5E5	2.9E8	2.0E8	7.37E9
Ru 103	7.8E5	1.3E5	1.6E8	1.16E10
Ru 106/Rh 106m	1.6E7	1.5E6	3.0E8	1.65E11
Ag 110m	6.8E6	2.1E10	3.1E9	8.05E9
Cd 115m/Cd115/ In115m	2.8E6	6.9E7	6.3E6	3.56E9
Sb 124	3.9E6	7.8E8	8.4E8	3.89E9
Sb 125	2.7E6	2.2E8	7.6E8	2.15E9
Te 129M	2.0E6	1.3E9	2.9E7	8.32E9
Cs 134	1.1E6	5.4E10	2.8E9	2.86E10
Cs 136	1.9E5	5.5E9	2.1E8	3.70E8
Cs 137	9.1E5	4.9E10	1.1E9	2.67E10
Ba 140	2.0E6	2.E38	2.9E7	3.52E8
Ce 141	6.1E5	1.5E7	1.9E7	5.72E8
Ce 144	1.3E7	1.3E8	5.9E7	1.35E10
Nd 147	3.7E5	6.9E5	1.2E7	2.35E8
UnId	1.1E8	1.0E11	3.1E9	1.55E12
I-131	1.6E7	5.2E11	2.5E7	2.67E10
I-133	3.8E6	4.8E9	3.5E6	4.12E8

NOTE: $\bar{X}/Q$ AND $\bar{D}/Q$ may be found in CAP A-8

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Equation (7), (8) and (9) in view of 'the values for $\bar{P_i}$'s and current met data from tables 6.5.1 and 6.5.2 simplify to the following:

$$\prescript{mx}{SB}{C}_T(IPT) = \frac{1}{(F_{pv} + F_{ct})[0.00338f_{H3} + 41.8f_{I131} + 9.91f_{I133} + \sum_P (2.60E\text{-}6\ \prescript{inh}{}{\bar{P}}_p + 9.19E\text{-}9\ \prescript{gp}{}{\bar{P}}_p)f_P]} \tag{10}$$

or

$$\prescript{mx}{VF}{C}_T(IPT) = \frac{1}{(F_{pv} + F_{ct})[0.00220f_{H3} + 91.9f_{I131} + 2.20f_{I133} + \sum_P (2.21E\text{-}7\ \prescript{inh}{}{\bar{P}}_p + 3.31E\text{-}9\ \prescript{a,v,gp}{}{\bar{P}}_p)f_P]} \tag{11}$$

or

$$\prescript{mx}{SMID}{C}_T(IPT) = \frac{1}{(F_{pv} + F_{ct})[0.000449f_{H3} + 153f_{I131} + 1.41f_{I133} + 2.95E\text{-}10 \sum_P \prescript{cm}{}{\bar{P}}_p\ f_P]} \tag{12}$$

In view of the foregoing expressions and equations (10), (11) and (12) one finally has,

$$\prescript{SB}{}{(P.R.R.L.)}_{IPT} = 100[F_{pv}C'_T(IPT) + F_{ct}C^*_T(IPT)][0.00338f_{H3} + 41.8f_{I131} + 9.91f_{I133} + \sum_P (2.60E\text{-}6\ \prescript{inh}{}{\bar{P}}_p + 9.19E\text{-}9\ \prescript{gp}{}{\bar{P}}_p)f_P] \tag{13}$$

or

$$\prescript{VF}{}{(P.R.R.L.)}_{IPT} = 100[F_{pv}C'_T(IPT) + F_{ct}C^*_T(IPT)][0.00220f_{H3} + 91.9f_{I131} + 2.20f_{I133} + \sum_P (2.21E\text{-}7\ \prescript{inh}{}{\bar{P}}_p + 3.31E\text{-}9\ \prescript{a,v,gp}{}{\bar{P}}_p)f_P] \tag{14}$$

or

$$\prescript{SMID}{}{(P.R.R.L.)}_{IPT} = 100[F_{pv}C'_T(IPT) + F_{ct}C^*_T(IPT)][0.000449f_{H3} + 153f_{I131} + 1.41f_{I133} + 2.95E\text{-}10 \sum_P \prescript{cm}{}{\bar{P}}_p\ f_P] \tag{15}$$

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9.0 REFERENCES

9.1   "Draft Radiological Technical Specifications for PWR's," NUREG No. 0472, May 1978.

9.2   "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I, "Regulatory Guide 1.109, Rev. 1, October 1977.

9.3   "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," NUREG No. 0133, October 1978.

9.4   "Age-Specific Radiation Dose Commitment Factors for a one-year Chronic Intake," NUREG No. 0172, November 1977.

9.5   "Methods for Demonstrating LWR Compliance with the EPA Uranium Fuel Cycle Standard 40 CFR Part 190," NUREG No. 0543, January 1980.

9.6   "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", Regulatory Guide, 1.111, Rev. 1, July, 1977.

9.7   "The Atomic Nucleus", R.D. Evans, McGraw-Hill, 1955.

9.8   "Radiological Health Handbook", U.S. Dept. Health, Education and Welfare, P.H.S., BRH, 1970.