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WILLIAM F. CONWAY
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161-04741-WFC/JRP
April 22, 1992

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Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Annual Radiological Environmental Operating Report
File: 92-005-419.05; 92-056-026

Enclosed please find a copy of the Annual Radiological Environmental Operating Report for PVNGS. This report covers the operation of PVNGS Units 1, 2, and 3 during 1991, and is being submitted pursuant to Technical Specification 6.9.1.7.

If you should have any questions, please contact Thomas R. Bradish of my staff at (602) 393-5421.

Sincerely,

WFC/JRP/pmm

Enclosure

cc: J. B. Martin
D. H. Coe
A. H. Gutterman (w/out enclosure)
A. C. Gehr (w/out enclosure)

50-528
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102-04404–AKK/SAB/RJR
February 7, 2000

Mr. David L. Meyers, Chief Rules and Directives Branch,
Office of Administration
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Sir:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Comments on NRC Draft DG-1094, "Fire Protection for Operating Nuclear Power Plants" (Federal Register Vol. 64, No. 209, Pg. 58461)

In the October 29, 1999 Federal Register (64 FR 58461), the NRC announced the availability, for public comment, of draft Regulatory Guide, DG-1094, Fire Protection for Operating Nuclear Power Plants. PVNGS appreciates the opportunity to comment on this draft guide and has enclosed comments for your consideration.

PVNGS also feels compelled to acknowledge and support the comments submitted by the Nuclear Energy Institute (NEI) in reference to project number 689. Specifically those identified on page two of NEI's cover letter identified as their most significant comments that we have repeated below.

1. Implementation: Two provisions in Section D suggest that the NRC will consider this regulatory guide as a new standard for fire protection programs: (1) The request for licensees to review existing programs against this regulatory guide; and (2) the NRC's proposed use of the regulatory guide for inspecting plant programs. Without further explanation, these statements effectively negate the NRC statement that existing programs need not be changed. It is difficult to envision how an NRC inspector in the field will be able to distinguish between the new NRC staff positions contained in the regulatory guide and the existing guidance a plant is committed to comply with as part of its licensing bases. More thought is necessary to determine how these regulatory guide provisions are reflected in revised NRC inspection procedures so that inappropriate pressure to "upgrade" fire protection programs does not arise. Plants should be inspected only for compliance with their existing

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licensing bases.

2. New guidance: Table 3 of Enclosure 1 of the NEI comment letter lists many examples of what industry considers to be new NRC staff positions in DG-1094. While new guidance can be useful in some areas, there is no evidence that the appropriate regulatory analyses have been performed for what are essentially new NRC staff positions. Staff has previously indicated their intent to perform these reviews. Industry would appreciate having the opportunity to review the regulatory analyses at the same time the draft regulatory guide is issued for formal public comment this April.

3. Revised guidance: In a number of cases there are changes to the wording of existing guidance documents. Even very minor changes can have a significant impact on plant fire protection programs. NRC should systematically review DG-1094 to assure that unintended changes do not occur, and intended changes are subject to appropriate backfit reviews.

Finally, National Fire Protection Association code NFPA-101 has been identified in several sub-sections of this draft guide. The state of Arizona does not recognize this Code and instead requires PVNGS to meet the Uniform Building Code and Uniform Fire Code. The draft guide does not provide for this situation.

No commitments are being made to the NRC by this letter.

Please contact Mr. Scott Bauer at (623) 393-5978 if you have any questions.

Sincerely,

Angela K Krainik

AKK/SAB/RJR/kg

cc: E. W. Merschoff
M. B. Fields
J. H. Moorman
D. J. Modeen (NEI)

ENCLOSURE

Comments on Draft Regulatory Guide DG-1094
Fire Protection for Operating Nuclear Power Plants

1. Draft RG DG-1094 states the following:

B 2.2 10 CFR Part 50.48 (page 14)

"As discussed later in Section B.3 of this guide, deviations from NRC fire protection requirements are documented and reviewed under different processes depending on the date of the operating license. Appendix R requirements for pre-1979 plants are processed under the exemption process. Deviations from other applicable guidelines are identified and evaluated in the staff's Safety Evaluation Reports. For post-1979 plants, where fire protection features do not meet applicable NRC requirements or commitments, or alternative approaches are proposed, the condition is documented as a deviation."

B 3.2 Plants Licensed After January 1, 1979 (page 19)

"Plants licensed after January 1, 1979, are subject to the requirements of 10 CFR 50.48 (a) and (e) only and as such must meet the provisions of GDC 3 as specified in their license conditions and as accepted by the NRC in their SERs. These plants are typically reviewed to the guidance of SRP Section 9.5-1. For these plants, where compliance with the provisions of GDC 3 and the applicable paragraphs of 10 CFR 50.48 cannot be achieved, or where commitments to specific guidelines cannot be met, or alternative approaches are proposed, the differences between the licensee's program and the NRC requirements and . guidelines are documented in deviations, that may be submitted for staff review and approval."

C 1.4.4 Deviations (page 37)

"Plants licensed after January 1, 1979 which have committed to meet the requirements of Section III.G, III.J and III.O, of Appendix R or other NRC guidance (e.g., Branch Technical Position CMEB 9.5-1), and are required to do so as a license condition, do not need to request exemptions for alternative configurations. However, deviations from the requirements of Section III.G, III.J and III.O or other applicable requirements or guidance should be identified and justified in the FSAR or FHA and the deviation may require a license amendment to change the license condition. Deviations submitted to the NRC for review and approval should include a technical justification for the proposed alternative approach. The technical justification should address the criteria described in Regulatory Positions C.1.4.1 for 50.59 Evaluations and C.1.4.2 for exemptions."

Appendix C C-2.1.3 Exemption/Deviation vs. 50.59 (page 123)

"If a proposed change involves a change to a license condition, technical specification, or other previously approved aspect of the fire protection program, a license amendment request should be submitted. When a change not involving a technical specification or license condition is planned, the evaluation made in conformance with 10 CFR 50.59 to determine whether an unreviewed safety question is involved should include an assessment of the modification's impact on the existing fire hazards analysis for the area. The assessment should include the effect on the fire hazard and the consideration of whether circuits or components, including associated circuits, for a division of equipment needed for safe shutdown are being affected or a new element introduced in the area. If this evaluation concludes that there is no significant impact, this conclusion and its basis should be documented as part of the 10 CFR 50.59 evaluation and be available for future inspection and reference. If the evaluation finds that there is an impact that could result in the area either not being in conformance with Appendix R, or some other aspect of the approved fire protection program, or being outside the basis for an exemption (or deviation) that was granted (or approved) for the area involved, the licensee should either make modifications to achieve conformance or justify and request exemption (or, for the post 1979 plants, deviation approval) from the NRC."

APS COMMENT: *Currently, NRC regulations do not contain provisions for requesting NRC approval of deviations from UFSAR Appendix R commitments, NRC Guidelines, or Safety Evaluation Reports. The NRC has established codified processes for changing the operating license (10 CFR 50.90), and the UFSAR (10 CFR 50.59), and plants such as Palo Verde, have license conditions controlling changes to their fire protection programs. The use of the term "Deviation" is inconsistent between the sections listed above. "deviations ... are documented and reviewed", "deviations, that may be submitted for staff review and approval", "deviations ... should be identified and justified", "deviation may require a license amendment", "deviations submitted ... for review and approval."*

There does not appear to be a regulatory basis for plants licensed after January 1, 1979, to request deviations. If there is a regulatory basis, does it govern the format, content, submittal, and review of the deviation?

2. Draft RG DG-1094 states the following:

C 1.1.1.1 <u>Offsite Positions/Organizations</u> (page 25)

"The following positions/organizations should be designated:

a. The upper level offsite management position which has management responsibility for the formulation, implementation, and assessment of the effectiveness of the nuclear plant fire protection program.

b. The offsite management position(s) directly responsible for formulating, implementing, and periodically assessing the effectiveness of the fire protection program for the licensee's nuclear power plant including fire drills and training conducted by the fire brigade and plant personnel. The results of these assessments should be reported to the upper level management position responsible for fire protection with recommendations for improvements or corrective actions as deemed necessary."

<u>*APS Comment*</u>*:* *Not all facilities have an offsite organization that could be charged with these responsibilities. There should be some provision in the RG for these facilities to eliminate the need for an exception/deviation from the RG.*

3. Draft RG DG-1094 states the following:

C 1.2.4.1 <u>Qualifications</u> (page 32)

The brigade leader and at least two brigade members should have sufficient training in or knowledge of plant systems to understand the effects of fire and fire suppressants on safe shutdown capability. The qualification of fire brigade members should include an annual physical examination to determine their ability to perform strenuous fire fighting activities. The brigade leader should be competent to assess the potential safety consequences of a fire and advise control room personnel. Such competence by the brigade leader may be evidenced by possession of an operator's license or equivalent knowledge of plant systems.

<u>APS COMMENT</u>: *This requirement does not acknowledge sites that have a dedicated full time fire brigade staffed by qualified fire fighters and brigade leader. In this case a fire team advisor supports the brigade and would meet the brigade leader requirements stated above. Some allowance should be made for other equivalently staffed organizations.*

4. Draft RG DG-1094 states the following:

C 3.4.2 <u>Hydrants and Hose Houses</u> (page 52)

Outside manual hose installation should be sufficient to provide an effective hose stream to any onsite location where fixed or transient combustibles could jeopardize equipment important to safety. Hydrants should be installed approximately every 76 m (250 ft) on the yard main system. A hose house equipped with hose and combination nozzle and other auxiliary equipment recommended in NFPA 24 should be provided as needed, but at least every 305 m (1,000 ft). Alternatively, mobile means of providing hose and associated equipment, such as hose carts or trucks, may be used. When provided, such mobile equipment should be equivalent to the equipment supplied by three hose houses.

<u>APS COMMENT</u>: *This requirement does not recognize those stations that may have a different commitment such as a Class A fire truck with the equivalent equipment of two hose houses. The difference between a truck and a Class A fire truck should be recognized.*

5. Draft RG DG-1094 states the following:

4.1.2.3 <u>Access and Egress Design</u>

"Provision should be made for personnel access to and escape routes from each fire area. Under emergency conditions, prompt ingress into certain areas important to safety should be assured to enable manual fire suppression and safe shutdown of a nuclear power plant, and unimpeded egress from all parts of the facility should be assured in the interest of life safety. NFPA 101, "Life Safety Code," provides guidance on egress design and requirements for protection of egress routes. This standard addresses in detail the number, locations, widths, and routes to emergency exits. It further details safety requirements for stairwell

escape routes, describes route and exit markings, and specifically instructs against the installation of a lock or other fastening on an emergency exit that would prevent escape from the inside of the building."

ASP COMMENT: *The state of Arizona does not recognize NFPA-101, but instead enforces the Uniform Building Code and Uniform Fire Code. The draft guide should recognize that this situation might exist and allow for the differences.*

6. Draft RG DG-1094 states the following:

Appendix C SCOPE (page 122)

As with other changes implemented under 10 CFR 50.59, the licensee should maintain, in auditable form, a current record of all such changes, including an analysis of the effects of the change on the fire protection program, and should make such records available to NRC Inspectors upon request. All changes to the approved program should be reported annually to the Director of the Office of Nuclear Reactor Regulation, along with the FSAR revisions required by 10 CFR 50.71(e).

APS COMMENT: *Many facilities have an exemption from the 10 CFR 50.71(e) requirements that allow the facilities to submit FSAR revisions less frequently than annually. Would this RG require those facilities to submit fire protection program changes annually?*

In addition, draft NEI 96-07, Guidelines for 10 CFR 50.59 Evaluations, which is expected to be endorsed by the NRC, states that fire protection-related changes should be evaluated under the fire protection license condition established by licensees based on Generic Letter 86-10. It also states that fire protection changes would not also be subject to 10 CFR 50.59 unless the changes effect non-fire protection design functions of SSCs. The paragraph quoted from DG-1094 above implies that FP changes are implemented under 50.59, and should be clarified to be consistent with the proposed 50.59 guidance.

7. Draft RG DG-1094 states the following:

Appendix C C-4.1 REPORTING GUIDELINES (page 127)

"The licensee should maintain records of fire protection program related changes in the facility, changes in procedures, and tests and experiments, made pursuant

to the provisions of 10 CFR 50.59. These records must include a written evaluation which provides the bases for the determination that the change, test or experiment does not require a license amendment pursuant to criteria in C-3.1 above."

"The licensee should submit, as specified in 10 CFR 50.4, a report containing a brief description of any changes, tests, and experiments, including a summary of the evaluation of each. A report should be submitted at intervals not to exceed 24 months."

"The records of changes in the facility should be maintained until the termination of a license issued pursuant to 10 CFR Part 50, or the termination of a license issued pursuant to 10 CFR Part 54, whichever is later. Records of changes in procedures and records of tests and experiments should be maintained for a period of 5 years."

APS COMMENT: *Draft NEI 96-07, Guidelines for 10 CFR 50.59 Evaluations, which is expected to be endorsed by the NRC, states that fire protection-related changes should be evaluated under the fire protection license condition established by licensees based on Generic Letter 86-10. It also states that fire protection changes would not also be subject to 10 CFR 50.59 unless the changes effect non-fire protection design functions of SSCs.*

Since FP program changes in the UFSAR would be evaluated under the FP license condition and not 50.59, there would be no regulatory requirement to report the evaluation for changes that do no require prior NRC approval. The changes would be included with the UFSAR updates required by 10 CFR 50.71(e). This would be similar to changes to the QA program under 10 CFR 50.54 that do not reduce commitments and thus do not require prior NRC approval. Regulations only require that those changes be reported in accordance with 10 CFR 50.71(e).

Suggested wording, " Changes to the fire protection program that do not reduce the ability to achieve and maintain safe shutdown must be submitted to the NRC in accordance with the requirements of 10 CFR 50.71(e)."

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Docket: 05000530, Notes: Standardized plant.

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64FR 61142
Nov. 9, 1999
(5)

APS

Palo Verde Nuclear
Generating Station

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102-04381 –GRO/ AKK/DGM
December 8, 1999

Mr. David L. Meyer
Chief, Rules and Directives Branch
Division of Administrative Services
Office of Administration
Mail Stop: T6D59
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Reference: Revision of the NRC Enforcement Policy (64 Fed. Reg. 61142; November 9, 1999)

Dear Mr. Meyer:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2 and 3
Docket Nos. STN 50-528/529/530
Comment on Revision of the NRC Enforcement Policy

The Palo Verde Nuclear Generating Station endorses the Nuclear Energy Institute (NEI) comments on the revisions to the Enforcement Policy, published November 9, 1999. (64 Fed. Reg. 61142).

As discussed in the NEI submittal, Palo Verde believes the revised Enforcement Policy is a clearer, more coherent guidance document. It reflects the NRC's extensive efforts to address industry and other stakeholder concerns. The instant revisions demonstrate the agency's commitment to a more risk informed, performance based regulatory scheme, and should make NRC enforcement action a more effective regulatory tool.

No commitments are being made to the NRC by this letter. Please contact Mr. Dan Marks at (623) 393-6492 if you have any questions regarding this matter.

Sincerely,

Gregg R. Overbeck

GRO/AKK/DGM

cc: E. W. Merschoff [Region IV]
M. B. Fields [NRR Project Manager]
J. H. Moorman [Resident Inspector]
R. W. Bishop [NEI]

#9204300345

PALO VERDE NUCLEAR GENERATING STATION ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT 1991

CONTENTS

TABLES

TABLES cont.

FIGURES

ABSTRACT

The radiological environmental monitoring program is an ongoing study conducted by Arizona Public Service Company. APS contracted the Radiation Measurements Facility (RMF) at Arizona State University (ASU) and Controls for Environmental Pollution, Inc. (CEP) to perform sample analysis. In addition, RMF personnel collected samples from January 1, 1991, through July 31, 1991, at which time PVNGS personnel assumed responsibility for sample collection.

During 1991, samples were collected by the Palo Verde Nuclear Generating Station and Radiation Measurements Facility personnel. The following categories of samples were collected:

- broad leaf vegetation
- fresh milk
- groundwater
- drinking water
- surface water
- airborne particulate and radioiodine
- sludge

Thermoluminescent dosimeters were used to measure environmental gamma radiation.

Sample analysis was performed by the Radiation Measurements Facility from January 1,1991, through August 1, 1991, at which time CEP became the primary analysis laboratory. Thermoluminescent dosimeters were issued and processed by the Palo Verde Nuclear Generating Station. PVNGS staff collect and ship samples and review analysis results for trends anomalies and inclusion in this report.

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

1.0 Introduction

This report presents the results of the operational environmental radiological monitoring program conducted by Arizona Public Service Co. (APS). In accordance with federal requirements to provide a complete environmental monitoring program for nuclear reactors and their concern for maintaining the quality of the local environment, the Radiological Environmental Monitoring Program (REMP) was established for the Palo Verde Nuclear Generating Station (PVNGS) by the Arizona Nuclear Power Project (ANPP) in 1979. The program complies with the requirements of the U.S. Nuclear Regulatory Commission (USNRC) in their Reactor Assessment Branch Technical Position, Revision 1, November 1979. This report contains the measurements and findings for 1991. All bracketed numbers refer to references contained in section 12.

The objectives of the radiological environmental monitoring program are as follows: 1) to determine baseline radiation levels in the environs prior to plant operation and to compare the findings with measurements obtained during reactor operations; 2) to monitor potential critical pathways of radio-effluent to man; and 3) to determine radiological impacts on the environment caused by the operation of PVNGS.

Results from the REMP help to evaluate sources of elevated levels of radiation in the environment, e.g., atmospheric nuclear detonations or abnormal plant releases.

Results for the PVNGS pre-operational environmental monitoring program are presented in references 1-5.

The initial criticality of Unit One occurred May 25, 1985. Initial criticality for Units Two and Three were April 18, 1986, and October 25, 1987, respectively. PVNGS operational findings are presented in reference 6. This report contains the measurements and findings for 1991.

2.0 Description of the Monitoring Program

The pre-operational radiological environmental monitoring program, which began in 1979, was performed by PVNGS and outside organizations. These organizations continued the program into the operational phase of PVNGS.

2.1 1991 PVNGS Radiological Monitoring Program

The assessment program consists of routine measurements of background gamma radiation and of radionuclide concentrations in media such as air, groundwater, drinking water, surface water, fresh milk, vegetation, and sludge.

Samples were collected by PVNGS or RMF personnel at the monitoring sites shown in Figures 2.1, 2.2 and 2.3. The specific sample types, sampling locations, and sampling frequencies as set forth in Palo Verde Nuclear Generating Station Technical Specifications [7] are presented in Tables 2.1, 2.2 and 2.3.

Sample analysis was performed at the RMF at ASU from January 1, 1991, to July 31, 1991. CEP performed the sample analysis from August 1, 1991, to December 31, 1991, at their facility in Santa Fe, New Mexico.

Background gamma radiation measurements are performed using thermoluminescent dosimetry at fifty locations by PVNGS.

2.2 Radiological Monitoring Program Changes for 1991

2.2.1 Effective August 1, 1991, REMP samples are being collected and composited at the frequency stated in the PVNGS Technical Specifications. Previously, samples were being collected and analyzed more often than required.

2.2.2 On August 1, 1991, CEP assumed sample analysis responsibility from the RMF at ASU, and PVNGS personnel assumed sample collection responsibility.

2.2.3 Sample location #52, DeShazo Residence garden was deleted without replacement. The garden has not been used since 1990.

TABLE 2.1

SAMPLE COLLECTION LOCATIONS [6]

Sample Site #	Type	Location(a)	Location Description
1	Air	E30	APS Goodyear Office
4	Air	E16	APS Buckeye Office, 615 N. 4th St, Buckeye
6*	Air	SSE31	APS Gila Bend Substation, Service Road West of Town.
7A	Air	SE8	Arlington School, 16351 S. Arlington School Road
14A	Air	NNE2	Buckeye-Salome Road & 371st Ave.
15	Air	NE2	North East Site Boundary
17A	Air	E4	351st Ave., 1 mile South of Buckeye-Salome Road
21	Air	S3	South Site Boundary
29	Air	W1	West Site Boundary
35	Air	NNW9	Tonopah, Palo Verde Inn Fire Station, 40901 W Osborn Rd.
40	Air	N3	Wintersburg, End of Transmission Road
46	Water,	NNW9	McArthur's Farm, Tonopah
47	Vegetation	ENE3	Adams's Residence, 355th Ave. & Buckeye - Salome Rd.
48	Water	S5	Shepard Farms, 13202 S. 383rd Avenue
49	Water	ESE4	Scott Residence, 351st Ave. & Dobbins Road
50	Milk	ENE12	Crosswinds Dairy, 295th Ave and Van Buren St.
51	Milk	E11	Butler Dairy, Palo Verde Road & Southern
53	Milk	E20	Kerr Dairy, Dean & Buckeye Roads
54	Milk	E17	Dickman Dairy, Broadway and Apache Roads.
55	Water	SW3	Gavette Residence, 39326 W. Elliot Road
56*	Milk	E75	Pew Dairy, McQueen & Ryan Roads
57	Water	on-site	Well 27ddc
58	Water	on-site	Well 34abb
59	Surface Water	on-site	PVNGS Evaporation Pond #1
60	Surface Water	on-site	PVNGS Reservoir
62*	Vegetation	ENE75	J.A. Wood Co., North Alma School Road, Scottsdale, AZ
63	Surface Water	on-site	PVNGS Evaporation Pond #2

* control site.
(a) Distances and direction are from center-line of Unit 2 containment.

TABLE 2

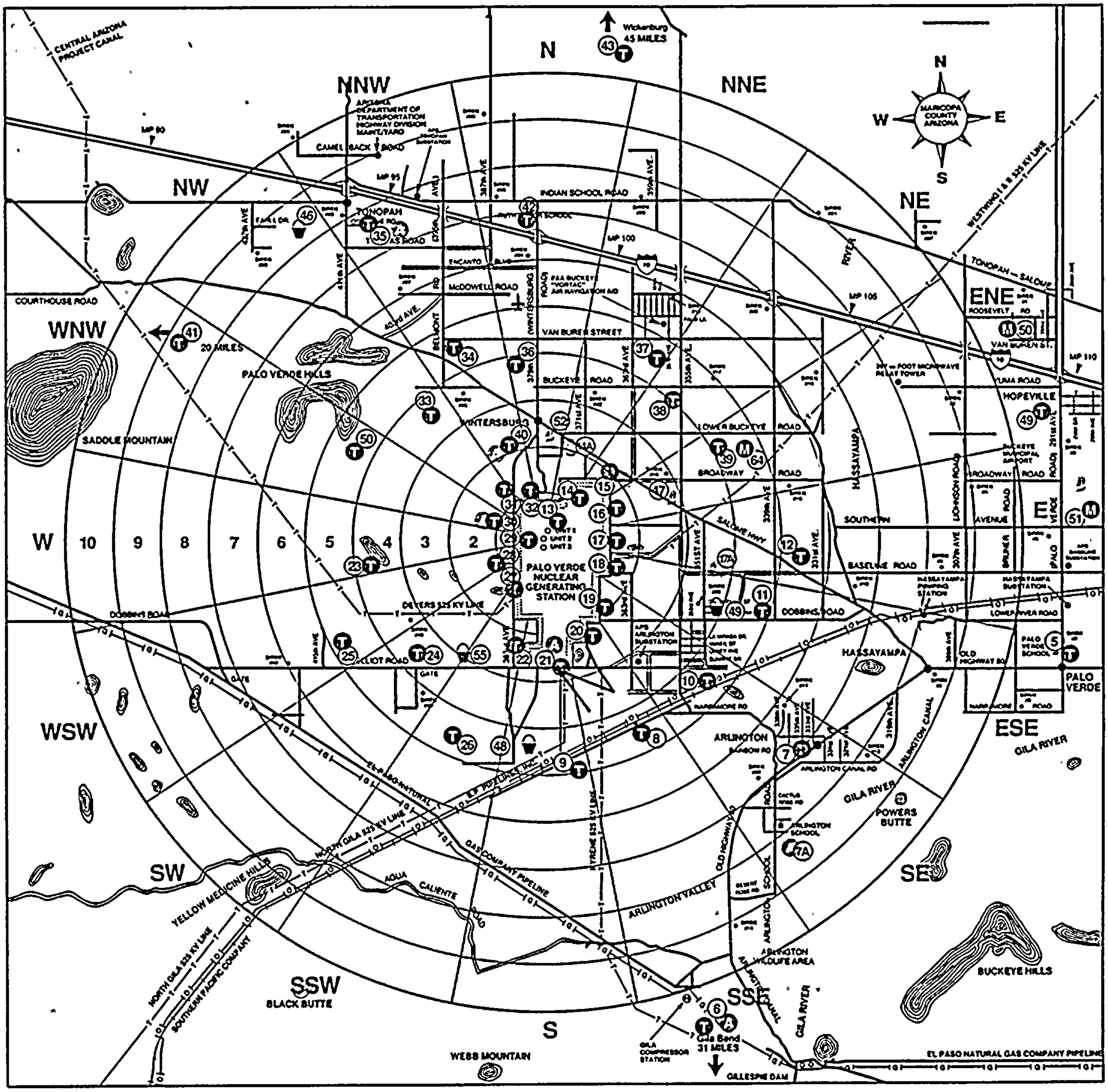
SAMPLE COLLECTION SCHEDULE [6]

Collection Site	Air Particulates	Airborne Radioiodine	Fresh Milk	Vegetation	Groundwater	Drinking Water	Surface Water
#1, APS Goodyear Office	W	W					
#4, APS Buckeye Office	W	W					
#6, APS Gila Bend Substation	W	W					
#7A, Arlington School	W	W					
#14A, Buckeye-Salome Road. & 371st Ave.	W	W					
#15, NE Site Boundary	W	W					
#17A, 351st. Ave., 1 mi South of Buckey-Salome Road.	W	W					
#21, South Site Boundary	W	W					
#29, W. Site Boundary	W	W					
#35, Tonapah, Palo Verde Inn Fire Station	W	W					
#40, Trailer Park at Wintersburg	W	W					
#46, McArthur's Farm						W	
#47, Adam's Residence				AA			
#48, Shepherd Farms						W	
#49, Scott Residence						W	
#50, Crosswinds Dairy			M				
#51, Butler Dairy			M				
#53, Kerr Dairy			M				
#54, Dickman Dairy			M				
#55, Gavette Residence						W	
#56, Pew Dairy			M				
#57, Well 27ddc					Q		
#58, Well 34abb					Q		
#59, PVNGS Evaporation Pond #1							W
#60, PVNGS Reservoir							W
#62, J.A. Wood Co.				AA			
#63, PVNGS Evaporation Pond #2							W

W = Weekly
M = Monthly
Q = quarterly
AA = As available

FIGURE 2.1

Graphic Scale in Miles 0 1 2 3 4 5



KEY TO MAP

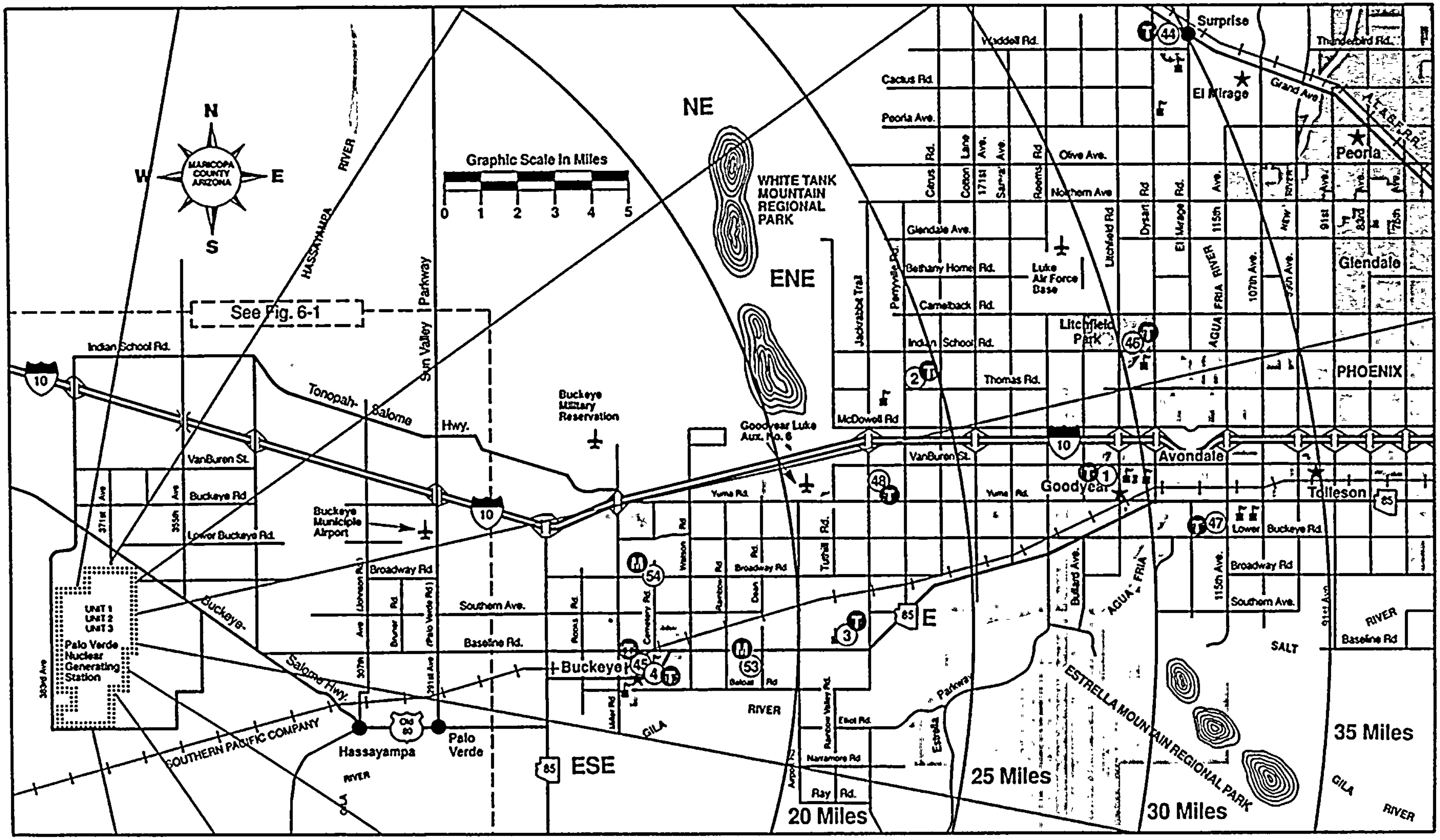
- Paved Road
- Unpaved Road
- 4WD Road
- Gas Pipeline
- Oil Pipeline
- Power Line
- Railroad
- Airstrip
- School
- Siren
- MP Milepost
- Palo Verde Nuclear Generating Station Boundary
- Thermoluminescent Dosimeters (TLD)
- Air Sample
- Vegetation Sample
- Water Sample
- Milk Sample
- Sample Sites

Palo Verde Nuclear Generating Station

Radiological Environmental Monitoring Program Sample Sites

0 – 10 Miles

Figure 6 – 1



KEY TO MAP

- Railroad
- Airstrip/Airport
- Schools Located Near Sample Sites
- Municipal Buildings
- Palo Verde Nuclear Generating Station Boundary
- Thermoluminescent Dosimeters (TLD)
- Air Sample
- Milk Sample
- Sample Sites

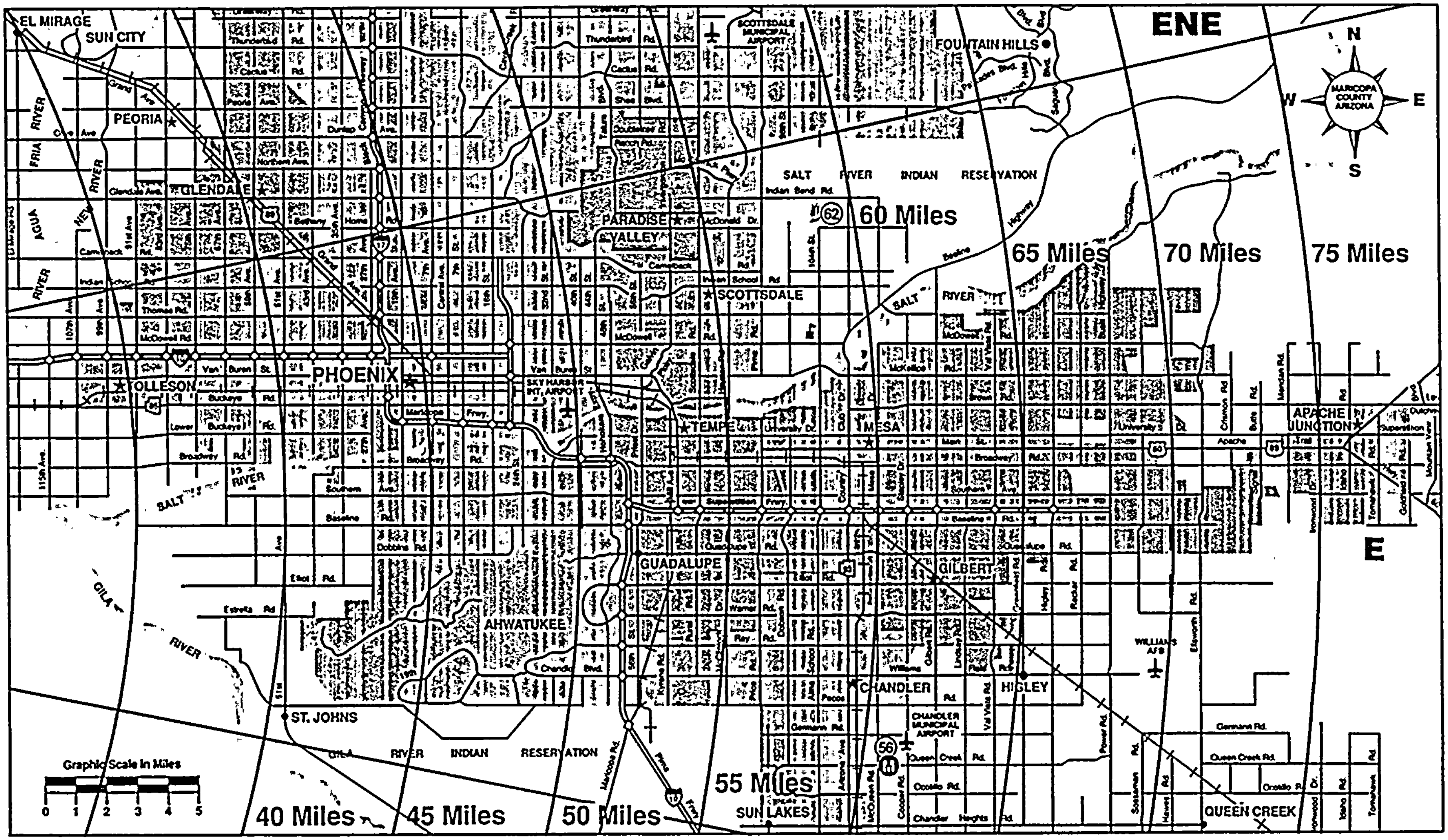
Palo Verde Nuclear Generating Station

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE SITES

0–35 Miles

Fig. 6-2

FIGURE 2.2



KEY TO MAP

- Railroad
- Airstrip/Airport
- Schools Located Near Sample Sites
- Municipal Buildings
- Palo Verde Nuclear Generating Station Boundary
- Milk Sample
- Sample Sites
- Vegetation Sample

Palo Verde Nuclear Generating Station

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLE SITES

35-75 Miles

Fig. 6-3

FIGURE 2.3

3.0 Sample Collection Program

3.1 Water

Water samples were collected by RMF and PVNGS personnel using PVNGS procedures.

3.1.1 Weekly samples were collected from the Reservoir, the Evaporation Pond #1, and Evaporation Pond #2. Weekly samples were collected in one-gallon cubitainers and 500-mL glass bottles at all three sites. Cubitainer samples were acidified with HCl in the laboratory prior to analysis. Begining in August, samples were composited monthly.

3.1.2 Monthly composited samples were collected at four residence wells. Monthly composited samples were collected in 500 mL glass bottles and in one gallon cubitainers. For the bi-weekly analyses, samples were collected in one-gallon cubitainer, and were acidified with HCl in the laboratory prior to analysis.

3.1.3 Grab samples were obtained from on-site wells 34abb and 27ddc. Samples were collected in 1-gallon cubitainers and 500-mL glass bottles. Cubitainer samples were acidified with HCl in the laboratory prior to analysis.

3.2 Vegetation

Vegetation samples were collected by RMF and PVNGS personnel using PVNGS procedures.

3.2.1 Vegetation samples were scheduled to be collected monthly, as available.

3.3 Air Filters and Canisters

Air samples were collected by RMF and PVNGS personnel using PVNGS procedures.

3.3.1 Air particulate filters and charcoal canisters were exchanged at 11 sites on a weekly basis.

3.4 Milk

Milk samples were collected by RMF and PVNGS personnel using PVNGS procedures.

3.4.1 Monthly milk samples were obtained from five dairies during the year. Samples were collected in 1-gallon cubitainers to which 100 mL of carrier/preservative was added. Beginning August 1, 1991, the use of preservative was discontinued, with concurrence from vendor laboratory. Milk samples are currently being stored and shipped in ice chests to prevent curdling.

3.5 Sludge

Sludge samples were collected by RMF and PVNGS personnel using PVNGS procedures.

3.5.1 Quarterly sludge samples were obtained from several on-site locations. Samples were collected using 1000-mL plastic bottles.

4.0 Analytical Procedures

4.1 ASU RMF

A summary of RMF methods is presented here. Sample sizes are provided in Table 4.1. Typical times between sample collection and counting are presented in Table 4.2. Typical counting efficiencies and radiochemical yields are presented in Table 4.3. Table 4.4 presents typical sample counting times. The sample size and counting times used for LLD calculations are the same as used for actual measurements.

4.1.1 Gamma Spectrometry

All gamma spectra are obtained from Ge(Li) or HPGe detectors. Efficiency calibrations are done annually, and in triplicate, for each geometry used. The calculations are performed with a solution of mixed gamma ray emitters whose activities are explicitly traceable to the U.S. National Institute of Standards and Technology.

4.1.1.1 Water

Samples are counted in a one-liter Marinelli beaker. To reduce the counting time, up to two liters may be evaporated to one-liter and counted.

4.1.1.2 Milk
Milk is counted as received, in a one-liter Marinelli beaker.

4.1.1.3 Soil, Animal Feeds, Vegetation
300 g of material is mixed with 200 mL of water and homogenized in a blender. The sample is then transferred to a 500-mL Marinelli beaker and counted.

4.1.1.4 Air Particulate Filters
Filters are counted as received. Monthly composites consist of 4-5 filters stacked in a plastic dish on the detector and counted.

4.1.1.5 Charcoal Canisters
Charcoal canisters are counted on a twin NaI(Tl) detector system. Gamma spectroscopy is used only for verification if I-131 is detected by NaI(Tl). Counting efficiency is determined by spiking blank canisters with I-131 traceable to the National Institute of Standards and Technology (NIST). A canister spiked with Ba-133 is used to verify system performance prior to counting each week's samples.

4.1.1.6 Sludge
Sludge was packed uniformly in a 500-mL Marinelli beaker and counted.

4.1.2 Gross Beta Activity

4.1.2.1 Water
Samples are converted to nitrates and then evaporated to dryness in stainless steel planchettes, which are then flamed and counted.

4.1.2.2 Air Particulate Filters
Efficiency calibration is obtained by depositing a known amount of NIST traceable Sr-90 on the surface of a glass fiber filter whose surface has been sealed to prevent penetration of the activity into the filter medium. Samples are counted as received after allowing 10 days for decay of radium and thorium daughters.

4.1.3 Tritium

4.1.3.1 Water
Water samples are distilled from an alkaline permanganate solution and counted in a liquid scintillation counter. Efficiency is determined on samples with identical quench and sample-to-scintillant ratios.

4.1.4 Iodine-131

4.1.4.1 Water
Radioiodine and added carrier are oxidized to I_2 and extracted into chloroform, reduced and back-extracted into aqueous bisulfite, precipitated as PdI_2, and counted in a low-background gas-flow proportional counter. Counting efficiency is corrected for self-absorption by adding a known amount of NIST-traceable I-131 standard to a series of samples containing varying amounts of iodide, precipitating as PdI_2, and counting in a low-background gas-flow proportional counter.

4.1.4.2 Milk
Radioiodine and added carrier are adsorbed onto Dowex 1-X8 anion exchange resin, stripped with hypochlorite, oxidized to I_2, extracted into chloroform and determination completed as for water samples.

4.1.5 Strontium-89 and Strontium-90
Radiostrontium and added carrier are precipitated from the samples as carbonates. Calcium and other elements are separated by differential solubility in acetone and repeated extractions with fuming nitric acid. The sample is counted immediately after separation from the Y-90 daughter of Sr-90. This gives the total activity due to Sr-89 and Sr-90. After a 14-day ingrowth the sample is counted again. The increase in count rate is due to Y-90, which at equilibrium is equal to Sr-90, whose activity is subtracted from the initial count to determine Sr-89. Counting efficiencies are corrected for self-absorption by adding a known amount of respective NIST traceable nuclide to a series of samples containing varying amounts of the respective carrier, precipitating as carbonate, and counting in a low-background counter.

4.2 CEP Analytical Procedures

The analytical procedures described in this report are those used by CEP to routinely analyze samples.

4.2.1 Air Particulate

4.2.1.1 Gross Beta

Air particulates are examined for Gross Beta. In analyzing the material, the glass fiber filter sample is placed in a 50 mm stainless steel planchet and counted for Gross Beta activity utilizing a low-background internal gas flow, proportional counter. CEP uses the Berthold 10-Channel Low Level Planchet Counting System discussed in section 5.2. The instrument's efficiency is checked weekly using an NIST traceable Cesium-137 standard.

4.2.1.2 Gamma Spectrometry

The air filters are sealed in a standard geometry container and counted on an intrinsic or Ge(Li) detector. The detector, coupled to a computer based analyzer produces a spectrum. When the spectrum is analyzed by computer, specific nuclides, if present, are identified and quantified. CEP uses the Nuclear Data Model 9900 Gamma Spectrometer described in section 5.2. The detectors are checked using NIST traceable standard geometry sources.

4.2.2 Airborne Radioiodine

4.2.2.1 Refer to section 4.2.1.2.

4.2.3 Milk

4.2.3.1 Iodine-131

Two (2) liters of milk containing standardized Iodine carrier are stirred with anion exchange resin for one hour. The Iodine is stripped from the resin with 2N sodium perchlorate ($NaClO_4$) and precipitated with silver nitrate ($AgNO_3$). The precipitate is filtered on a tared glass fiber filter. The dried precipitate is weighed for percent recovery and counted for Iodine-131 in a thin window, gas flow, proportional counter. Samples are analyzed within forty-eight hours of receipt to keep Iodine-131 decay to a minimum.

4.2.3.2 Gamma Spectrometry

Four (4) liters of sample are placed in a 4 liter plastic Marinelli beaker and counted on a multichannel analyzer equipped with an intrinsic Ge detector. (See section 5.2) The resulting spectrum is analyzed by computer, and specific nuclides, if present, are identified and quantified.

4.2.4 Pasturage

4.2.4.1 Gamma Spectrometry

The wet sample is placed in a medium plastic Marinelli beaker and counted on a multichannel analyzer equipped with an intrinsic Ge detector (See Section 5.2). The resulting spectrum is analyzed by computer and specific nuclides, if present, are identified and quantified.

4.2.5 Garden Vegetables

4.2.5.1 Gamma Spectrometry
Refer to Pasturage Section 4.2.4.1

4.2.6 Sludge

4.2.6.1 Gamma Spectrometry
Refer to Pasturage Section 4.2.4.1

4.2.7 Water

4.2.7.1 Gamma Spectrometry
A 4.0 liter aliquot of water in a 4 liter plastic Marinelli beaker is Gamma scanned utilizing a computer-based multi-channel analyzer equipped with an intrinsic Ge detector (See Section 5.2.1). The resulting spectrum is analyzed for nuclides present to yield values for total sample activity.

4.2.7.2 Tritium
Three milliliters of water are mixed with liquid scintillation cocktail. The mixture used is twenty-three percent sample in a clear liquid scintillation cocktail. This gives a Tritium counting efficiency of approximately thirty percent. The counting system used is a Beckman LS-5801 Liquid Scintillation Counter.

4.2.7.3 Iodine-131
One liter of water containing standardized Iodine carrier is acidified with nitric acid (HNO_3), then extracted with carbon tetrachloride (CCl_4) and sodium nitrate ($NaNO_2$) to remove the Iodine. The Iodine is back extracted from the carbon tetrachloride (CCl_4) using a 0.2% hydrazine solution which supplies more purification and an aqueous media for precipitation. Iodine is precipitated with silver nitrate ($AgNO_3$) and filtered on a tared glass fiber filter as silver iodide (AgI). The dried precipitate is weighed for recovery and counted for Iodine-131 in a thin window, gas flow, proportional counter. Samples are analyzed within forty-eight hours of receipt to keep Iodine-131 decay to a minimum. The typical lower limit of detection for this method is 1.0 pCi/L.

4.2.7.4 Gross Beta
A 250 milliliter sample is placed in a beaker. Ten milliliters of concentrated nitric acid is added to the sample, which is then dried down. The residue is wet ashed with 30% hydrogen peroxide and 16N nitric acid. Nitric acid (.5N) is then added to the beaker and placed on a stainless steel planchet and evaporated, flamed, and weighed. The planchet is counted for gross beta in a gas flow proportional counter.

4.3 CEP Sample Preparation Methods

The following sample preparation methods are used routinely by CEP.

4.3.1 Sludge Sample Preparation
1. The plastic containers are opened and weighed when they arrive at the CEP laboratory and after analysis the contents transferred into drying pans.
2. The pans are placed into an oven at 110°C and allowed to dry thoroughly.
3. Results are reported in pCi/Kg wet weight.

4.3.2 Pasturage and Vegetable Sample Preparation
1. The plastic bags are opened and the sample weighed immediately to obtain the wet weight.
2. A known wet weight of sample is placed in a 4 liter plastic Marinelli beaker for Gamma Spectrometry.
3. After weighing, the sample is transferred to a drying pan and placed in an oven at 110°C.
4. The sample is then dissolved or ashed, whichever is required, for further isotopic analysis.
5. Results are reported at pCi/kg wet weight.

TAB[illegible].1

TYPICAL ALIQUOT SIZES
CEP values denoted by ( ) if different.

Sample Type	Gross Beta	Gamma Spec.	Iodine-131	Strontium-89	Strontium-90	Tritium
Air Particulates	430 m^3* (400 m^3)	1720 m^3*				
Airborne Radioiodine		430 m^3* (400 m^3)				
Fresh Milk		1000 mL (4000 mL)	2000 mL			
Broadleaf Vegetation		300 g (1000 g)				
Groundwater	250 mL	1000 mL (4000 mL)	2000 mL(1000mL)			5mL(3mL)
Drinking Water	250 mL	1000 mL (4000 mL)	2000 mL(1000mL)			5 mL(3mL)
Surface	100 mL (250mL)	1000 mL		1000 mL	1000mL	5 mL(3mL)

* Air sample volume determined using assumed constant flow of 1.5 CFM times conversions factors (cubic feet to cubic meters and hours to minutes) times the elapsed time. 1.5 ft^3/min x .02832m^3/ft^3 x 60 min/hr x Elapsed time in hours (ETM reading) = total flow in cubic meters.

TABLE 4.2

TYPICAL TIMES BETWEEN SAMPLE COLLECTION AND COUNTING**

Sample Type	Time between collection and Counting
Air Particulates	10 d
Airborne Radioiodine	1 d < T < 2d
Fresh Milk	2 d < T < 4d *
Vegetation	2 d < T < 5d
Water	1 d < T < 7d
Sludge	1 d < T < 7d

* Priority is given to Iodine-131 radiochemical assay, then measurement of other nuclides with longer half lives.
** Time interval between collection and analysis by CEP will be greater due to shipping distance.

TAB[illegible]3

TYPICAL COUNTING EFFICIENCIES AND RADIOCHEMICAL YIELDS

GAMMA SPECTROSCOPY

Energy MeV	Isotope	Detector Efficiency
0.134	Ce-144	0.019
0.365	I-131	0.010
0.537	Ba-140	0.0064
0.605	Cs-134	0.0059
0.622	Ru, Rh-106	0.0057
0.662	Cs-137	0.0054
0.765	Zr, Nb-95	0.0047
0.811	Co-58	0.0045
0.835	Mn-54	0.0043
1.095	Fe-59	0.0034
1.115	Zn-65	0.0033
1.173	Co-60	0.0031
1.596	La-140	0.0024

OTHER THAN GAMMA SPECTROSCOPY

(Detector Efficiency // Chemical Recovery)

Sample Type	Gross Beta	I-131	Sr-89	Sr-90	H-3
Air Particulates	0.40//na				
Airborne Radioiodine		0.12//na			
Fresh Milk		0.30//0.70	0.45//0.85	0.30//0.85	
Groundwater	0.32//na	0.30//0.90	0.45//0.85	0.30//0.85	0.35//na
Drinking Water	0.32//na	0.30//0.90	0.45//0.85	0.30//0.85	0.35//na
Surface Water	0.20//na	0.30//0.90	0.45//0.85	0.30//0.85	0.35//na

na not applicable

TABLE 4.4

TYPICAL SAMPLE COUNTING TIMES
CEP values denoted by ( ) if different.

Sample Type	Gross Beta	Gamma Spec.	I-131	Sr-89	Sr-90	H-3
Air Particulates	100 m	45 m(4 h)				
Airborne Radioiodine		60 m	60 m(100 m)			
Fresh Milk		16 h	300 m(200 m)			
Broadleaf Vegetation		8 h				
Groundwater	200 m	16 h*				100 m(120 m)
Drinking Water	200 m	16 h*				100 m(120 m)
Surface Water	200 m	16 h*	300 m	100 m	300 m	100 m(120 m)
Sludge		8 h*				

* Counting times may be increased to meet LLD requirements.

5.0 Nuclear Instrumentation

5.1 ASU RMF

5.1.1 Detectors and Equipment

Gamma spectra are analyzed by a Canberra Series 95 Multichannel Analyzer (MCA) using a MicroVax computer. Four Detectors are available:

1) PGT Ge(Li), 26% efficiency, 1.90 KeV FWHM @ 1332.5 KeV
2) Canberra Ge(Li), 14% efficiency, 2.08 KeV FWHM @ 1332.5 KeV
3) ORTEC HPGe, 13% efficiency, 1.98 KeV FWHM @ 1332.5 KeV
4) ORTEC HPGe, 43% efficiency, 1.80 KeV FWHM @ 1332.5 KeV

Two Tennelec LB-5100 low background proportional counters are used for alpha and beta counting. Each system has been interfaced to a personal computer and is completely automatic. Sample results and background counts are stored on disk. In addition, the computer is able to produce control charts and voltage plateaus.

Liquid scintillation counting is done in a Beckman LS-1801 Liquid Scintillation Spectrometer.

5.2 CEP Major Instrumentation

5.2.1 Nuclear Data Computer Based Gamma Spectrometer

The Gamma Spectrometer consists of a Nuclear Data Model #9900 Multichannel Analyzer equipped with eight intrinsic detectors having resolutions of 1.87 KeV, 1.69 KeV, 2.10 KeV, 1.90 KeV, 1.87 KeV, 1.90 KeV, 1.79 KeV and 1.90 Kev determined by full width half mass with an energy of 0.5 KeV per channel; and respective efficiencies of 18.2%, 19.9%, 22.6%, 23.7%, 25.1%, 30.6%, 32.2%, and 34.3% as determined by the manufacturer with Co-60. The Computer Based Nuclear Data Gamma Spectrometry System is used for all Gamma counting. The system uses Nuclear Data developed software (automatic isotope analysis) to search and identify, as well as quantify the peaks of interest.

5.2.2 Beckman Liquid Scintillation Counting Systems

A Beckman LS-5801 Liquid Scintillation Counters will be used for all Tritium determinations. The system background averages approximately 20 cpm with a counting efficiency of sixty percent using an unquenched sample.

5.2.3 Berthold-10-Channel Low-Level Planchet Counting System

The Berthold LB770 is capable of simultaneously counting 10 planchets for Gross Alpha and Gross Beta activities with proportional gas flow detectors. The system has an average background count rate of less then 1 count per minute for Beta and less than 0.05 count per minute for Alpha. The instrument has an Alpha efficiency of forty-three percent for Plutonium-239 and Beta efficiencies of fifty-four percent for Strontium-Yttrium-90, and forty-two percent for Cesium-137.

5.2.4 Numelec Nu20-8 Channel Low-Level Planchet Counting System

The Nu20 is capable of counting 8 samples for Gross Alpha and Gross Beta simultaneously with proportional gas flow detectors. The system has an average background count rate of less than 1 count per minute for Beta and less than 0.10 counts per minute for Alpha. The instrument has an Alpha efficiency (Pu239) of 42% and Beta (Sr90) efficiency of 44% and Beta (Cs137) efficiency of 41%.

6.0 Isotopic Detection Limits and Reporting Criteria

6.1 Lower Limits of Detection

The lower limits of detection (LLD) and the method for calculation are specified in the PVNGS Technical Specifications [7] and are presented in Table 6.1. RMF/CEP "a priori" LLDs are presented in Table 6.2.

6.2 Data Reporting Criteria

All results which are less than the Technical Specifications defined LLD are reported as "<LLD".All results which are less than the Technical Specifications defined LLD, but greater than the a posteriori LLD are reported at the amount of activity determined and its respective error. Errors are presented as ± one sigma.

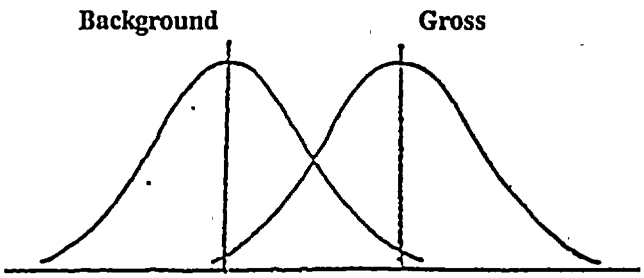
Occasionally the PVNGS Technical Specifications "a priori" LLDs [7] may not be achieved as a result of:

- background fluctuations,
- unavoidably small sample sizes,
- the presence of interfering nuclides,
- self absorption corrections,
- decay corrections for short half-lived radionuclides, or
- other uncontrollable circumstances.

In these instances, the contributing factors will be noted in the table where the data is presented.

6.2 LLD and Reporting Criteria Overview

Making a reasonable estimate of the limits of detection for a counting procedure or a radiochemical method is usually complicated by the presence of significant background. It must be considered that the background or blank is not a fixed value but that a series of replicates would be normally distributed. The desired net activity is thus the difference between the gross and background activity distributions. The interpretation of this difference becomes a problem if the two distributions intersect as indicated in the diagram.



If a sufficient number of replicate analyses are run, it is to be expected that the results would fall in a normal Gaussian Distribution. Standard statistics allow an estimate of the probability of any particular deviation from the mean value. It is common practice to report the mean ± one or two standard deviations as the final result. In routine analysis such replication is not carried out, and it is not possible to report a Gaussian standard deviation ± one or two Poisson standard deviations. The reported values are then considered to give some indication of the range in which the true value might be expected to occur.

The simplest possible case to consider would be one where the background is negligible and the sample activity is zero. It is sometimes not realized that if a series of counts is taken on such a system, half of the net values should be less than zero. Negative counts are not possible, of course. But when there is an appreciable background, the entire scale is raised. The resulting situation: half of the sample counts on a zero activity sample would be less than background. The negative net counts occur frequently in low-level measurements, causing considerable concern. Actually, such results are to be expected.

A lower limit of detection (LLD) is the smallest amount of sample activity that will yield a net count for which there is confidence at a predetermined level that activity is present. LLD's are calculated values for individual nuclides based on a number of different factors including sample size, counting efficiency and background count rate of the instrument, the background and sample counting time, the decay time, and the chemical recovery of the analytical procedures. LLD's are normally calculated using average values from analyses performed over a long period of time. A minimum detectable activity value (MDA) is the smallest amount of activity that can be detected in an actual sample and uses the values obtained from the instrument and outcome of the analytical process. Therefore, the MDA values may differ from the calculated LLD values if the sample size and chemical recovery, decay values or the instrument efficiency, background, or count time differed from those used in the LLD calculation.

The factors governing the calculation of the LLD and MDA values are discussed below:

1. **Sample Size**
2. **Counting Efficiency**
   The fundamental quantity in the measurement of a radioactive substance is the number of disintegrations per unit time. As with most physical measurements in analytical chemistry, it is seldom possible to make an absolute measurement of the disintegration rate, but rather it is necessary to compare the sample with one or more standards. The standards determine the counter efficiency which may then be used to convert sample counts per minute (cpm) to disintegrations per minute (dpm).
3. **Background Count Rate**
   Any counter will show a certain counting rate without a sample in position. This background counting rate comes from several sources: 1) natural environmental radiation from the surroundings, 2) cosmic radiation, and 3) the natural radioactivity in the counter material itself. The background counting rate will depend on the amounts of these types of radiation and the sensitivity of the counter to the radiation.
4. **Background and Sample Counting Time**
   The amount of time devoted to the counting of the background depends on the level of activity being measured. In general, with low level samples, this time should be about equal to that devoted to counting a sample (Table 4.4).
5. **Time Interval Between Sample Collection and Counting**
   Decay measurements are useful in identifying certain short-lived isotopes. The disintegration constant is one of the basic characteristics of a specific radionuclide and is readily determined, if the half life is sufficiently short. In order to ensure the required LLD's are achieved conservative values are used in decay correction to allow for transit time and sample processing.
6. **Chemical Recovery of the Analytical Procedures**
   Most radiochemical analyses are carried out in such a way that losses occur during the separations. These losses occur due to the large number of contaminants that may be present and interfere during chemical separations. Thus, it is necessary to include a technique for estimating these losses in the development of the analytical procedure.

The lower limits of detection presented in Table 6.2 are calculated using the following formula:

$$LLD = \frac{2.71/t_s + 3.29\ S_b}{3.70E\text{-}2\ (Y)\ (E)\ (V)\ \exp(-\Delta\lambda t_c)}$$

Where

LLD = Lower limit of Detection (pCi/g or pCi/L).

S_b = The standard deviation of the background counting rate.

= $(B/t_b\ t_s + B/t^2_b)^{0.5}$

B = Background counts.

t_b = Background counting interval (seconds).

t_s = Sample counting interval (seconds).

E = Counting efficiency (counts/disintegration).

V = Sample volume or mass (Liters or kilograms).

Y = Fraction chemical yield (dimensionless).

3.70 E-2 - disintegrations per second per picocurie.

λ = Decay constant (seconds-1)

tc = time from endpoint of collection to start of counting.

The lower limits of detection for spectroscopy are calculated using the following formula:

$$LLD = \frac{2.71/t_s + 4.65\ \sqrt{B}}{(3.7E4)\ (Y)\ (E)\ (V)\ \exp(-\Delta\lambda t_c)}$$

B = Counts in region of interest.

The calculation formula for minimum detectable activities are calculated using the following formula:

$$MDA = \frac{2.71/t_s + 4.65\sqrt{B}\ (Decay) \times 1E6}{(E)\ (A)\ (LT)\ (3.70E4)\ (V)}$$

Where

B = Background Sum.

Decay = Decay factor

E = Efficiency.

A = Abundance

LT = Elapsed live time.

V = Sample volume.

1E6 = Conversion from microcuries to picocuries.

The activities per unit sample mass or volume are determined using the following formula:

$$A = \frac{C - B}{(2.22)(V)(T)(R)(E)(e^{-\lambda t})} \pm \frac{1.96 \left(\frac{C + B}{T}\right)^{1/2}}{(2.22)(V)(R)(E)(e^{-\lambda t})}$$

WHERE:

A	=	Activity as pCi per unit sample mass or volume.
C	=	Sample count rate in counts per minute.
B	=	Background count rate in counts per minute.
V	=	Sample volume or mass analyzed.
E	=	Counter efficiency in cpm/dpm.
2.22	=	Numerical constant to convert disintegrations per minute to picocuries.
$(e^{-\lambda t})$	=	Decay factor to correct the activity to time of collection.
T	=	Counting time in minutes.
1.96	=	Statistical constant for the 95% confidence level.
R	=	Chemical recovery or photon yield.

TABLE 6.1

PVNGS TECHNICAL SPECIFICATION LOWER LIMITS OF DETECTION (a priori) [7]

Analysis	Water (pCi/L)	Airborne Particulate or Gas (pCi/m^3)	Fresh Milk (pCi/L)	Food Products (pCi/kg, wet)
Gross beta	4	0.01		
H-3	2000*			
Mn-54	15			
Fe-59	30			
Co-58,-60	15			
Zn-65	30			
Zr-95	30			
Nb-95	15			
I-131	1**	0.07	1	60
Cs-134	15	0.05	15	60
Cs-137	18	0.06	18	80
Ba-140	60		60	
La-140	15		15	

Note: this list does not mean that only these nuclides are to be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

*If no drinking water pathway exists, a value of 3000 pCi/L may be used.

**If no drinking water pathway exists, a value of 15 pCi/L may be used.

TAB[illegible]2

ASU/RMF & CEP "a priori" LOWER LIMITS OF DETECTION
CEP values denoted by ( )

GAMMA SPECTROSCOPY

Energy MeV	Isotope	Vegetation pCi/KGm	Water pCi/L	Fresh Milk pCi/L	Air Particulate pCi/m3
0.365	I-131	15(60)	9(15)	9(15)	0.040(0.02)
0.537	Ba-140		30(45)	30(15)	
0.605	Cs-134	13(60)	8(8)	8(8)	0.015(0.001)
0.662	Cs-137	17(80)	10(8)	10(8)	0.030(0.001)
0.756	Zr-95		16(14)	16(14)	
0.765	Nb-95		9(6)	9(6)	
0.811	Co-58		9(10)	9(10)	
0.835	Mn-54		9(10)	9(10)	
1.095	Fe-59		18(20)	18(20)	
1.115	Zn-65		20(20)	20(20)	
1.173	Co-60		10(10)	10(10)	
1.596	La-140		11(15)	11(15)	

OTHER THAN GAMMA SPECTROSCOPY

Sample Type	Gross Beta	I-131	Sr-89	Sr-90	H-3
Air Particulates	0.0034(0.004) pCi/m3				
Airborne Radioiodine		0.06(0.020) pCi/m3			
Fresh Milk		0.5(0.8) pCi/L	1.0 pCi/L	0.5 pCi/L	
Groundwater	2.0(2.0) pCi/L			0.5 pCi/L	570(800) pCi/L
Drinking Water	2.0 pCi/L	0.5(0.8) pCi/L	1.0 pCi/L	0.5 pCi/L	570(800) pCi/L
Surface Water	2.0 pCi/L	0.5(0.8) pCi/L	1.0 pCi/L	0.5 pCi/L	570(800) pCi/L

7.0 Quality Control

7.1 ASU RMF Intercomparisons and Certification

The RMF routinely participates in intercomparisons sponsored by USEPA and BRMD.

7.2 CEP Quality Control Program

CEP employs a multi-faceted Quality Control Program designed to maintain high performance of its laboratory. The overall objectives of the program are to:

1. Verify that work procedures are adequate to meet specifications of APS.
2. Coordinate the in-house quality control program independent of external programs to assure that CEP is operating at maximum efficiency.

Objectives are met by a variety of procedures that oversee areas of sample receipt and handling, analysis, and data review. These procedures include standard operating procedures, known and unknown spike analysis, blank analysis, reagent, carriers and nuclide standardization as well as participation in the U.S. Environmental Protection Agency's Interlaboratory Cross-check Program.

During the second quarter of 1991 CEP tested the following USEPA distributed samples for analysis under the laboratory intercomparison study.

- Alpha, Beta, Gamma in Air Filter (March 29)
- Iodine in Milk (April 26)
- Beta in Water (May 17)
- Gamma in Water (June 7)
- Tritium in Water (June 21)
- Performance Study (April 16)

In addition, CEP analyzed duplicate, blank and intralaboratory spike samples at a frequency of 10% for the analytical procedures performed. This means that for every ten samples analyzed by CEP the technician also submits one duplicate sample, one blank and one intralaboratory spike sample. The acceptance of the laboratory analysis is dependent upon the outcome of those quality assurance samples.

CEP's Quality Assurance Program is reviewed and revised (when necessary) on a regularly scheduled basis. This review assures that the program meets all current regulatory guidelines as well as maintaining the highest standards of quality assurance practice.

7.3 Intercomparison Results

Results for the intercomparison program with the USEPA are presented in Table 7.1.

TABLE 7.1
U.S. EPA Intercomparison Results

EPA REPORT DATA					
DATE	SAMPLE TYPE	EPA KNOWN VALUE	EPA CONTROL LIMITS	ASU LAB RESULTS	CEP LAB RESULTS
1/91	Sr-89 in water Sr-90 in water	5.0 pCi/liter 5.0	0 - 13.7 0 - 13.7	5.3 4.7	NA NA
1/91	Gross beta in water	5.0 pCi/liter	0 - 13.7	3.7	NA
2/91	GAMMA IN WATER Co-60 Zn-65 Ru-106 Cs-134 Cs-137 Ba-133	 40.0 pCi/liter 149.0 186.0 8.0 8.0 75.0	 31.3 - 48.7 123.0 - 175.0 153.0 - 219.0 0.0 - 16.7 0.0 - 16.7 61.1 - 88.9	 41.3 156.7 177.3 7.3 9.3 75.0	NA
2/91	I-131 in water	75.0 pCi/liter	61.1 - 88.9	75.7	NA
2/91	Tritium in water	4418.0 pCi/liter	3651.2 - 5184.8	4550.0	NA
3/91	AIR FILTER Gross beta Sr-90 Cs-137	 124.0 pCi/filter 40.0 40.0	 113.6 - 134.4 31.3 - 48.7 31.3 - 48.7	 134.0 40.0 40.3	NA
4/91	BLIND WATER SAMPLE Gross beta Sr-89 Sr-90 Cs-134 Cs-137	 115.0 pCi/liter 28.0 26.0 24.0 25.0	 85.5 - 144.5 19.3 - 36.7 17.3 - 34.7 15.3 - 32.7 16.3 - 33.7	 NO DATA * 28.0 25.3 NO DATA * NO DATA *	NA

* No data submitted to EPA. No action necessary since this lab has been replaced and no longer performs REMP sample analysis.

TABLE 7.1
U.S. EPA Intercomparison Results

EPA REPORT DATA					
DATE	SAMPLE TYPE	EPA KNOWN VALUE	EPA CONTROL LIMITS	ASU LAB RESULTS	CEP LAB RESULTS
4/91	MILK				NA
	I-131	60.0 pCi/liter	49.6 - 70.4	60.7	
	Cs-137	49.0	40.3 - 57.7	52.3	
5/91	Gross beta in water	46.0 pCi/liter	37.3 - 54.7	43.3	NA
5/91	Sr-89 in water	39.0 pCi/liter	30.3 - 47.7	36.3	NA
	Sr-90 in water	24.0	15.3 - 32.7	24.7	
6/91	GAMMA IN WATER				NA
	Co-60	10.0 pCi/liter	1.3 - 18.7	10.3	
	Zn-65	108.0	88.9 - 127.1	104.7	
	Ru-106	149.0	123.0 - 175.0	151.0	
	Cs-134	15.0	6.3 - 23.7	14.0	
	Cs-137	14.0	5.3 - 22.7	15.3	
	Ba-133	62.0	51.6 - 72.4	63.3	
6/91	Tritium in water	12480.0 pCi/liter	10314.8 - 14645.2	13100.0	NA
8/91	I-131 in water	20.0 pCi/liter	9.6 - 30.4	19.7	35.3 **
8/91	AIR FILTER			NA	
	Gross beta	92.0 pCi/filter	74.7 - 109.3		92.0
	Sr-90	30.0	21.3 - 38.7		30.0
	Cs-137	30.0	21.3 - 38.7		31.0

** Result is outside EPA control limits. The problem was that the sample was tested after too many half-lives had passed. This was caused by the fact that EPA samples were not logged into the normal system of scheduling by the vendor lab. Corrective action was to log all EPA samples in the same manner as routine samples.

TABLE 7.1
U.S. EPA Intercomparison Results

EPA REPORT DATA					
DATE	SAMPLE TYPE	EPA KNOWN VALUE	EPA CONTROL LIMITS	ASU LAB RESULTS	CEP LAB RESULTS
9/91	Gross beta in water	20.0 pCi/liter	11.3 - 28.7	NA	11.3
9/91	MILK I-131 Cs-137	 108.0 pCi/liter 30.0	 88.9 - 127.1 21.3 - 38.7	NA	 109.7 34.0
10/91	GAMMA IN WATER Co-60 Zn-65 Ru-106 Cs-134 Cs-137 Ba-133	 29.0 pCi/liter 73.0 199.0 10.0 10.0 98.0	 20.3 - 37.7 60.9 - 85.1 164.3 - 233.7 1.3 - 18.7 1.3 - 18.7 80.7 - 115.3	 NA	 34.0 84.3 210.7 10.0 11.0 104.3
10/91	BLIND WATER SAMPLE Gross beta Sr-89 Sr-90 Co-60 Cs-134 Cs-137	 65.0 pCi/liter 10.0 10.0 20.0 10.0 11.0	 47.7 - 82.3 1.3 - 18.7 1.3 - 18.7 11.3 - 28.7 1.3 - 18.7 2.3 - 19.7	NA	 52.3 8.7 10.0 20.3 9.0 15.3
10/91	Tritium in water	2454.0 pCi/liter	1843.3 - 3064.7	NA	2420.7

8.0 Data Interpretations and Conclusions

Associated with the analytical process are potential random and systematic errors. Systematic errors can be caused by instrument malfunctions, incomplete precipitation, and back scattering and self-absorption. Random errors are beyond the control of the analyst and are caused by the random nature of radioactive decay.

Efforts are made to eliminate both systematic and random errors in the data reported. Systematic errors are eliminated by performing reviews throughout the analysis. For example, instrument calibrations are checked with radioactive sources daily and after any instrument maintenance or adjustment, and recovéry and self-absorption factors based on individual sample analyses are incorporated into the calculation equations where necessary. Random errors are reduced by comparing all data to historical data for the same site and performing cross comparisons between analytical results when available (e.g., comparing a Gross Beta result to a Strontium-90 result). In addition, when data does not appear to match historical results, analyses would be rerun on a separate aliquot of the sample to verify the presence of the activity. In addition, CEP's Quality Assurance Plan requires the analysis of quality control samples with each set of samples. The results of these samples will indicate whether an error (random or systematic) occurred that could be associated with the entire set. The acceptance of the data from the set is dependent upon the results of these quality assurance samples and is part of the data review process for all analytical results.

The "plus or minus value" reported with each analytical result represents the error associated with the result and gives the 95% confidence interval around the data. The actual calculation for this value is presented in Section 6.2.

Quarterly means are calculated using the data obtained from analyses of samples collected from specific locations during the quarter. During the review process, unusual data from a historical standpoint is verified as correct and is thus not anomalous from an analytical perspective. Such data is used in the calculation of the means. If the sample is determined to be anomalous from a collection error, or confirmed contamination or exposure of the sample, the data is omitted from the mean calculation. Any samples exhibiting elevated MDA's due to insufficient mass or volume are also deemed anomalous and are not used in mean calculations. In addition, missing data from samples not collected or lost or damaged during shipment are excluded from the mean calculations.

Results and interpretation of the data for all of the samples analyzed during 1991 are presented in the following sections. Assessment of pre-operational and operational data revealed no significant changes to environmental radiation levels. There was no observed impact on the environment due to PVNGS operations in 1991.

8.1 Air Particulates

Weekly gross beta results in quarterly format, are presented in Tables 8.1 through 8.4. Table 8.5 contains the average gross beta activities by station. Average quarterly activities are calculated using all weekly activities except those marked invalid. The findings are consistent with pre-operational baseline and previous operational results. Table 8.6 displays the results of gamma spectrometry on the monthly composite. The results are summarized in Table 11.1. No Cs-134 or Cs-137 was observed.

8.2 Airborne Radioiodine

Tables 8.7 through 8.10 present the quarterly radioiodine results. No radioiodine was detected in any of the samples.

8.3 Vegetation
Table 8.11 presents I-131, Cs-134 and Cs-137 data for the vegetation samples. No activity was observed in any of the samples.

8.4 Drinking Water
Samples were analyzed for I-131 (radiochemical), Gross Beta, H-3, and for gamma-emitting nuclides. Results of these analysis are summarized in Tables 8.12 and 8.13. Gross Beta activity ranged from 1.7 pCi/L to a high of 12 pCi/L (Scott Residence 11/26/91). Tritium was detected in 5 out of 36 samples, at levels slightly above the "a posteriori" LLD, but were considerably below the LLD required by Technical Specifications (2000 pCi/l). No gamma-emitting nuclides of man-made origin (excluding I-131) were detected. I-131 results ranged from 0.5 to 0.7 pCi/L. It should be noted that there were 3 positives out of 104 analyses and although the results were below the reported "a priori" LLD, they were greater than the "a posteriori" LLD.

8.5 Groundwater
Groundwater samples were analyzed for H-3, I-131, and for gamma-emitting nuclides. Results obtained from the analysis of the samples are presented in Table 8.14.

No radioactivity was observed above the LLD values for I-131, H-3, or gamma-emitting nuclides.

8.6 Surface Water
Surface water samples from the Reservoir and Evaporation ponds were analyzed for H-3 and gamma-emitting nuclides. Results are presented in Tables 8.15 through 8.17.

Influent samples collected by the Water Reclamation Facility (WRF) were analyzed for gamma-emitting nuclides and H-3. The results, presented in Table 8.19, demonstrate that I-131 was observed routinely. The highest concentration was 66 pCi/L (6-18-91). The results are consistent with assays from the previous years.

Gamma spectrometry and tritium analysis were performed on samples obtained from each of the three circulating water systems and results are presented in Tables 8.20 through 8.22. Tritium ranging from 610 to 2260 pCi/L was detected in 21 out of 69 samples analyzed. The presence of tritium in surface water is the subject of an ongoing study. Thus far, it has been determined that tritium detected in the circulating water is not as a result of effluent release from PVNGS but more likely due to interference from another source such as Pb-210 or chemical interference. Iodine-131 was routinely observed in the circulating water of all three units.

Elevated I-131 levels in the circulating water are not the result of plant effluents, but instead reflect the increased concentration observed in the WRF influent. The WRF influent I-131 is a result of radiopharmaceutical discharges into the Phoenix sewage system. Refer to Section 11 of the 1988 AREOR for a detailed explanation.

Water samples from the Retention Basins were analyzed for Tritium and for gamma-emitting nuclides. The results, presented in Tables 8.23 and 8.24, show that Cs-134, Cs-137, and I-131 concentrations were above LLD in a few of the samples collected during the year. Tritium was detected in both Retention Basins routinely.

Table 8.25 presents gamma spectrometry and tritium measurements of samples collected from Sedimentation Basin #2 (J-Hook Pond). No man-made gamma-emitting radionuclides were observed. Tritium was detected in 6 samples of Sedimentation Basin #2 at levels above the LLD. The activity ranged from 550 to 4080 pCi/L. An extensive review of the data revealed some weaknesses in the collection, analysis and subsequent interpretation of the results. As a result of the review, several enhancements have been implemented to improve the quality of the data and reduce what appears to be anomalous results.

8.7 Milk
Fresh Milk samples were analyzed by gamma spectrometry for Cs-134, Cs-137, Ba-140, and La-140. Samples were analyzed radiochemically for I-131. As shown in Table 8.18, there were 2 samples out of 58 analyzed with I-131 above detectable levels. The highest level (0.9 pCi/L) was detected at sample site #56 (Pew Dairy), which is the control site and is located 75 miles from the site, in Chandler Az. The other positive (0.4 pCi/L) was at site #51 (Butler Dairy). Both positive results were less than the required LLD of 1.0 pCi/L.

8.8 Sludge
Sludge samples were obtained from several on-site locations and analyzed by gamma spectrometry. Results can be found in Table 8.26. No man-made radionuclides were detected in either Sedimentation Basin #2 or Evaporation Ponds. The sludge from the Retention Basins contains Co-58, Co-60, Cs-134, Cs-137 and Mn-54. Sludge samples were obtained from the Unit 2 Cooling Towers during the 1991 refueling outage. The samples contained I-131, ranging from 50 to 130 pCi/kg and Cs-137, ranging from 60 to 80 pCi/kg. The source of the I-131 is the same as previously discussed in this section, medical waste in the Water Reclaimation Facility influent. The Cs-137 concentration in the sludge is consistent with pre-operational concentrations of Cs-137 in soil (20 to 750 pCi/kg). Approximately 500 cubic yards of Unit 2 cooling tower sludge was removed and placed in the sludge landfill. The normal volume of sludge removed per cycle is ~ 250 cubic yards. Sludge was not removed from the Unit 2 cooling towers in the previous outage. The sludge was not released for disposal to the Water Reclaimation Facility landfill until after 12-2-91 to allow for decay to a concentration below the limit specified in Groundwater permit #G-077-07.

8.9 Sewage Plant
Sewage Plant samples were collected on a batch sample basis as each tanker truck was filled with Digester liquids/sludge. Cs-137 was identified in a sample taken on 4-10-91. I-131 was identified on several occasions. See table 8.27 for results and discussion concerning positive results.

8.10 Summary of Results
A summary of the sample results is presented in Table 11.1.

GROSS BETA IN AIR

1985 – 1991

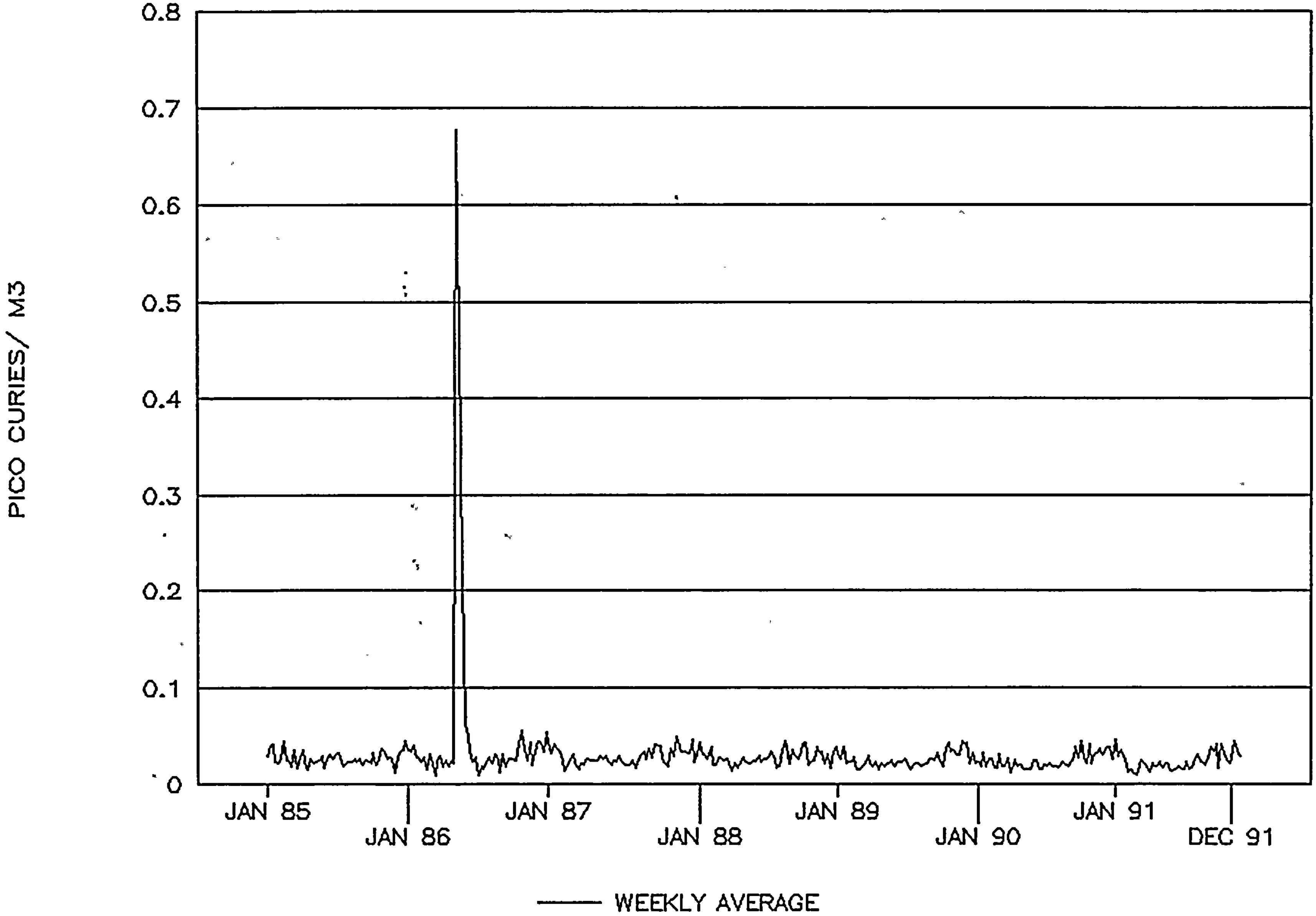


FIGURE 8.1

GROSS BETA IN AIR

1987 – 1991

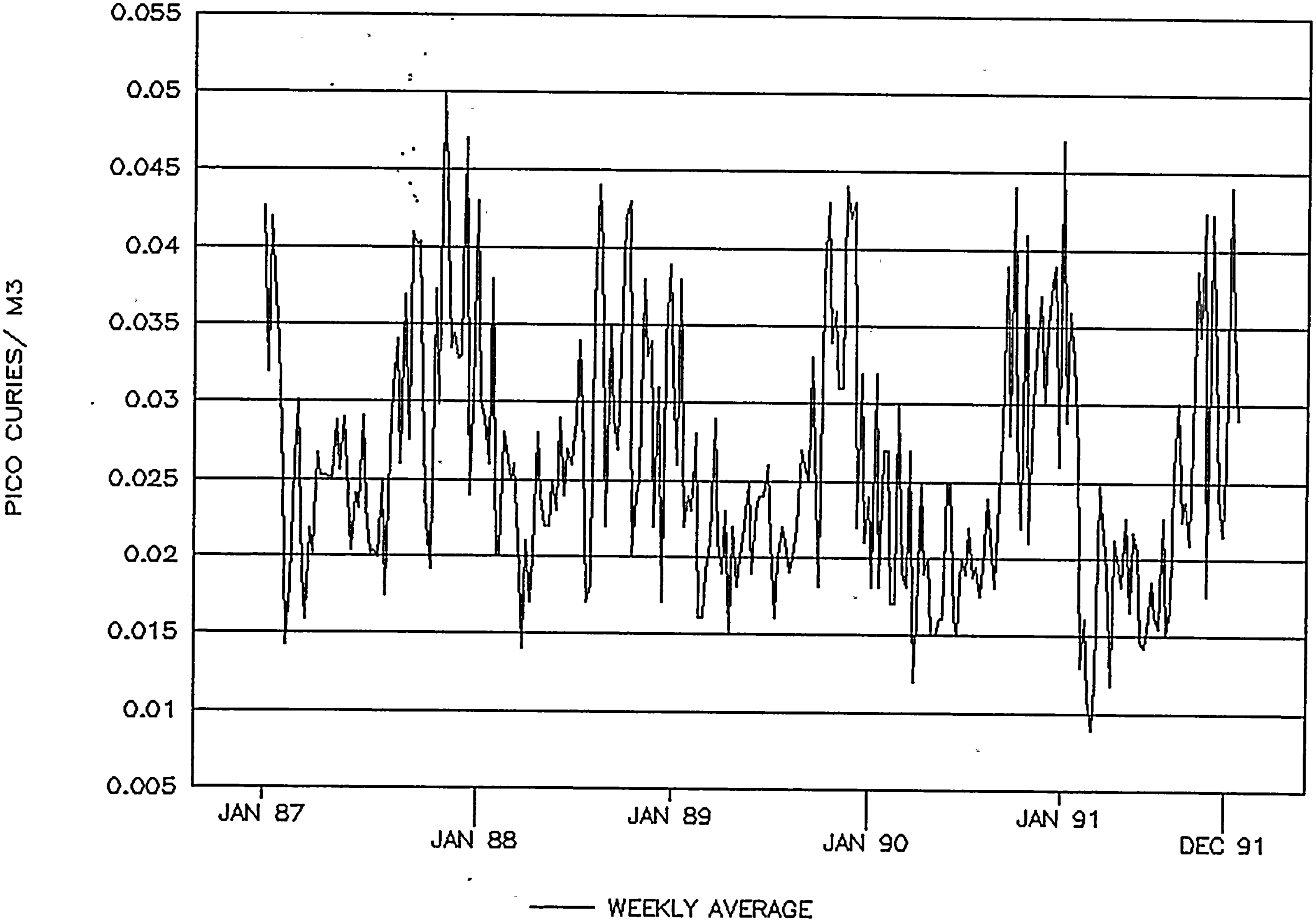


FIGURE 8.2

TABLE 8.1
GROSS BETA IN AIR PARTICULATE (pCi/m^3)
FIRST QUARTER

COLLECTION PERIOD	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40	% SD
12/26/90 - 01/02/91	0.033 ± 0.001	0.035 ± 0.001	INVALID[2]	0.039 ± 0.002	0.034 ± 0.001	0.033 ± 0.001	0.036 ± 0.001	0.036 ± 0.001	0.037 ± 0.001	0.033 ± 0.001	0.036 ± 0.001	5.7
01/02/91 - 01/08/91	0.038 ± 0.002	0.036 ± 0.002	0.036 ± 0.002	0.042 ± 0.002	0.037 ± 0.002	0.039 ± 0.002	0.037 ± 0.002	0.040 ± 0.002	0.040 ± 0.002	0.038 ± 0.002	0.039 ± 0.002	4.8
01/08/91 - 01/15/91	0.034 ± 0.001	0.033 ± 0.001	0.039 ± 0.001	0.041 ± 0.002	0.041 ± 0.002	0.038 ± 0.002	0.042 ± 0.002	0.042 ± 0.002	0.040 ± 0.002	0.042 ± 0.002	0.040 ± 0.002	8.0
01/15/91 - 01/22/91	0.025 ± 0.001	0.023 ± 0.001	0.026 ± 0.001	0.028 ± 0.001	0.026 ± 0.001	0.024 ± 0.001	0.027 ± 0.001	0.027 ± 0.001	0.028 ± 0.001	0.024 ± 0.001	0.026 ± 0.001	6.4
01/22/91 - 01/29/91	0.045 ± 0.002	0.043 ± 0.002	0.048 ± 0.002	0.052 ± 0.002	0.044 ± 0.002	0.046 ± 0.002	0.045 ± 0.002	0.048 ± 0.002	0.047 ± 0.002	0.047 ± 0.002	0.047 ± 0.002	5.2
01/29/91 - 02/05/91	0.029 ± 0.001	0.029 ± 0.001	0.028 ± 0.001	0.032 ± 0.001	0.029 ± 0.001	0.028 ± 0.001	0.029 ± 0.001	0.031 ± 0.001	0.030 ± 0.001	0.030 ± 0.001	0.026 ± 0.001	5.5
02/05/91 - 02/12/91	0.033 ± 0.001	0.034 ± 0.001	0.037 ± 0.001	0.036 ± 0.001	0.034 ± 0.001	0.031 ± 0.001	0.036 ± 0.001	0.039 ± 0.001	0.037 ± 0.001	0.037 ± 0.001	0.037 ± 0.001	6.5
02/12/91 - 02/19/91	0:033 ± 0.001	0.032 ± 0.001	0.033 ± 0.001	0.033 ± 0.001	0.031 ± 0.001	0.032 ± 0.001	0.031 ± 0.001	0.035 ± 0.001	0.035 ± 0.001	0.030 ± 0.001	0.032 ± 0.001	4.8
02/19/91 - 02/26/91	0.025 ± 0.001	0.026 ± 0.001	0.028 ± 0.001	0.025 ± 0.001	0.026 ± 0.001	0.027 ± 0.001	0.026 ± 0.001	0.029 ± 0.001	0.028 ± 0.001	0.024 ± 0.001	0.030 ± 0.001	6.9
02/26/91 - 03/05/91	0.015 ± 0.001	0.016 ± 0.001	0.014 ± 0.001	0.018 ± 0.001	0.011 ± 0.001	0.009 ± 0.001	0.011 ± 0.001	0.012 ± 0.001	0.012 ± 0.001	0.011 ± 0.001	0.009 ± 0.001	22.9[1]
03/05/91 - 03/12/91	0.015 ± 0.001	0.017 ± 0.001	0.016 ± 0.001	0.017 ± 0.001	0.017 ± 0.001	0.016 ± 0.001	0.015 ± 0.001	0.016 ± 0.001	0.019 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	6.8
03/12/91 - 03/19/91	0.011 ± 0.001	0.010 ± 0.001	0.010 ± 0.001	0.009[3] ± 0.001	0.009 ± 0.001	0.012 ± 0.001	0.010 ± 0.001	0.011 ± 0.001	0.011 ± 0.001	0.011 ± 0.001	0.011 ± 0.001	8.9
03/19/91 - 03/26/91	0.010 ± 0.001	0.011 ± 0.001	0.009 ± 0.001	0.009[4] ± 0.001	0.009 ± 0.001	0.010 ± 0.001	0.010 ± 0.001	0.009 ± 0.001	0.008 ± 0.001	0.008 ± 0.001	0.008 ± 0.001	10.7

[1] Samples collected over 2 day period. Recount of all samples yielded same results (%SD = 22.2)
[2] Site 6 invalid due to flow regulator problems.
[3] Elapsed Time Meter (ETM) reading abnormally high.
[4] ETM reading abnormally low.

TABLE 8.2
GROSS BETA IN AIR PARTICULATE (pCi/m^3)
SECOND QUARTER

COLLECTION PERIOD	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40	% SD
03/26/90 - 04/02/91	0.011 ± 0.001	0.013 ± 0.001	0.011 ± 0.001	0.013 ± 0.002	0.011 ± 0.001	0.011 ± 0.001	0.012 ± 0.001	0.012 ± 0.001	0.012 ± 0.001	0.012 ± 0.001	0.012 ± 0.001	6.4
04/02/91 - 04/09/91	0.024 ± 0.001	0.024 ± 0.001	0.026 ± 0.001	0.025 ± 0.001	0.026 ± 0.001	0.025 ± 0.001	0.024 ± 0.001	0.025 ± 0.001	0.021 ± 0.001	0.027 ± 0.001	0.026 ± 0.001	6.5
04/09/91 - 04/16/91	0.022 ± 0.001	0.021 ± 0.001	0.021 ± 0.001	0.021 ± 0.001	0.022 ± 0.001	0.021 ± 0.001	0.024 ± 0.001	0.023 ± 0.001	0.022 ± 0.001	0.021 ± 0.001	0.019 ± 0.001	6.0
04/16/91 - 04/23/91	0.018 ± 0.001	0.018 ± 0.001	0.017 ± 0.001	0.019 ± 0.001	0.019 ± 0.001	0.019 ± 0.001	0.021 ± 0.001	0.020 ± 0.001	0.020 ± 0.001	0.018 ± 0.001	0.021 ± 0.001	6.8
04/23/91 - 04/30/91	0.011 ± 0.001	0.010 ± 0.001	0.013 ± 0.001	0.012 ± 0.001	0.013 ± 0.001	0.013 ± 0.001	0.012 ± 0.001	0.012 ± 0.001	0.011 ± 0.001	0.011 ± 0.001	0.012 ± 0.001	8.3
04/30/91 - 05/07/91	0.020 ± 0.001	0.020 ± 0.001	0.017 ± 0.001	0.023 ± 0.001	0.022 ± 0.001	0.021 ± 0.001	0.024 ± 0.001	0.021 ± 0.001	0.021 ± 0.001	0.019 ± 0.001	0.025 ± 0.001	10.7
05/07/91 - 05/14/91	0.018 ± 0.001	0.019 ± 0.001	0.020 ± 0.001	0.019 ± 0.001	0.021 ± 0.001	0.018 ± 0.001	0.019 ± 0.001	0.020 ± 0.001	0.019 ± 0.001	0.019 ± 0.001	0.021 ± 0.001	5.3
05/14/91 - 05/21/91	0.019 ± 0.001	0.018 ± 0.001	0.019 ± 0.001	0.019 ± 0.001	0.016 ± 0.001	0.017 ± 0.001	0.017 ± 0.001	0.019 ± 0.001	0.018 ± 0.001	0.019 ± 0.001	0.019 ± 0.001	5.9
05/21/91 - 05/28/91	0.023 ± 0.001	0.022 ± 0.001	0.022 ± 0.001	0.024 ± 0.001	0.024 ± 0.001	0.022 ± 0.001	0.022 ± 0.001	0.023 ± 0.001	0.024 ± 0.001	0.023 ± 0.001	0.021 ± 0.001	4.4
05/28/91 - 06/05/91	0.017 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.017 ± 0.001	0.018 ± 0.001	0.016 ± 0.001	0.017 ± 0.001	4.2
06/05/91 - 06/11/91	0.022 ± 0.001	0.022 ± 0.001	0.020 ± 0.001	0.022 ± 0.001	0.023 ± 0.001	0.022 ± 0.001	0.023 ± 0.001	0.021 ± 0.001	0.022 ± 0.001	0.020 ± 0.001	0.022 ± 0.001	4.6
06/11/91 - 06/19/91	0.022 ± 0.001	0.020 ± 0.001	0.020 ± 0.001	0.023 ± 0.001	0.019 ± 0.001	0.020 ± 0.001	0.020 ± 0.001	0.021 ± 0.001	0.021 ± 0.001	0.020 ± 0.001	0.021 ± 0.001	5.4
06/19/91 - 06/25/91	0.017 ± 0.001	0.014 ± 0.001	0.013 ± 0.001	0.015 ± 0.001	0.013 ± 0.001	0.014 ± 0.001	0.014 ± 0.001	0.014 ± 0.001	0.016 ± 0.001	0.015 ± 0.001	0.016 ± 0.001	8.8

TABLE 8.3
GROSS BETA IN AIR PARTICULATE DATA (pCi/m^3)
THIRD QUARTER

COLLECTION PERIOD	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40	% SD
06/25/91 - 07/02/91	0.015 ± 0.001	0.013 ± 0.001	0.013 ± 0.001	0.015 ± 0.001	0.015 ± 0.001	0.012 ± 0.001	0.013 ± 0.001	0.015 ± 0.001	0.014 ± 0.001	0.016 ± 0.001	0.015 ± 0.001	8.8
07/02/91 - 07/09/91	0.014 ± 0.001	0.016 ± 0.001	0.017 ± 0.001	0.016 ± 0.001	0.017 ± 0.001	0.014 ± 0.001	0.015 ± 0.001	0.016 ± 0.001	0.015 ± 0.001	0.015 ± 0.001	0.014 ± 0.001	7.3
07/09/91 - 07/16/91	0.018 ± 0.001	0.017 ± 0.001	0.018 ± 0.001	0.017 ± 0.001	0.018 ± 0.001	0.017 ± 0.001	0.020 ± 0.001	0.020 ± 0.001	0.021 ± 0.001	0.017 ± 0.001	0.019 ± 0.001	7.8
07/16/91 - 07/23/91	0.017 ± 0.001	0.017 ± 0.001	0.015 ± 0.001	0.015 ± 0.001	0.018 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.017 ± 0.001	0.015 ± 0.001	6.1
07/23/91 - 07/30/91	0.016 ± 0.001	0.016 ± 0.001	0.017 ± 0.001	0.015 ± 0.001	0.016 ± 0.001	0.015 ± 0.001	0.015 ± 0.001	0.014 ± 0.001	0.015 ± 0.001	0.016 ± 0.001	0.015 ± 0.001	5.3
07/30/91 - 08/06/91	0.019 ± 0.002	0.023 ± 0.002	0.024 ± 0.002	0.023 ± 0.002	0.023 ± 0.002	0.024 ± 0.002	0.021 ± 0.002	0.024 ± 0.002	0.025 ± 0.002	0.020 ± 0.002	0.023 ± 0.002	8.2
08/06/91 - 08/13/91	0.015 ± 0.001	0.013 ± 0.001	0.013 ± 0.001	0.015 ± 0.001	0.016 ± 0.001	0.016 ± 0.001	0.014 ± 0.001	0.015 ± 0.001	0.017 ± 0.001	0.017 ± 0.001	0.015 ± 0.001	9.1
08/13/91 - 08/20/91	0.016 ± 0.002	0.016 ± 0.002	0.015 ± 0.002	0.014 ± 0.002	0.019 ± 0.002	0.014 ± 0.002	0.016 ± 0.002	0.018 ± 0.002	0.017 ± 0.002	0.018 ± 0.002	0.020 ± 0.002	11.8
08/20/91 - 08/27/91 [2]	0.026 ± 0.002	0.021 ± 0.002	0.024 ± 0.002	0.022 ± 0.002	0.028 ± 0.002	0.031 ± 0.002	0.029 ± 0.002	INVALID[1]	0.025 ± 0.002	0.027 ± 0.002	0.024 ± 0.002	12.2
08/27/91 - 09/04/91	0.024 ± 0.002	0.029 ± 0.002	0.030 ± 0.002	0.029 ± 0.002	0.033 ± 0.002	0.029 ± 0.002	0.031 ± 0.002	0.034 ± 0.002	0.026 ± 0.002	0.031 ± 0.002	0.025 ± 0.002	10.8
09/04/91 - 09/10/91	0.024 ± 0.002	0.025 ± 0.002	0.020 ± 0.002	0.022 ± 0.002	0.024 ± 0.002	0.024 ± 0.002	0.024 ± 0.002	0.020 ± 0.002	0.021 ± 0.002	0.023 ± 0.002	0.021 ± 0.002	8.0
09/10/91 - 09/17/91	0.028 ± 0.002	0.022 ± 0.002	0.025 ± 0.002	0.025 ± 0.002	0.023 ± 0.002	0.022 ± 0.002	0.022 ± 0.002	0.022 ± 0.002	0.021 ± 0.002	0.026 ± 0.002	0.025 ± 0.002	9.3
09/17/91 - 09/24/91	0.022 ± 0.002	0.019 ± 0.002	0.020 ± 0.002	0.020 ± 0.002	0.022 ± 0.002	0.022 ± 0.002	0.025 ± 0.002	0.020 ± 0.002	0.018 ± 0.002	0.020 ± 0.002	0.022 ± 0.002	9.2

[1] Sample invalid due to equipment malfunction.
[2] Power out at sites 14A, 15, 17A, and 35. Flows estimated based on past history of flow regulator operation.

TABLE 8.4
GROSS BETA IN AIR PARTICULATE DATA (pCi/m³)
FOURTH QUARTER

COLLECTION PERIOD	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40	% SD
09/24/91 - 10/01/91	0.026 ± 0.002	0.029 ± 0.002	0.026 ± 0.002	0.031 ± 0.002	0.027 ± 0.002	0.031 ± 0.002	0.026 ± 0.002	0.026 ± 0.002	0.029 ± 0.002	0.027 ± 0.002	0.027 ± 0.002	7.1
10/01/91 - 10/08/91	0.036 ± 0.003	0.036 ± 0.003	0.040 ± 0.003	0.041 ± 0.003	0.040 ± 0.003	0.043 ± 0.003	0.038 ± 0.003	0.037 ± 0.003	0.038 ± 0.003	0.038 ± 0.003	INVALID[1]	5.9
10/08/91 - 10/15/91	0.026 ± 0.002	0.032 ± 0.002	0.042 ± 0.002	0.037 ± 0.002	0.035 ± 0.002	0.037 ± 0.002	0.032 ± 0.002	0.039 ± 0.002	0.030 ± 0.002	0.034 ± 0.002	INVALID[1]	13.5
10/15/91 - 10/22/91	0.036 ± 0.002	0.038 ± 0.002	0.046 ± 0.002	0.040 ± 0.002	0.039 ± 0.002	0.046 ± 0.002	0.043 ± 0.002	0.044 ± 0.002	0.047 ± 0.002	0.043 ± 0.002	0.044 ± 0.002	8.5
10/22/91 - 10/29/91	0.014 ± 0.002	0.019 ± 0.002	0.018 ± 0.002	0.019 ± 0.002	0.019 ± 0.002	0.015 ± 0.002	0.021 ± 0.002	0.013 ± 0.002	0.017 ± 0.002	0.020 ± 0.002	0.019 ± 0.002	14.6
10/29/91 - 11/05/91	0.044 ± 0.002	0.040 ± 0.002	0.048 ± 0.003	0.045 ± 0.002	0.038 ± 0.002	0.042 ± 0.002	0.044 ± 0.002	0.045 ± 0.002	0.040 ± 0.002	0.035 ± 0.002	0.044 ± 0.002	8.8
11/05/91 - 11/13/91	0.026 ± 0.002	0.028 ± 0.002	0.036 ± 0.002	0.034 ± 0.002	0.033 ± 0.002	0.034 ± 0.002	0.037 ± 0.002	0.039 ± 0.002	0.030 ± 0.002	0.031 ± 0.002	0.036 ± 0.002	12.1
11/13/91 - 11/19/91	0.023 ± 0.002	0.023 ± 0.002	0.022 ± 0.002	0.023 ± 0.002	0.025 ± 0.002	0.024 ± 0.002	0.020 ± 0.002	0.023 ± 0.002	0.027 ± 0.002	0.029 ± 0.002	0.027 ± 0.002	10.8
11/19/91 - 11/26/91	0.021 ± 0.002	0.020 ± 0.002	0.022 ± 0.002	0.024 ± 0.002	0.018 ± 0.002	0.028 ± 0.002	0.019 ± 0.002	0.020 ± 0.002	0.024 ± 0.002	0.020 ± 0.002	0.020 ± 0.002	13.4
11/26/91 - 12/03/91	0.028 ± 0.002	0.022 ± 0.002	0.027 ± 0.002	0.026 ± 0.002	0.025 ± 0.002	0.024 ± 0.002	0.025 ± 0.002	0.028 ± 0.002	0.028 ± 0.002	0.026 ± 0.002	0.027 ± 0.002	7.3
12/03/91 - 12/10/91	0.040 ± 0.003	0.043 ± 0.003	0.048 ± 0.003	0.049 ± 0.003	0.043 ± 0.003	0.042 ± 0.003	0.045 ± 0.003	0.045 ± 0.003	0.042 ± 0.003	0.042 ± 0.003	0.045 ± 0.003	6.2
12/10/91 - 12/17/91	0.033 ± 0.002	0.032 ± 0.002	0.034 ± 0.002	0.039 ± 0.002	0.034 ± 0.002	0.034 ± 0.002	0.035 ± 0.002	0.035 ± 0.002	0.037 ± 0.002	0.037 ± 0.002	0.038 ± 0.002	6.2
12/17/91 - 12/24/91	0.021 ± 0.002	0.025 ± 0.002	0.019 ± 0.002	0.035 ± 0.002	0.032 ± 0.002	0.032 ± 0.002	0.035 ± 0.002	0.034 ± 0.002	0.034 ± 0.002	0.030 ± 0.002	0.023 ± 0.002	20.5
12/24/91 - 12/31/91	0.034 ± 0.002	0.033 ± 0.002	0.031 ± 0.002	0.034 ± 0.002	0.032 ± 0.002	0.037 ± 0.002	0.047 ± 0.002	0.036 ± 0.002	0.034 ± 0.002	0.034 ± 0.002	0.036 ± 0.002	12.1

[1] Sample invalid due to ETM malfunction.

TABLE 8.5
AVERAGE GROSS BETA IN AIR PARTICULATE (pCi/m³)
STATION SUMMARY

Site #	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Average
1	0.027	0.019	0.020	0.029	0.024
4	0.027	0.018	0.019	0.030	0.024
6	0.027	0.018	0.019	0.033	0.024
7A	0.029	0.019	0.019	0.034	0.025
14A	0.027	0.019	0.021	0.031	0.025
15	0.027	0.018	0.020	0.034	0.025
17A	0.027	0.019	0.020	0.033	0.025
21	0.029	0.019	0.020	0.033	0.025
29	0.029	0.019	0.019	0.033	0.025
35	0.027	0.018	0.020	0.032	0.024
40	0.027	0.019	0.019	0.032	0.024
AVERAGE ALL SITES	0.028	0.019	0.020	0.032	0.025

TABLE 8.6

GAMMA RADIATION AIR FILTER COMPOSITES (pCi/m^3)

COLLECTION PERIOD	ISOTOPES	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40
JANUARY	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
FEBRUARY	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
MARCH	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
APRIL	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
MAY	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
JUNE	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
JULY	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
AUGUST/SEPTEMBER COMPOSITE [1]	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
OCTOBER/NOVEMBER/ DECEMBER COMPOSITE [2]	Cs-134	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	Cs-137	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

[1] Analysis performed as a two month composite of weekly grab samples.

[2] Analysis frequency reduced to a quarterly composite of weekly grab samples to agree with Technical Specification requirement.

TABLE 8.7

AIRBORNE RADIOIODINE (pCi/m^3)

FIRST QUARTER

COLLECTION PERIOD	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40
12/26/90 - 01/02/91	<LLD	<LLD	INVALID[1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/02/91 - 01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/08/91 - 01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/15/91 - 01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/22/91 - 01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/29/91 - 02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/05/91 - 02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/12/91 - 02/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/19/91 - 02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/26/91 - 03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
03/05/91 - 03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
03/12/91 - 03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
03/19/91 - 03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

[1] Site 6 invalid due to flow regulator problems.

TABLE 8.8

AIRBORNE RADIOIODINE (pCi/m^3)

SECOND QUARTER

COLLECTION PERIOD	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40
03/26/91 - 04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/02/91 - 04/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/09/91 - 04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/16/91 - 04/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/23/91 - 04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/30/91 - 05/07/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91 - 05/14/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
05/14/91 - 05/21/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
05/21/91 - 05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
05/28/91 - 06/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
06/05/91 - 06/11/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
06/11/91 - 06/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
06/19/91 - 06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

TABLE 8.9

AIRBORNE RADIOIODINE (pCi/m³)

THIRD QUARTER

COLLECTION PERIOD	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40
06/25/91 - 07/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
07/02/91 - 07/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
07/09/91 - 07/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
07/16/91 - 07/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
07/23/91 - 07/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
07/30/91 - 08/06/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
08/06/91 - 08/13/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
08/13/91 - 08/20/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
08/20/91 - 08/27/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	INVALID[1]	<LLD	<LLD	<LLD
08/27/91 - 09/04/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
09/04/91 - 09/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
09/10/91 - 09/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
09/17/91 - 09/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

[1] Sample invalid due to equipment malfunction.

TABLE 8.10

AIRBORNE RADIOIODINE (pCi/m^3)

FOURTH QUARTER

COLLECTION PERIOD	SITE 1	SITE 4	SITE 6	SITE 7A	SITE 14A	SITE 15	SITE 17A	SITE 21	SITE 29	SITE 35	SITE 40
09/24/91 - 10/01/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
10/01/91 - 10/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	INVALID [1]
10/08/91 - 10/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	INVALID [1]
10/15/91 - 10/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
10/22/91 - 10/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
10/29/91 - 11/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/05/91 - 11/13/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/13/91 - 11/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/19/91 - 11/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/26/91 - 12/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/03/91 - 12/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/10/91 - 12/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/17/91 - 12/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/24/91 - 12/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

[1] Sample invalid due to ETM malfunction.

TABLE 8.11
BROADLEAF VEGETATION (pCi/kg, wet)

COLLECTION LOCATION	SAMPLE DESCRIPTION	DATE COLLECTED	I-131	Cs-134	Cs-137
J.A.WOODS (SITE #62)[1]	BROCCOLI LEAVES	12/04/91	<LLD	<LLD	<LLD
ADAMS RESIDENCE (SITE #47)	LETTUCE	04/23/91	<LLD	<LLD	<LLD
	SWISS CHARD	04/23/91	<LLD	<LLD	<LLD
	LETTUCE	06/05/91	<LLD	<LLD	<LLD
	SWISS CHARD	06/05/91	<LLD	<LLD	<LLD

[1] Control location

TABLE 8.12

DRINKING WATER BI-WEEKLY I-131 (pCi/liter)
(RADIOCHEMICAL SEPARATION)

DATE COLLECTED	McARTHUR RESIDENCE (SITE #46)	SCOTT RESIDENCE (SITE #49)	SHEPARD RESIDENCE (SITE #48)	GAVETTE RESIDENCE (SITE #55)
01/02/91 01/08/91	<LLD	<LLD	<LLD	<LLD
01/15/91 01/22/91	<LLD	<LLD	<LLD	<LLD
01/29/91 02/05/91	<LLD	<LLD	<LLD	<LLD
02/12/91 02/19/91	<LLD	<LLD	<LLD	<LLD
02/26/91 03/05/91	<LLD	<LLD	<LLD	<LLD
03/12/91 03/19/91	<LLD	<LLD	<LLD	<LLD
03/26/91 04/02/91	<LLD	<LLD	<LLD	<LLD
04/09/91 04/16/91	<LLD	<LLD	<LLD	<LLD
04/23/91 04/30/91	<LLD	<LLD	<LLD	<LLD
05/07/91 05/14/91	<LLD	<LLD	<LLD	<LLD
05/21/91 05/28/91	<LLD	<LLD	<LLD	<LLD
06/05/91 06/11/91	<LLD	<LLD	<LLD	<LLD
06/19/91 06/25/91	<LLD	<LLD	<LLD	<LLD

TABLE 8.12

DRINKING WATER BI-WEEKLY I-131 (pCi/liter)
(RADIOCHEMICAL SEPARATION)

DATE COLLECTED	McARTHUR RESIDENCE (SITE #46)	SCOTT RESIDENCE (SITE #49)	SHEPARD RESIDENCE (SITE #48)	GAVETTE RESIDENCE (SITE #55)
07/02/91 07/09/91	<LLD	<LLD	0.6 ± 0.2	<LLD
07/16/91 07/23/91	<LLD	<LLD	<LLD	<LLD
07/30/91 08/06/91	<LLD	<LLD	<LLD	<LLD
08/13/91 08/20/91	<LLD	<LLD	<LLD	<LLD
08/27/91 09/03/91	<LLD	<LLD	0.7 ± 0.5	<LLD
09/10/91 09/17/91	<LLD	<LLD	<LLD	<LLD
09/24/91 10/01/91	<LLD	<LLD	<LLD	<LLD
10/08/91 10/15/91	<LLD	<LLD	<LLD	<LLD
10/22/91 10/29/91	<LLD	<LLD	<LLD	<LLD
11/05/91 11/13/91	<LLD	<LLD	<LLD	<LLD
11/19/91 11/26/91	<LLD	<LLD	<LLD	<LLD
12/03/91 12/10/91	<LLD	0.5 ± 0.3	<LLD	<LLD
12/17/91 12/24/91	*[1]	*[1]	*[1]	*[1]

[1] Samples not analyzed for I-131. To prevent recurrence, the vendor laboratory now tracks samples requiring analysis for short-lived isotopes on a late list to ensure samples are analyzed in a timely manner.

TABLE 8.13

DRINKING WATER (pCi/liter)

COLLECTION LOCATION	DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	Mn-54	Nb-95	Zn-65	Zr-95	H-3	GROSS BETA
GAVETTE RESIDENCE (SITE #55)	01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	[1]
	02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	6.9 ± 0.9
	03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.3 ± 0.7
	04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.6 ± 0.7
	05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	490 ± 470	4.6 ± 0.7
	06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	3.1 ± 0.7
	07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.9 ± 0.7
	08/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [2]	2.6 ± 1.4
	09/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		2.0 ± 1.3
	10/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	720 ± 530 [3]	1.8 ± 1.6
	11/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		<LLD
	12/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		<LLD
McARTHUR RESIDENCE (SITE #46)	01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	[1]
	02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	5.2 ± 0.7
	03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.3 ± 0.7
	04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	3.6 ± 0.7
	05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	3.1 ± 0.6
	06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.3 ± 0.7
	07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	6.4 ± 0.7
	08/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [2]	3.3 ± 1.4
	09/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		1.7 ± 1.3
	10/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [3]	<LLD
	11/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		<LLD
	12/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		<LLD

[1] Samples discarded prior to analysis. This occurred due to the dual responsibility for sample tracking at the vendor lab. Sample tracking was delegated to one individual to prevent recurrence.

[2] Analysis performed as a two month composite of weekly grab samples.

[3] Analysis performed as a quarterly composite of weekly grab samples.

TABLE 8.13

DRINKING WATER (pCi/liter)

COLLECTION LOCATION	DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	Mn-54	Nb-95	Zn-65	Zr-95	H-3	GROSS BETA
SCOTT RESIDENCE (SITE #49)	01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	[1]
	02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.9 ± 0.7
	03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	3.6 ± 0.7
	04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.1 ± 0.7
	05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	480 ± 470	2.0 ± 0.6
	06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	630 ± 460	3.7 ± 0.7
	07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.3 ± 0.7
	08/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [2]	1.7 ± 1.4
	09/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		3.6 ± 1.4
	10/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [3]	<LLD
	11/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		12 ± 2.4
	12/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		<LLD
SHEPARD RESIDENCE (SITE #48)	01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	[1]
	02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	6.8 ± 1.0
	03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	5.1 ± 1.2
	04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4.9 ± 1.2
	05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	810 ± 470	7.7 ± 1.3
	06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	640 ± 460	7.9 ± 1.4
	07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	9.7 ± 1.3
	08/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [2]	3.0 ± 1.4
	09/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		3.0 ± 1.3
	10/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [3]	<LLD
	11/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		4.0 ± 2.1
	12/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD		<LLD

[1] Samples discarded prior to analysis. This occurred due to the dual responsibility for sample tracking at the vendor lab. Sample tracking was delegated to one individual to prevent recurrence.

[2] Analysis performed as a two month composite of weekly grab samples.

[3] Analysis performed as a quarterly composite of weekly grab samples.

TABLE 8.14

GROUNDWATER (pCi/liter)

COLLECTION LOCATION	DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	Mn-54	Nb-95	Zn-65	Zr-95	H-3	I-131 (radio-chem.)
WELL 27ddc (SITE #57)	02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	05/07/91	<98 [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	08/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
	11/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
WELL 34abb (SITE #58)	02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	05/07/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
	08/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
	11/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA

[1] MDA was greater than LLD due to computer outage and subsequent time lapse between sample collection and sample counting.

TABLE 8.15

SURFACE WATER (pCi/liter)
RESERVOIR (SITE #60)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	6 ± 1	<LLD	<LLD	<LLD	<LLD	<LLD
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	9 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	24 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	21 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	15 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	6 ± 1	<LLD	<LLD	<LLD	<LLD	<LLD
02/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	9 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	7 ± 1	<LLD	<LLD	<LLD	<LLD	<LLD
03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	29 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	21 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	18 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	15 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
04/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	8 ± 1	<LLD	<LLD	<LLD	<LLD	<LLD
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	22 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
04/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	15 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	13 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<46[1]	<LLD	<LLD	<LLD	<LLD	
05/14/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<31[1]	<LLD	<LLD	<LLD	<LLD	
05/21/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<22[1]	<LLD	<LLD	<LLD	<LLD	<LLD [2]
05/28/91	<78[1]	<LLD	<LLD	<LLD	<LLD	<LLD	<78[1]	<LLD	<LLD	<LLD	<LLD	
06/04/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
06/11/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
06/18/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [2]
06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	

[1] MDA was greater than LLD due to computer outage and resultant delay of counting samples.
[2] Analysis was performed as a monthly composite of weekly grab samples.

TABLE 8.15

SURFACE WATER (pCi/liter)
RESERVOIR (SITE #60)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	QTRLY H-3
07/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD[2]
07/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	7 ± 2	<LLD	<LLD	<LLD	<LLD	
07/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	10 ± 3	<LLD	<LLD	<LLD	<LLD	
07/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	12 ± 3	<LLD	<LLD	<LLD	<LLD	
07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
AUGUST COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD[3]
SEPTEMBER COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<16 [5]	<LLD	<LLD	<LLD	<LLD	
OCTOBER COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	8 ± 5	<LLD	<LLD	<LLD	<LLD	<LLD[4]
NOVEMBER COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<23 [5]	<LLD	<LLD	<LLD	<LLD	
DECEMBER COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	

[1] Gamma isotopic analysis performed as a monthly composite of weekly grab samples beginning in August.
[2] Analysis performed as a monthly composite of weekly grab samples.
[3] Analysis performed as a two month composite of weekly grab samples.
[4] Analysis performed as a quarterly composite of weekly grab samples.
[5] MDA greater than LLD due to time delay between sample collection and count.

TABLE 8.16

SURFACE WATER (pCi/liter)
EVAPORATION POND 1 (SITE #59)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	42 ± 3	<LLD	<LLD	<LLD	<LLD	670 ± 200
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/19/91/	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	870 ± 240
03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	770 ± 240
04/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	840 ± 240
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	790 ± 240
04/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91	<64[1]	<LLD	<LLD	<LLD	<LLD	<LLD	<63[1]	<LLD	<LLD	<LLD	<LLD	<LLD[2]
05/14/91	<82[1]	<LLD	<LLD	<LLD	<LLD	<LLD	<56[1]	<LLD	<LLD	<LLD	<LLD	
05/21/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<29[1]	<LLD	<LLD	<LLD	<LLD	
05/28/91	<97[1]	<LLD	<LLD	<LLD	<LLD	<LLD	<100[1]	<LLD	<LLD	<LLD	<LLD	
06/04/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<18[1]	<LLD	<LLD	<LLD	<LLD	720 ± 490 [2]
06/11/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
06/18/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	

[1] MDA higher than LLD due to computer outage and resultant delay of counting samples.
[2] Analysis performed as a monthly composite of weekly grab samples.

TABLE 8.16

SURFACE WATER (pCi/liter)
EVAPORATION POND 1 (SITE #59)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	QTRLY H-3
07/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	10 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD [2]
07/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
07/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
07/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
AUGUST COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<17 [5]	<LLD	<LLD	<LLD	<LLD	<LLD [2]
SEPTEMBER [3]	<129 [5]	<LLD	<LLD	<LLD	<LLD	<LLD	<94 [5]	<LLD	<LLD	<LLD	<LLD	<LLD [3]
OCTOBER COMPOSITE [4]												
NOVEMBER COMPOSITE [4]												
DECEMBER COMPOSITE [4]												

[1] Gamma isotopic analysis performed as a monthly composite of weekly grab samples beginning in August.
[2] Analysis performed as a monthly composite of weekly grab samples.
[3] Evap Pond 1 was pumped dry early in September for liner replacement. Results were from grab sample collected on 9/3/91, counted 10/91.
[4] Evaporation Pond 1 empty.
[5] MDA greater than LLD due to delay between sample collection and sample count.

TABLE 8.17

SURFACE WATER (pCi/liter)
EVAPORATION POND 2 (SITE #63)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	610 ± 200
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	10 ± 2	<LLD	<LLD	<LLD	<LLD	870 ± 230
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	12 ± 2	<LLD	<LLD	<LLD	<LLD	900 ± 200
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	670 ± 200
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4 ± 1	<LLD	<LLD	<LLD	<LLD	<LLD
02/19/91/	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1140 ± 350
02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1420 ± 360
03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	840 ± 230
03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	890 ± 240
03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	6 ± 1	<LLD	<LLD	<LLD	<LLD	830 ± 240
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1450 ± 260
04/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1060 ± 250
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	980 ± 270
04/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91	<66[1]	<LLD	<LLD	<LLD	<LLD	<LLD	<47[1]	<LLD	<LLD	<LLD	<LLD	900 ± 500 [2]
05/14/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<20[1]	<LLD	<LLD	<LLD	<LLD	
05/21/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<30[1]	<LLD	<LLD	<LLD	<LLD	
05/28/91	<88[1]	<LLD	<LLD	<LLD	<LLD	<LLD	<66[1]	<LLD	<LLD	<LLD	<LLD	
06/04/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	770 ± 500 [2]
06/11/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
06/18/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	

[1] MDA higher than LLD due to computer outage and resultant delay of counting samples.
[2] Analysis performed as a monthly composite of weekly grab samples.

TABLE 8.17

SURFACE WATER (pCi/liter)
EVAPORATION POND 2 (SITE #63)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	QTRLY H-3
07/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [2]
07/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
07/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
07/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
AUGUST COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	2260 ± 500 [3]
SEPTEMBER COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	
OCTOBER COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD [4]
NOVEMBER COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<24 [5]	<LLD	<LLD	<LLD	<LLD	
DECEMBER COMPOSITE [1]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	

[1] Gamma isotopic analysis performed as a monthly composite of weekly grab samples beginning in August.
[2] Analysis performed as a monthly composite of weekly grab samples.
[3] Analysis performed as a two month composite of weekly grab samples.
[4] Analysis performed as a quarterly composite of weekly grab samples.
[5] MDA greater than LLD due to time delay between sample collection and count.

TABLE 8.18

MILK (pCi/liter)

COLLECTION LOCATION	DATE COLLECTED	I-131	Cs-134	Cs-137	Ba/La-140
CROSSWINDS DAIRY (SITE #50)	01/09/91	<LLD	<LLD	<LLD	<LLD
	02/03/91	<LLD	<LLD	<LLD	<LLD
	03/03/91	<LLD	<LLD	<LLD	<LLD
	04/07/91	<LLD	<LLD	<LLD	<LLD
	05/05/91	<LLD	<LLD	<LLD	<LLD
	06/01/91	<LLD	<LLD	<LLD	<LLD
	07/09/91	<LLD	<LLD	<LLD	<LLD
	08/05/91	<LLD	<LLD	<LLD	<LLD
	09/03/91	<LLD	<LLD	<LLD	<LLD
	10/02/91	<LLD	<LLD	<LLD	<LLD
	11/04/91	<LLD	<LLD	<LLD	<LLD
	12/04/91	<LLD	<LLD	<LLD	<LLD
DICKMAN DAIRY (SITE #54)	01/09/91	<LLD	<LLD	<LLD	<LLD
	02/03/91	<LLD	<LLD	<LLD	<LLD
	03/03/91	<LLD	<LLD	<LLD	<LLD
	04/07/91	<LLD	<LLD	<LLD	<LLD
	05/05/91	<LLD	<LLD	<LLD	<LLD
	06/01/91	<LLD	<LLD	<LLD	<LLD
	07/09/91	<LLD	<LLD	<LLD	<LLD
	08/05/91	<LLD	<LLD	<LLD	<LLD
	09/03/91	<LLD	<LLD	<LLD	<LLD
	10/02/91	<LLD	<LLD	<LLD	<LLD
	11/04/91	<LLD	<LLD	<LLD	<LLD
	12/04/91	<LLD	<LLD	<LLD	<LLD

TABLE 8.18

MILK (pCi/liter)

COLLECTION LOCATION	DATE COLLECTED	I-131	Cs-134	Cs-137	Ba/La-140
KERR DAIRY (SITE #53)	01/09/91	<LLD	<LLD	<LLD	<LLD
	02/03/91	<LLD	<LLD	<LLD	<LLD
	03/03/91	<LLD	<LLD	<LLD	<LLD
	04/07/91	<LLD	<LLD	<LLD	<LLD
	05/05/91	<LLD	<LLD	<LLD	<LLD
	06/01/91[1]				
	07/09/91[1]				
	08/05/91	<LLD	<LLD	<LLD	<LLD
	09/03/91	<LLD	<LLD	<LLD	<LLD
	10/02/91	<LLD	<LLD	<LLD	<LLD
	11/04/91	<LLD	<LLD	<LLD	<LLD
	12/04/91	<LLD	<LLD	<LLD	<LLD
BUTLER DAIRY (SITE #51)	01/09/91	<LLD	<LLD	<LLD	<LLD
	02/03/91	<LLD	<LLD	<LLD	<LLD
	03/03/91	<LLD	<LLD	<LLD	<LLD
	04/07/91	<LLD	<LLD	<LLD	<LLD
	05/05/91	<LLD	<LLD	<LLD	<LLD
	06/01/91	<LLD	<LLD	<LLD	<LLD
	07/09/91	<LLD	<LLD	<LLD	<LLD
	08/05/91	<LLD	<LLD	<LLD	<LLD
	09/03/91	<LLD	<LLD	<LLD	<LLD
	10/02/91	0.4 ± 0.3	<LLD	<LLD	<LLD
	11/04/91	<LLD	<LLD	<LLD	<LLD
	12/04/91	<LLD	<LLD	<LLD	<LLD

[1] No sample available, supplemental milk sample site used.

TABLE 8.18

MILK (pCi/liter)

COLLECTION LOCATION	DATE COLLECTED	I-131	Cs-134	Cs-137	Ba/La-140
PEW DAIRY (SITE #56)	01/09/91	<LLD	<LLD	<LLD	<LLD
	02/03/91	<LLD	<LLD	<LLD	<LLD
	03/03/91	<LLD	<LLD	<LLD	<LLD
	04/07/91	<LLD	<LLD	<LLD	<LLD
	05/05/91	<LLD	<LLD	<LLD	<LLD
	06/01/91	<LLD	<LLD	<LLD	<LLD
	07/09/91	<LLD	<LLD	<LLD	<LLD
	08/05/91	<LLD	<LLD	<LLD	<LLD
	09/03/91	<LLD	<LLD	<LLD	<LLD
	10/02/91	<LLD	<LLD	<LLD	<LLD
	11/04/91	0.9 ± 0.5	<LLD	<LLD	<LLD
	12/04/91	<LLD	<LLD	<LLD	<LLD

TABLE 8.19

WRF INFLUENT WATER (pCi/liter)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	22 ± 6	<LLD	<LLD	<LLD	<LLD	<LLD
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	29 ± 4	<LLD	<LLD	<LLD	<LLD	<LLD
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	22 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	12 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	14 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
02/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	22 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	8 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	55 ± 4	<LLD	<LLD	<LLD	<LLD	<LLD
03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	26 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	32 ± 4	<LLD	<LLD	<LLD	<LLD	<LLD
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	21 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	19 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
04/09/91[1]												
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	27 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
04/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	35 ± 4	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91[1]												
05/14/91	<70	<LLD	<LLD	<LLD	<LLD	<LLD	<58	<LLD	<LLD	<LLD	<LLD	NA
05/21/91	<77	<LLD	<LLD	<LLD	<LLD	<LLD	<57	<LLD	<LLD	<LLD	<LLD	NA
05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	32 ± 10	<LLD	<LLD	<LLD	<LLD	NA
06/04/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<34	<LLD	<LLD	<LLD	<LLD	NA
06/11/91	<77	<LLD	<LLD	<LLD	<LLD	<LLD	<72	<LLD	<LLD	<LLD	<LLD	NA
06/18/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	66 ± 10	<LLD	<LLD	<LLD	<LLD	NA
06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	26 ± 8	<LLD	<LLD	<LLD	<LLD	NA

[1] No sample available.

TABLE 8.19

WRF INFLUENT WATER (pCi/liter)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
07/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	23 ± 5	<LLD	<LLD	<LLD	<LLD	NA
07/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	7 ± 3	<LLD	<LLD	<LLD	<LLD	NA
07/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	13 ± 3	<LLD	<LLD	<LLD	<LLD	NA
07/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	31 ± 5	<LLD	<LLD	<LLD	<LLD	NA
07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	10 ± 2	<LLD	<LLD	<LLD	<LLD	NA
AUGUST COMPOSITE [1]												
SEPTEMBER COMPOSITE	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	18 ± 9	<LLD	<LLD	<LLD	<LLD	NA
OCTOBER COMPOSITE	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	17 ± 7	<LLD	<LLD	<LLD	<LLD	NA
NOVEMBER COMPOSITE	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<25	<LLD	<LLD	<LLD	<LLD	<LLD
DECEMBER COMPOSITE	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	5 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD

[1] Water reclamation facility shutdown during most of August.

TABLE 8.20

CIRC WATER (pCi/liter)
UNIT 1

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	74 ± 5	<LLD	<LLD	<LLD	<LLD	NA
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	56 ± 5	<LLD	<LLD	<LLD	<LLD	NA
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	39 ± 4	<LLD	<LLD	<LLD	<LLD	NA
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	22 ± 3	<LLD	<LLD	<LLD	<LLD	NA
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	18 ± 3	<LLD	<LLD	<LLD	<LLD	NA
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
02/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	27 ± 4	<LLD	<LLD	<LLD	<LLD	NA
02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	42 ± 5	<LLD	<LLD	<LLD	<LLD	NA
03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	94 ± 7	<LLD	<LLD	<LLD	<LLD	NA
03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	99 ± 7	<LLD	<LLD	<LLD	<LLD	NA
03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	89 ± 6	<LLD	<LLD	<LLD	<LLD	NA
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	98 ± 4	<LLD	<LLD	<LLD	<LLD	1990 ± 270
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	120 ± 7	<LLD	<LLD	<LLD	<LLD	2000 ± 270
04/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	66 ± 5	<LLD	<LLD	<LLD	<LLD	<LLD
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	69 ± 6	<LLD	<LLD	<LLD	<LLD	1200 ± 250
04/23/91	<LLD	<LLD	<LLD	<LLD	4 ± 1	<LLD	84 ± 5	<LLD	<LLD	<LLD	<LLD	1090 ± 260
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	88 ± 7	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91	<170	<LLD	<LLD	<LLD	<LLD	<LLD	<170	<LLD	<LLD	<LLD	<LLD	NA
05/14/91	<93	<LLD	<LLD	<LLD	<LLD	<LLD	71 ± 26	<LLD	<LLD	<LLD	<LLD	NA
05/21/91	<90	<LLD	<LLD	<LLD	<LLD	<LLD	121 ±27	<LLD	<LLD	<LLD	<LLD	NA
05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	135 ±17	<LLD	<LLD	<LLD	<LLD	NA
06/04/91	<65	<LLD	<LLD	<LLD	<LLD	<LLD	120 ±20	<LLD	<LLD	<LLD	<LLD	NA
06/11/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	73 ± 14	<LLD	<LLD	<LLD	<LLD	NA
06/18/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	65 ± 10	<LLD	<LLD	<LLD	<LLD	NA
06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	93 ± 10	<LLD	<LLD	<LLD	<LLD	NA

TABLE 8.20

CIRC WATER (pCi/liter)
UNIT 1

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
07/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	133 ±13	<LLD	<LLD	<LLD	<LLD	NA
07/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	88 ± 9	<LLD	<LLD	<LLD	<LLD	NA
07/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	93 ± 9	<LLD	<LLD	<LLD	<LLD	NA
07/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	161 ± 13	<LLD	<LLD	<LLD	<LLD	NA
07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	131 ± 12	<LLD	<LLD	<LLD	<LLD	NA
AUGUST COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<18 [1]	<LLD	<LLD	<LLD	<LLD	<LLD
SEPTEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	29 ± 10	<LLD	<LLD	<LLD	<LLD	<LLD
OCTOBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	50 ± 4	<LLD	<LLD	<LLD	<LLD	670 ± 480
NOVEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	53 ± 24	<LLD	<LLD	<LLD	<LLD	510 ± 470
DECEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	38 ± 10	<LLD	<LLD	<LLD	<LLD	<LLD

[1] Value lower than normal due to sample change to a monthly composite.
[2] Gamma isotopic and tritium analyses performed as monthly composites of weekly grab samples.

TABLE 8.21

CIRC WATER (pCi/liter)
UNIT 2

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	73 ± 5	<LLD	<LLD	<LLD	<LLD	NA
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	60 ± 5	<LLD	<LLD	<LLD	<LLD	NA
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	120 ± 7	<LLD	<LLD	<LLD	<LLD	NA
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	160 ±11	<LLD	<LLD	<LLD	<LLD	NA
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	140 ± 8	<LLD	<LLD	<LLD	<LLD	NA
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	87 ± 6	<LLD	<LLD	<LLD	<LLD	NA
02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	62 ± 4	<LLD	<LLD	<LLD	<LLD	NA
02/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	57 ± 5	<LLD	<LLD	<LLD	<LLD	NA
02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	49 ± 4	<LLD	<LLD	<LLD	<LLD	NA
03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	91 ± 7	<LLD	<LLD	<LLD	<LLD	NA
03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	140 ± 8	<LLD	<LLD	<LLD	<LLD	NA
03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	130 ± 9	<LLD	<LLD	<LLD	<LLD	NA
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	110 ± 7	<LLD	<LLD	<LLD	<LLD	<LLD
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	99 ± 8	<LLD	<LLD	<LLD	<LLD	5010 ± 340
04/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	90 ± 5	<LLD	<LLD	<LLD	<LLD	1820 ± 270
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	76 ± 6	<LLD	<LLD	<LLD	<LLD	<LLD
04/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	89 ± 7	<LLD	<LLD	<LLD	<LLD	<LLD
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	83 ± 7	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91	<78	<LLD	<LLD	<LLD	<LLD	<LLD	<130	<LLD	<LLD	<LLD	<LLD	NA
05/14/91	<120	<LLD	<LLD	<LLD	<LLD	<LLD	104 ±34	<LLD	<LLD	<LLD	<LLD	NA
05/21/91	<79	<LLD	<LLD	<LLD	<LLD	<LLD	116 ±26	<LLD	<LLD	<LLD	<LLD	NA
05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	135 ±14	<LLD	<LLD	<LLD	<LLD	NA
06/04/91	<89	<LLD	<LLD	<LLD	<LLD	<LLD	110 ±26	<LLD	<LLD	<LLD	<LLD	NA
06/11/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	84 ± 14	<LLD	<LLD	<LLD	<LLD	NA
06/18/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	36 ± 7	<LLD	<LLD	<LLD	<LLD	NA
06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	91 ± 12	<LLD	<LLD	<LLD	<LLD	NA

TABLE 8.21

CIRC WATER (pCi/liter)
UNIT 2

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
07/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	132 ± 10	<LLD	<LLD	<LLD	<LLD	NA
07/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	88 ± 9	<LLD	<LLD	<LLD	<LLD	NA
07/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	100 ± 10	<LLD	<LLD	<LLD	<LLD	NA
07/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	164 ± 15	<LLD	<LLD	<LLD	<LLD	NA
07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	134 ± 10	<LLD	<LLD	<LLD	<LLD	NA
AUGUST COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	39 ± 32 [1]	<LLD	<LLD	<LLD	<LLD	830 ± 480
SEPTEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	40 ± 16	<LLD	<LLD	<LLD	<LLD	880 ± 480
OCTOBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	37 ± 6	<LLD	<LLD	<LLD	<LLD	<LLD
NOVEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<24 [3]	<LLD	<LLD	<LLD	<LLD	<LLD
DECEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1090 ± 490

[1] Value lower than normal due to sample change to a monthly composite.
[2] Gamma isotopic and tritium analyses performed as a monthly composite of weekly grab samples.
[3] Unit 2 down for refueling.

TABLE 8.22

CIRC WATER (pCi/liter)
UNIT 3

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	61 ± 5	<LLD	<LLD	<LLD	<LLD	NA
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	45 ± 5	<LLD	<LLD	<LLD	<LLD	NA
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	110 ± 8	<LLD	<LLD	<LLD	<LLD	NA
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	120 ± 8	<LLD	<LLD	<LLD	<LLD	NA
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	99 ± 7	<LLD	<LLD	<LLD	<LLD	NA
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	71 ± 5	<LLD	<LLD	<LLD	<LLD	NA
02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	50 ± 5	<LLD	<LLD	<LLD	<LLD	NA
02/19/91/	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	55 ± 5	<LLD	<LLD	<LLD	<LLD	NA
02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	45 ± 4	<LLD	<LLD	<LLD	<LLD	NA
03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	100 ± 7	<LLD	<LLD	<LLD	<LLD	NA
03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	64 ± 6	<LLD	<LLD	<LLD	<LLD	NA
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	34 ± 4	<LLD	<LLD	<LLD	<LLD	<LLD
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	15 ± 3	<LLD	<LLD	<LLD	<LLD	2260 ± 280
04/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	18 ± 3	<LLD	<LLD	<LLD	<LLD	2310 ± 280
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	87 ± 19	<LLD	<LLD	<LLD	<LLD	1670 ± 260
04/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	9 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	20 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91	<120	<LLD	<LLD	<LLD	<LLD	<LLD	<120	<LLD	<LLD	<LLD	<LLD	NA
05/14/91	<72	<LLD	<LLD	<LLD	<LLD	<LLD	<93	<LLD	<LLD	<LLD	<LLD	NA
05/21/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<38	<LLD	<LLD	<LLD	<LLD	NA
05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<23	<LLD	<LLD	<LLD	<LLD	NA
06/04/91	<72	<LLD	<LLD	<LLD	<LLD	<LLD	<50	<LLD	<LLD	<LLD	<LLD	NA
06/11/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	45 ± 12	<LLD	<LLD	<LLD	<LLD	NA
06/18/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
06/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	67 ± 10	<LLD	<LLD	<LLD	<LLD	NA

TABLE 8.22

CIRC WATER (pCi/liter)
UNIT 3

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
07/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	128 ± 12	<LLD	<LLD	<LLD	<LLD	NA
07/10/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	92 ± 10	<LLD	<LLD	<LLD	<LLD	NA
07/17/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	95 ± 9	<LLD	<LLD	<LLD	<LLD	NA
07/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	154 ± 11	<LLD	<LLD	<LLD	<LLD	NA
07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	127 ± 9	<LLD	<LLD	<LLD	<LLD	NA
AUGUST COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<27 [1]	<LLD	<LLD	<LLD	<LLD	<LLD
SEPTEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	37 ± 10	<LLD	<LLD	<LLD	<LLD	2360 ± 500
OCTOBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	77 ± 7	<LLD	<LLD	<LLD	<LLD	530 ± 480
NOVEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	33 ± 26	<LLD	<LLD	<LLD	<LLD	<LLD
DECEMBER COMPOSITE [2]	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	32 ± 8	<LLD	<LLD	<LLD	<LLD	<LLD

[1] Value lower than normal due to sample change to a monthly composite.
[2] Gamma isotopic and tritium analyses performed as monthly composites of weekly grab samples.

TABLE 8.23

RETENTION BASIN #1 (pCi/liter)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4 ± 1	<LLD	<LLD	<LLD	<LLD	5200 ± 290
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1850 ± 380
02/12/91	<LLD	<LLD	<LLD	<LLD	8 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
03/05/91	<LLD	<LLD	<LLD	<LLD	4 ± 1	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	2480 ± 270
03/19/91	<LLD	<LLD	<LLD	<LLD	8 ± 1	<LLD	47 ± 4	<LLD	<LLD	<LLD	<LLD	760 ± 240
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1640 ± 260
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1820 ± 270
05/14/91	<88	<LLD	<LLD	<LLD	<LLD	<LLD	<72	<LLD	<LLD	<LLD	<LLD	NA
05/28/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<25	<LLD	<LLD	<LLD	<LLD	NA
07/17/91	<LLD	<LLD	<LLD	<LLD	8 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
07/31/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA

Note: Effective 8-1-91, the unit chemistry groups assumed responsibility for sampling and analysis of the retention basins on a batch-wise basis.

TABLE 8.24

RETENTION BASIN #2 (pCi/liter)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	2530 ± 240
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	2230 ± 230
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1300 ± 200
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1120 ± 350
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
02/19/91	<LLD	<LLD	<LLD	15 ± 1	24 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1470 ± 350
03/05/91	<LLD	<LLD	<LLD	<LLD	9 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	3120 ± 290
03/12/91	<LLD	<LLD	<LLD	<LLD	16 ± 2	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	2240 ± 270
03/19/91	<LLD	<LLD	<LLD	<LLD	8 ± 1	<LLD	11 ± 3	<LLD	<LLD	<LLD	<LLD	1430 ± 260
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	2180 ± 270
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	1170 ± 250
05/07/91	<96	<LLD	<LLD	14 ± 2	29 ± 3	<LLD	<100	<LLD	<LLD	<LLD	<LLD	NA
06/04/91	<LLD	<LLD	<LLD	<LLD	3 ± 1	<LLD	<21	<LLD	<LLD	<LLD	<LLD	NA
07/10/91	<LLD	<LLD	<LLD	14 ± 1	29 ± 3	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
07/24/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA

TABLE 8.25

SEDIMENTATION BASIN #2 (pCi/liter)

DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95	H-3
01/08/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
01/15/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
01/22/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
01/29/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
02/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
02/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
02/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
02/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
03/05/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	3820 ± 300
03/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
03/19/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	NA
03/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/02/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	810 ± 240
04/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
04/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
05/07/91	<130	<LLD	<LLD	<LLD	<LLD	<LLD	<120	<LLD	<LLD	<LLD	<LLD	NA
05/14/91	<130	<LLD	<LLD	<LLD	<LLD	<LLD	<81	<LLD	<LLD	<LLD	<LLD	NA
08/26/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
09/03/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
09/09/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<26	<LLD	<LLD	<LLD	<LLD	2770 ± 540
09/16/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	610 ± 530
09/23/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	4080 ± 530
09/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/12/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
11/18/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<32	<LLD	<LLD	<LLD	<LLD	550 ± 490
11/25/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
12/02/91	<61	<LLD	<LLD	<LLD	<LLD	<LLD	<44	<LLD	<LLD	<LLD	<LLD	<LLD
12/30/91	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD

TABLE 8.26

SLUDGE (pCi/kg)

COLLECTION LOCATION	DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95
WRF WASTE CENTRIFUGE	01/14/91	<58	<12	<9	<8	<10	<21	890 ± 48	<10	<12	<21	<19
	03/19/91	<42	<8	<8	<7	<8	<15	680 ± 90	<8	<10	<14	<14
	04/14/91	<38	<9	<9	<9	<10	<21	640 ± 33	<10	<11	<19	<14
	04/23/91	<49	<10	<9	<9	<11	<19	650 ± 36	<9	<12	<22	<17
	08/06/91	<468	<74	<69	<60	<70	<163	3726 ± 219	<70	<86	<156	<134
	08/13/91	<650	<120	<68	<113	<122	<292	1281 ± 335	<91	<131	<229	<208
	09/02/91	<520	<50	<60	<58	<63	<126	1051 ± 247	<39	<65	<120	<103
	10/02/91	<257	<53	<39	<51	<54	<108	1133 ± 133	<57	<54	<121	<87
	11/05/91	<102	<14	<13	<12	<14	<30	1108 ± 73	<14	<17	<32	<25
	12/03/91	<79	<11	<11	<9	<10	<25	559 ± 43	<10	<13	<24	<21
SEDIMENTATION BASIN #2	03/05/91	<54	<15	<17	<13	<18	<35	<17	<16	<16	<42	<27
RETENTION BASIN #1	03/05/91	<12	<33	1470 ± 61	600 ± 27	1360 ± 63	<63	<33	120 ± 11	<31	<75	<54
	09/16/91	<128	55 ± 21	1591 ± 46	563 ± 24	1445 ± 41	<60	<41	114 ± 24	<28	<62	<46
RETENTION BASIN #2	03/05/91	<110	<29	1390 ± 59	560 ± 25	1240 ± 58	<57	<29	110 ± 11	<28	<76	<45
	09/16/91	<105	104 ± 19	1172 ± 44	363 ± 20	880 ± 33	<55	<34	115 ± 24	<24	<54	<40
EVAP POND 1 (SOUTHWEST)	09/30/91	<792	<126	<105	<89	<159	<257	<309	<129	<159	<183	<218
EVAP POND 1 (NORTHEAST)	09/30/91	<581	<76	<63	<78	<108	<252	<227	<88	<121	<236	<165
UNIT 2 COOLING TOWER[1]	10/29/91	<80	<28	<40	<24	78[2]	<69	130[2]	<39	<40	<117	<73

[1] Analyzed by PVNGS personnel.

[2] Values reported were the highest observed in a set of 11 samples.

TABLE 8.27

SEWAGE PLANT (pCi/liter)

COLLECTION LOCATION	DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95
SEWAGE TREATMENT PLANT (TANKER)	01/14/91	<59	<12	<13	<11	<10	<28	<19	<13	<15	<24	<24
	01/21/91	<48	<10	<12	<12	<12	<21	<19	<9	<11	<22	<19
	02/04/91	<17	<8	<7	<6	<7	<20	<180	<7	<13	<14	<15
	03/19/91	<3	<8	<10	<10	<11	<20	<10	<10	<9	<21	<15
	04/10/91	<21	<7	<7	<7	7 ± 2 [1]	<12	3530 ± 140 [3]	<6	<7	<12	<11
	05/01/91	<14	<4	<5	<4	<5	<8	<5	<4	<4	<10	<12
	05/07/91	<21	<6	<7	<6	<7	<13	<6	<6	<6	<14	<11
	05/12/91	<27	<8	<10	<9	<10	<14	<6	<9	<7	<16	<15
	05/17/91	<22	<11	<8	<7	<5	<12	<7	<7	<7	<15	<17
	05/25/91	<35	<10	<11	<9	<11	<19	<10	<10	<9	<25	<18
	05/29/91	<32	<9	<12	<9	<11	<21	<9	<11	<10	<25	<17
	06/11/91	<30	<9	<10	<9	<10	<19	<10	<9	<9	<23	<17
	06/19/91	<22	<7	<7	<6	<8	<13	<7	<6	<6	<14	<11
	06/24/91	<36	<11	<10	<10	<11	<22	<8	<10	<11	<23	<16
	07/08/91	<32	<9	<8	<9	<11	<18	<9	<9	<9	<19	<15
	07/24/91	<46	<12	<16	<13	<12	<25	<12	<12	<12	<29	<22
	07/31/91 [2]	<60	<7	<7	<6	<6	<16	<30	<6	<8	<14	<13
	08/22/91	<60	<8	<7	<7	<8	<18	<27	<7	HALF-LIFE TOO SHORT	<16	<14
	08/25/91	<56	<8	<9	<7	<8	<19	<23	<8	HALF-LIFE TOO SHORT	<17	<15
	09/09/91	<96	<14	<13	<12	<13	<30	<40	<13	<16	<29	<25

[1] This activity is at the a priori LLD value and is consistent with pre-operational soil study levels.

[2] Mo-99 was also identified in this sample at 1086 ± 486 pCi/liter. This activity was verified to be due to radiopharmaceutical uptake of Tc-99m by three employees in May and June (56.3 mCi, total).

[3] This activity was verified to be due to radiopharmaceutical uptake of I-131 by an employee administered on 3-25-91 (2.3 mCi).

TABLE 8.27

SEWAGE PLANT (pCi/liter)

COLLECTION LOCATION	DATE COLLECTED	Ba/La-140	Co-58	Co-60	Cs-134	Cs-137	Fe-59	I-131	Mn-54	Nb-95	Zn-65	Zr-95
SEWAGE TREATMENT PLANT (TANKER)	09/17/91	<34	<7	<8	<6	<7	<15	<11	<7	<7	<15	<12
	09/27/91	<96	<17	<16	<14	<16	<38	<36	<16	<19	<39	<31
	10/02/91	<39	<6	<6	<5	<6	<13	<16	<6	<7	<13	<11
	10/13/91	<61	<11	<11	<9	<10	<26	<22	<10	<12	<24	<19
	10/22/91	<527	<34	<35	<30	<33	<92	<373	<33	<50	<73	<73
	10/24/91	<439	<35	<30	<26	<32	<83	<287	<29	<47	<65	<63
	10/31/91	<124	<14	<13	<11	<13	<31	292 ± 62 [1]	<12	<18	<26	<25
	11/06/91	<112	<16	<16	<13	<14	<33	259 ± 47 [1]	<14	<18	<32	<28
	11/13/91	<69	<7	<6	<5	<6	<16	383 ± 50 [1]	<6	<9	<12	<12
	11/25/91	<99	<10	<9	<8	<8	<23	377 ± 60 [1]	<8	<12	<19	<17
	12/03/91	<67	<9	<9	<8	<9	<21	113 ± 32 [1]	<8	<11	<18	<16
	12/09/91	<45	<8	<8	<7	<8	<17	107 ± 15 [1]	<7	<9	<18	<15
	12/12/91	<122	<12	<12	<9	<10	<28	76 ± 65 [1]	<10	<15	<23	<20
	12/21/91	<61	<8	<8	<7	<8	<19	<28	<8	<9	<18	<15

[1] This activity was verified to be due to radiopharmaceutical uptake of I-131 by an employee administered on 10-25-91 (10mCi).

TABLE 8.28

SURFACE WATER COMPOSITE ANALYSIS

COLLECTION LOCATION	DATE COLLECTED	GROSS BETA	Sr-89	Sr-90
EVAPORATION POND #1 (SITE #59)	03/26/91	578 ± 45	<0.72	1.32 ± 0.44
	06/25/91	638 ± 45	<0.59	1.20 ± 0.2
EVAPORATION POND #2 (SITE #63)	03/26/91	490 ± 41	<0.74	2.0 ± 0.73
	06/25/91	531 ± 40	0.68 ± 0.11	0.93 ± 0.16
RESERVOIR (SITE #60)	03/26/91	20 ± 1	<0.75	0.56 ± 0.31
	06/25/91	18 ± 1	<0.65	<0.48

9.0 Thermoluminescent Dosimetry Results and Data Interpretation

Thermoluminescent Dosimeters were placed in fifty locations ranging from one to forty-five miles from the Palo Verde Nuclear Generating Station. Beginning in 1984, the Panasonic Model 812 Dosimeter replaced all other TLD's in use. The 812 is a multi-element dosimeter combining two elements of Lithium Borate and two elements of Calcium Sulfate.

TLD locations are shown in Figures 2.1 and 2.2. TLD locations are described in Table 9.1. TLD results for 1991 are presented in Table 9.2. TLD results for 1984 through 1991 are presented in Figure 9.1 (excluding transit control TLD #45).

TLD results for 1991 are consistent with pre-operational data.

TABLE 9.1
THERMOLUMINESCENT DOSIMETRY SITE LOCATIONS

TLD NUMBER	TLD LOCATION	LOCATION DESCRIPTION
1	E 30	APS Western Div. Offices, W. of Litchfield on Van Buren, Goodyear
2	ENE 24	Scott-Libby School, Perryville Rd. and Thomas Rd.
3	E 21	Inside Irrigation Pump Station, Liberty School 19800 West Hwy 85
4	E 16	W. of parking lot APS Buckeye Offices - 615 N. 4th St, Buckeye
5	ESE 11	Town of Palo Verde - N. of Palo Verde School & Old 80 on Palo Verde Rd. Inside Maintenance Fence
6	SSE 31	APS Gila Bend Substation - Service off I-8 West of Gila Bend
7	SE 7	NE Corner Arlington School Rd and US 80
8	SSE 5	So. Pacific Pipeline Rd 1.4 mi SW of 355th Ave
9	S5	SPRR 2.5 mi SW of 355th Ave
10	SE 5	SE Corner of 355th Ave & Elliot Rd
11	ESE 5	NW corner of 339th Ave. and Dobbins Rd
12	E5	NE Corner of 339th Ave and Buckeye Salome Rd
13	N 1	N Site Boundary N. Unit 1 Cooling Tower
14	NNE 2	NNE Site Boundary, 371st Ave
15	NE 2	Site Boundary WRF Road
16	ENE 2	ENE Site Boundary/Pipeline
17	E 2	E Site Boundary, E. of Unit 1
18	ESE 2	ESE Site Boundary
19	SE 2	SE Site Boundary
20	SSE 2	SSE Site Boundary
21	S 3	S Site Boundary, South Gate
22	SSW 3	SSW Site Boundary - Corner of Wintersburg & Elliot Rd.
23	W 5	2 mi North of Elliot Rd. and 3 mi West of Wintersburg Rd
24	SW 4	Elliot Rd 2 mi W of Wintersburg Rd

TABLE 9.1
THERMOLUMINESCENT DOSIMETRY SITE LOCATIONS

TLD NUMBER	TLD LOCATION	LOCATION DESCRIPTION
25	WSW 5	Elliot Rd at Cattleguard - 3.5 mi W of Wintersburg Rd
26	SSW 5	Shephard Farm, 13202 S. 383rd Ave, .5 mi West of house
27	SW 1	SW Site Boundary, 1/4 mile South of OPS Entrance
28	WSW 1	WSW Site Boundary, West of Unit 3
29	W 1	W Site Boundary, West of Unit 2
30	WNW 1	WNW Site Boundary, South of Main Gate
31	NW 1	NW Site Boundary
32	NNW 1	NNW Site Boundary, 1 MI N of U/3 Cooling Tower
33	NW 4	Buckeye Rd, 1/2 mi W of 395th Ave.
34	NNW 5	SE Corner of 395th & Van Buren Rd
35	NNW 9	Palo Verde Inn Fire Station, 40901 W. Osborn Rd, Tonopah
36	N 5	Southwest corner of Wintersburg Rd and Van Buren Rd
37	NNE 5	Southeast corner of 363rd Ave and Van Buren Rd
38	NE 5	0.2 mi S of Buckeye Rd on W side of 355th Ave
39	ENE 5	W side of 343rd Ave 1/2 mi S of Lower Buckeye Rd.
40	N 3	Wintersburg, At telephone pole S of Transmission Rd
41	WNW 20	Harquahala Valley School, Van Buren St., 1 mi W of Steve Martori Dr
42	N 8	Ruth Fisher School Indian Sch Rd & Wintersburg - NW Corner of Parking Lot.
43	N 45	Vulture Mine Rd. School, 1 mi S of US 60, Wickenburg
45	E 16	REMP Lab, APS Office (Lead Pig) 615 N. 4th St. Buckeye, Arizona
46	ENE 30	Litchfield Park School, Inside Fence, Sagebrush and Litchfield Rd
47	E 35	Littleton School, 115th Ave. and Hwy 85, Cashion
48	E 24	Perryville - Jackrabbit Rd S of I-10 between Circle K and Filmore St, E. side of Rd
49	ENE 11	Hopeville - 1/4 mi S of I-10, Palo Verde Rd across from 1st fire hydrant
50	WNW 5	Olinski Rd - 2 mi S of Buckeye - Salome Rd

TABLE 9.2
1991 Environmental TLD Results

Station #	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Average mR/std Qtr
1	21.8	20.7	20.5	22.0	21.1
2	21.2	20.7	20.5	22.9	21.4
3	21.8	21.2	19.0	22.9	21.0
4	22.2	22.7	22.9	24.4	23.3
5	17.7	17.3	16.0	18.1	17.1
6	25.7	25.7	24.4	27.9	26.0
7	24.2	24.6	23.5	25.5	24.6
8	21.8	22.2	21.6	24.0	22.6
9	28.1	28.1	27.4	30.7	28.7
10	22.7	22.2	21.6	24.4	22.8
11	24.2	24.6	21.6	24.2	23.5
12	21.2	21.2	21.6	24.4	22.4
13	24.6	23.8	24.4	26.4	24.8
14	23.8	22.7	25.1	25.5	24.4
15	22.2	22.7	21.6	24.4	22.9
16	20.7	20.7	21.6	22.9	21.7
17	22.7	24.6	23.5	24.8	24.3
18	21.8	22.7	22.5	24.4	23.2
19	24.2	23.3	23.5	25.9	24.3
20	22.7	22.2	22.9	24.4	23.2
21	25.3	24.2	25.1	26.8	25.3
22	26.1	25.3	24.4	27.4	25.7
23	21.8	21.8	21.0	24.0	22.2
24	20.3	21.2	20.1	22.9	21.4
25	21.8	22.2	21.0	22.9	22.0
26	26.8	26.8	26.6	28.7	27.4
27	26.1	26.1	25.9	29.4	27.1
28	24.6	24.2	24.0	25.9	24.7
29	24.2	23.8	24.4	25.5	24.6

Station #	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Average mR/std Qtr
30	24.2	24.2	25.5	26.4	25.3
31	23.3	22.7	21.6	24.4	22.9
32	23.8	24.2	23.5	25.9	24.6
33	24.6	25.3	24.4	27.9	25.8
34	26.8	26.1	27.0	28.3	27.1
35	28.7	29.2	28.5	29.4	29.0
36	24.2	24.2	24.4	25.9	24.8
37	21.8	22.2	22.9	24.0	23.0
38	25.3	26.1	25.9	27.9	26.6
39	22.2	22.2	22.5	24.0	22.9
40	23.8	22.7	21.0	24.8	22.8
41	25.7	26.1	26.6	28.7	27.1
42	23.8	23.8	24.0	24.8	24.2
43	22.7	23.8	25.1	25.5	24.8
44	19.2	19.2	20.1	21.0	20.1
45	5.4	5.8	5.4	6.5	5.9
46	20.3	20.7	20.1	19.7	20.2
47	25.3	27.2	26.6	28.3	27.4
48	20.7	21.8	21.6	23.5	22.3
49	20.7	21.2	21.0	21.0	21.0
50	16.8	18.4	18.6	19.0	18.6

PVNGS Network TLD Exposure Rate

1983 – 1991

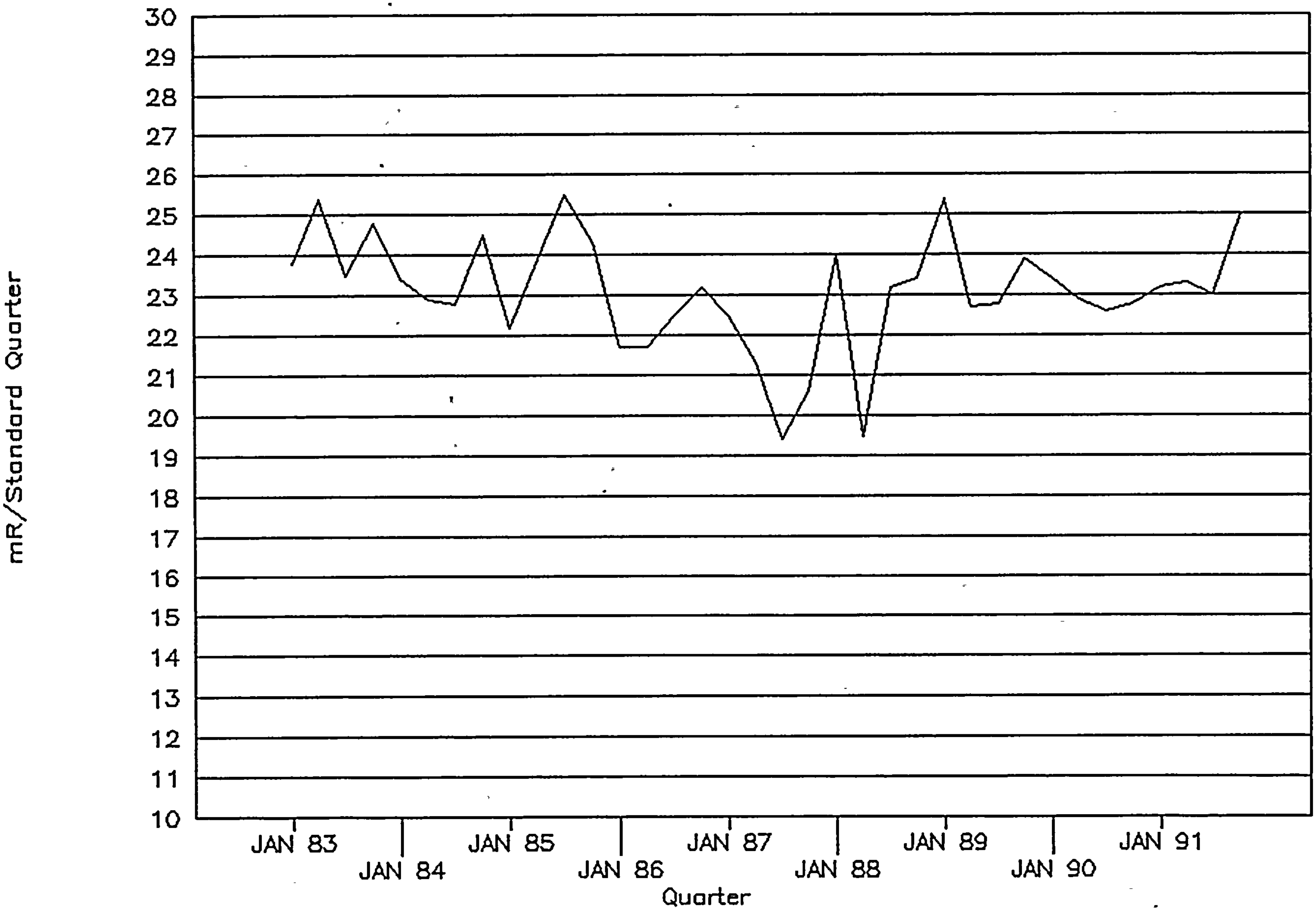


FIGURE 9.1

10.0 Land Use Census

10.1 Introduction

In accordance with PVNGS Technical Specifications 3.12.2, the annual Land Use Census within a five mile radius of mid-line PVNGS Unit 2 containment was performed during December, 1991.

Observations were made in each of the 16 meteorological sectors of the nearest milking animals (cows and goats), nearest residence, and the nearest garden of greater than 500 square feet producing broad leaf vegetation. This census was completed by driving the roads and speaking with residents within a five mile radius of PVNGS.

The results of the Land Use Census are presented in Table 10.1 and discussed below. The directions and distances are listed in sectors and miles from Unit 2 containment. The mileage was estimated from map positions of each location. Unless otherwise stated, the actual location is the same as stated in the 1990 AREOR.

10.2 Census Results

10.2.1 Nearest Resident

There were four changes in the nearest resident status noted in the 1990 census. These changes were in the N, ESE, SSE and WSW sectors.

10.2.2 Milking Animals

There were no milking animals located in the five mile radius in the 1991 census.

10.2.3 Vegetable Gardens

There were no changes in the garden data. The garden located in the ENE sector is the same as in the 1990 Land Use Census.

10.3 Conclusion

No changes were made to the REMP as a result of the 1991 Land Use Census.

TABLE 10.1

1991 LAND USE CENSUS
(distances in miles)

SECTOR	NEAREST RESIDENT	NEAREST GARDEN	NEAREST MILK ANIMAL COW	GOAT	CHANGED LOCATION
N	1.83	NONE	NONE	NONE	RESIDENCE
NNE	1.66	NONE	NONE	NONE	
NE	2.10	NONE	NONE	NONE	
ENE	2.80	2.85	NONE	NONE	
E	2.89	NONE	NONE	NONE	
ESE	3.78	NONE	NONE	NONE	RESIDENCE
SE	4.31	NONE	NONE	NONE	
SSE	4.37	NONE	NONE	NONE	RESIDENCE
S	4.28	NONE	NONE	NONE	
SSW	NONE	NONE	NONE	NONE	
SW	2.65	NONE	NONE	NONE	
WSW	NONE	NONE	NONE	NONE	RESIDENCE
W	NONE	NONE	NONE	NONE	
WNW	NONE	NONE	NONE	NONE	
NW	4.08	NONE	NONE	NONE	
NNW	2.51	NONE	NONE	NONE	

11.0 Summary and Conclusions

The conclusions are based on a review of the radioassay results and background gamma radiation measurements for the 1991 calendar year. The radioassay conclusions are based on observations of fission product radionuclides and do not include observations of naturally occurring radionuclides such as the uranium or thorium series, C-14, or K-40.

A summary of all sample results for 1991 is presented in Table 11.1. With the exception of on-site surface water and associated sludge, all sample assays presented in the annual report reveal no detectable man-made radioactivity which can be attributed to PVNGS. I-131 concentrations in the Reservoir, Cooling Towers and Evaporation Ponds are the result of off-site sources and appear in the effluent sewage from Phoenix. The levels of I-131 detected in these locations are consistent with levels identified in previous years.

Natural background radiation is consistent with measurements reported in previous pre-operational and operational radiological environmental monitoring program annual reports. [6]

TABLE 11.1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY

Palo Verde Nuclear Generating Station
Maricopa County, Arizona

Docket Nos. 50-528, 50-529, 50-530
Calendar Year 1991

Medium or Pathway Sampled (unit of measurement)	Type and (Total Number of Analyses Performed)	All Indicator Locations Mean (a) Range	Location With Highest Annual Mean Name Distance & Direction	 Mean (a) Range	Control Locations Mean (a) Range	Number of Non-routine Reported Measurements
Air Particulates (pCi/m^3)	Gross Beta (579)	0.025 (579/579) 0.008 - 0.052	Site #7A 8 miles 135°	0.026 (53/53) 0.009 - 0.052	0.024 (52/52) 0.009 - 0.048	0
	Gamma Spec Composites (99)	<LLD	NA	<LLD	<LLD	0
Air Radioiodine (pCi/m^3)	Radioiodine (579)	<LLD	NA	<LLD	<LLD	0
Broadleaf Vegetation (pCi/Kg-wet)	Gamma Spec (5)	<LLD	NA	<LLD	<LLD	0
Drinking Water (pCi/L)	Gross Beta (44)	4.5 (35/44) 1.7 - 12	Site #48 5 miles 190°	5.8 (9/11) 3 - 9.7	NA	0
	Gamma Spec (48)	<LLD	NA	<LLD	NA	0
	Iodine-131 (104)	0.6 (3/104) 0.5 - 0.7	Site #48 5 miles 190°	0.65 (2/26) 0.6 - 0.7	NA	0
	Tritium (36)	610 (5/36) 480 - 810	Site #48 5 miles 190°	730 (2/9) 640 - 810	NA	0
Groundwater (pCi/L)	Gamma Spec (8)	<LLD	NA	<LLD	NA	0
	Tritium (8)	<LLD	NA	<LLD	NA	0
	Iodine-131 (4)	<LLD	NA	<LLD	NA	0
Milk (pCi/L)	Gamma Spec (58)	<LLD	NA	<LLD	<LLD	0
	I-131 (58)	0.65 (2/58) 0.4 - 0.9	Site #56 61 miles 90°	0.9 (1/12) 0.9	0.9 (1/12) 0.9	0

TABLE 11.1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM ANNUAL SUMMARY (continued)

Medium or Pathway Sampled (unit of measurement)	Type and (Total Number of Analyses Performed)	All Indicator Locations Mean (a) Range	Location With Highest Annual Mean Name Distance & Direction	 Mean (a) Range	Control Locations Mean (a) Range	Number of Non-routine Reported Measure-ments
Surface Water (pCi/L)	Tritium (69)	960 (21/69) 610 - 2260	Site #63 Onsite 160°	1040 (15/23) 610 - 2260	NA	0
	Gamma Spec I-131 (105)	14 (26/105) 4 - 42	Site #59 Onsite 70°	26 (2/33) 10 - 42	NA	0

(a) Mean and range are based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parentheses.

NOTE: Miscellaneous samples which are not indicated on Table 6-1 of the ODCM are not included on this table.

12.0 References

1. 1981 Annual Report, Palo Verde Nuclear Generating Station's Pre-Operational Radiological Monitoring Program.

2. 1982 Annual Report, Palo Verde Nuclear Generating Station's Pre-Operational Radiological Monitoring Program.

3. 1983 Annual Report, Palo Verde Nuclear Generating Station's Pre-Operational Radiological Monitoring Program.

4. 1984 Annual Report, Palo Verde Nuclear Generating Station's Pre-Operational Radiological Monitoring Program.

5. Pre-Operational Radiological Monitoring Program, Summary Report 1979-1985.

6. 1985 - 1990 Annual Reports, Palo Verde Nuclear Generating Station's Radiological Environmental Operational Monitoring Program.

7. Palo Verde Nuclear Generating Station Technical Specifications.

8. Offsite Dose Calculation Manual, PVNGS Units 1,2,3.

9. Regulatory Guide 4.8, Environmental Technical Specifications for Nuclear Power Plants, Branch Technical Position, Revision 1, November 1979.

PALO VERDE NUCLEAR GENERATING STATION
REQUEST FOR ADDITIONAL INFORMATION
AUXILIARY SYSTEMS BRANCH

1. Provide further justification for the assumption in the PRA study that automobiles can be excluded from consideration in the tornado missile analysis.

<u>Response:</u>

One of the assumptions listed in Section 1.4 of the PRA study indicated that:

"...Class G missiles (auto) are excluded from consideration because the parking area and roads are far from the spray pond and a tornado of credible intensity cannot transport them such a distance nor to the elevation of the spray nozzles (12 ft)."

This assumption is more accurately stated as follows:

"...Class G missiles (auto) are excluded from <u>explicit</u> consideration..." The probability of the auto becoming airborne is one order of magnitude less than the "standard" missile. In addition, a survey of seven plants [1] indicates that autos constitute about 1% of the total number of potential tornado missiles. These two factors suggest that the number of "standard" missiles should be increased by 0.1% to account for the Class G missiles. This factor is insignificant when compared to the factor of 10 conservatism used in the number of "standard" missiles.

2. The PRA study as currently presented may not provide sufficient evaluation of the effects of existing site features on the installed spray pond. This analysis is required in order to assure that a complete assessment of potential tornado missile damage to the spray pond has been performed. Therefore, provide the following additional information.

   a) It appears that only the SRP Section 3.5.1.4 missile spectrum was considered in determining the "standard" missile used in the PRA study. As the study is an evaluation of an existing structure, it must be shown that the standard missile bounds all potential missile impacts against unprotected spray pond components. Therefore, provide justification and any necessary supporting calculations for excluding potential site missiles of less mass than the "standard" missile traveling at lesser velocity from the PRA evaluation.

   b) A response to part a) above is not required if it can be demonstrated that the actual design wind loading and impulse load due to tornado missiles for which the spray riser piping and nozzles have been designed is adequate to assure that unacceptable damage does not occur as a result of impact from the realistic potential site missiles to be addressed in a. above.

Response:

a) The concept of the "standard" missile was developed from the spectrum in SRP Section 3.5.1.4. However, analysis of surveys at seven nuclear plants [1] shows that potential site missiles have aerodynamic characteristic that are essentially the same as the "standard" missile, except for the automobile. Since the number of potential site missiles varies from time to time, it is not reasonable to base an analysis on one plant survey. The present study uses a conservative distribution of number and type of missiles based on the seven surveyed plants. The "standard" missile bounds all potential missiles.

The study conservatively assumes that any missile strike on the spray arm completely destroys all four spray arms in that set. thus, the missile mass and velocity are immaterial.

b) Although the spray pond system is designed to withstand tornado wind loads up to 300 MPH, it is not specifically designed to withstand impulse loads associated with missile strike. As mentioned above, the study conservatively assumes spray system damage from any missile impact.

3. Identify the upper and lower bounds selected for each of the conditional probabilities in the PRA study and justify the actual bounds selected.

Response:

Equation 4.1 in the study identifies two conditional probability terms. The first is the conditional probability of hitting a target given the tornado occurrence (P_H). The second is the conditional probability of target damage given the missile hit (P_D). The latter term was conservatively assigned the maximum value of unity. Thus, the upper and lower bounds of the conditional probability P_H is the matter for consideration. (In the study consideration was given to multiple missile strikes, however, this response will be limited to discussion of one strike.)

The conditional probability of hitting a single target given the tornado is dependent on five factors, as follows:

$$P_H = n_p A \sum_{F=0}^{6} \Phi(F/a)\, \eta(F)\, \psi(z,F)$$

where:

n_p = local density of potential missiles near the spray ponds (ft^2),

A = effective target area of one nozzle set (ft^2),

$\Phi(F/a)$ = relative frequency of tornado with severity equal to F on the Fujita scale given path area (a) of tornado,

$\eta(F)$ = Probability that a potential missile becomes airborne (probability of missile injection) for tornado of F-scale,

$\psi(z,F)$ = height distribution of airborne missiles.

The local density of potential missiles near the spray ponds is determined from the nuclear plant surveys. The upper and lower bounds are 3.6×10^{-4} and 2.0×10^{-4}, respectively. These values are conservative in that they are five to nine times greater than data developed by Twisdale [1] based on the same surveys.

The probability of hitting the effective area A by a point missile has to be the same as the probability of hitting the real target by a real missile of length ℓ. Therefore, the effective area A depends on the real geometry of the target and the spectrum of missile lengths. A Monte Carlo simulation was applied to estimate the effective area of a nozzle set as a function of missile length. Instead of a real spectrum of missile lengths based on survey data a more conservative spectrum was used, assuming that 20% of the potential missiles are utility poles with length ℓ = 35 ft and 80% of the missiles have length ℓ = 20 ft each. The effective area for this spectrum is 2.5 times greater than the spectrum based on the survey data.

The summation of the three terms in the above equation is the conditional probability that a tornado missile becomes airborne and is transported to a target at elevation z, given the tornado occurrence. The first term, relative frequency ϕ (F/a) of tornado with severity equal to F on the Fujita scale given path area a, is based on historical data consisting of about 20,000 tornado occurrences. The relative frequency ϕ (F/a) for typical values of path area a and tornado intensity F are given in Table 3-1. This distribution conservatively over estimates the higher intensity tornadoes. The second term, $\eta(F)$ is the probability that a potential missile becomes airborne for a given intensity tornado.

The upper and lower limits are provided in Table 3-2. The upper limit corresponds to the case when the restraining force for horizontal injection is zero friction and for vertical injection is gravity. The lower limit is based on a restraining force equal to five times gravity. The third term ψ(Z,F) is the height distribution of airborne missiles. The height distribution for the spray nozzles, located at elevation z = 12′, is given in Table 3-2. This distribution is based on a theoretical model. The model has been found to be in good agreement with Twisdale′s [1] Monte Carlo simulation.

TABLE 3-1

RELATIVE FREQUENCY OF TORNADO $\Phi(F/a)$ WITH SEVERITY F ON THE FUJITA SCALE GIVEN PATH AREA a

F \ a	Lower Path Area $0.012\ mi^2$	Median Path Area $0.345\ mi^2$	Upper Path Area $10.150\ mi^2$
0	.6417	.1293	.0004
1	.3344	.5516	.1514
2	.0173	.2737	.4238
3	.0066	.0416	.3037
4	.0000	.0036	.0993
5	.0000	.0002	.0185
6	.0000	.0000	.0029

TABLE 3-2

PROBABILITY $\eta(F)$ THAT A POTENTIAL MISSILE BECOMES AIRBORNE AND PROBABILITY $\psi(Z,F)$ THAT AN AIRBORNE MISSILE IS ELEVATED TO A HEIGHT Z = 12 FT

F-Scale	$\eta(F)$			ψ (Z,F) (Z = 12 ft)
	Lower Limit	Median	Upper Limit	
0	0.00	0.01	0.18	0.224
1	0.00	0.03	0.43	0.273
2	0.00	0.04	0.65	0.349
3	0.01	0.09	0.77	0.430
4	0.08	0.25	0.82	0.588
5	0.22	0.43	0.86	0.701
6	0.35	0.56	0.89	0.779

4. The probability of the tornado as derived and used in Appendix A of the PRA study does not appear to be a total conditional probability, but a conditional probability of tornado severity occurrence given a path area. Justify the acceptability of this approach.

Response:

The probability $P_o(a)$ considered in Appendix A is the conditional probability of tornado occurrence with path area (a). The so-called "total" probability P_o of tornado occurrence is simply the expectation of tornado strike and can be expressed through $P_o(a)$ by:

$$P_o = \int_0^{\infty} P_o(a) \; f(a) \, da = \frac{\nu \bar{a}}{S}$$

where f(a) is distribution of striking tornado by path area a, and $\bar{a}$ is an average tornado path area given by the equation:

$$\bar{a} = \int_0^{\infty} a \, f(a) \, da$$

The expected value P_o is not used directly for two reasons. First, the PRA Study used distributions for the probability of events of interest, and not a point estimate (e.g. mean value). Second, the probability of hitting a target depends on the path area. The expected value P_o is of limited usefulness even in the case of a point estimate because of strong correlation between path area and Fujita intensity. If the correlation between path area and Fujita intensity is taken into account (i.e. the joint distribution function $f(a,F) = f(a) \, \phi(F/a)$ is used), the result is significantly greater. This approach was used in the PRA Study.

5. Identify and justify all assumptions and assumed conditions utilized in determining the conditional probabilities associated with Appendices B, C, D and E. The justification shall discuss the significance of each assumption and its effect (the sensitivity) on the final answer.

Response:

All significant assumptions and conditions that effect the conditional probabilities associated with Appendices B, C, D and E were considered in the response to question 3. It was shown that the effective area is overestimated by a factor of 2.5. The tornado path area is overestimated by a factor of 5 and the upper bound number of potential missiles was increased by a factor of 10 over Twisdale's [1]. The total conservatism incorporated in the upper limit of probability is 125 (5x10x2.5).

6. In Appendix A of the PRA study, an assumption is made of a constant tornado frequency per unit area to account for a nonuniform geographic distribution of tornado characteristics. Justify the approach of adjusting the tornado frequency per county based on population distribution and neglecting the meteorological and/or geographic variabilities of the site area.

Response:

Appendix A of the PRA study examined a thirty year record of tornado occurrences for each county in the state of Arizona. A regression analysis indicated that the low number of recorded tornadoes for some counties could be attributed to their low population density. It was further found that the tornado record for Maricopa County had the highest occurrence rate and did not require adjustment for population density.

The regression analysis did show a mild correlation between county area and the number of tornado occurrences. This correlation may be due to meteorological or geographic variables. However, any adjustments for these effects would result in a reduced frequency of tornado occurrence rate at the plant site compared to the Maricopa County data. Since this adjustment could not be justified and may be nonconservative, it was not used. Since the plant is located in Maricopa County and it reports the highest frequency of tornado occurrences, the actual record was used in the PRA analysis.

7. In Appendix B of the PRA study, it is stated that $P_o(a)$ is the probability of any tornado striking per year. However, this quantity is actually the probability of tornados of path area a. Explain the effects on the results for smaller path area tornados as appears to often be the case with tornadoes near the site area.

Response:

The quantity $P_o(a)$ is the conditional probability of tornado occurrence with path area a striking the plant site. The words "with path area (a)" was omitted because the argument "a" in the notation $P_o(a)$ is implicit. As indicated in response 4, the PRA study considered a distribution of tornadoes by path area. The final results are for tornadoes included in the distribution.

The contribution of any tornado size depends on frequency of occurrence according to Thom distribution. Tornadoes with small path area are less likely to strike a given target; however, tornadoes with small path area generally mean more frequent occurrences. The net effect is that tornadoes with small path areas are more likely to strike the plant. These factors have been included in the PRA Study.

References

1. Twisdale, L.A., Dunn, W.L. Clue, J. "Tornado Missile Risk Analysis," EPRI NP-768, May 1978.

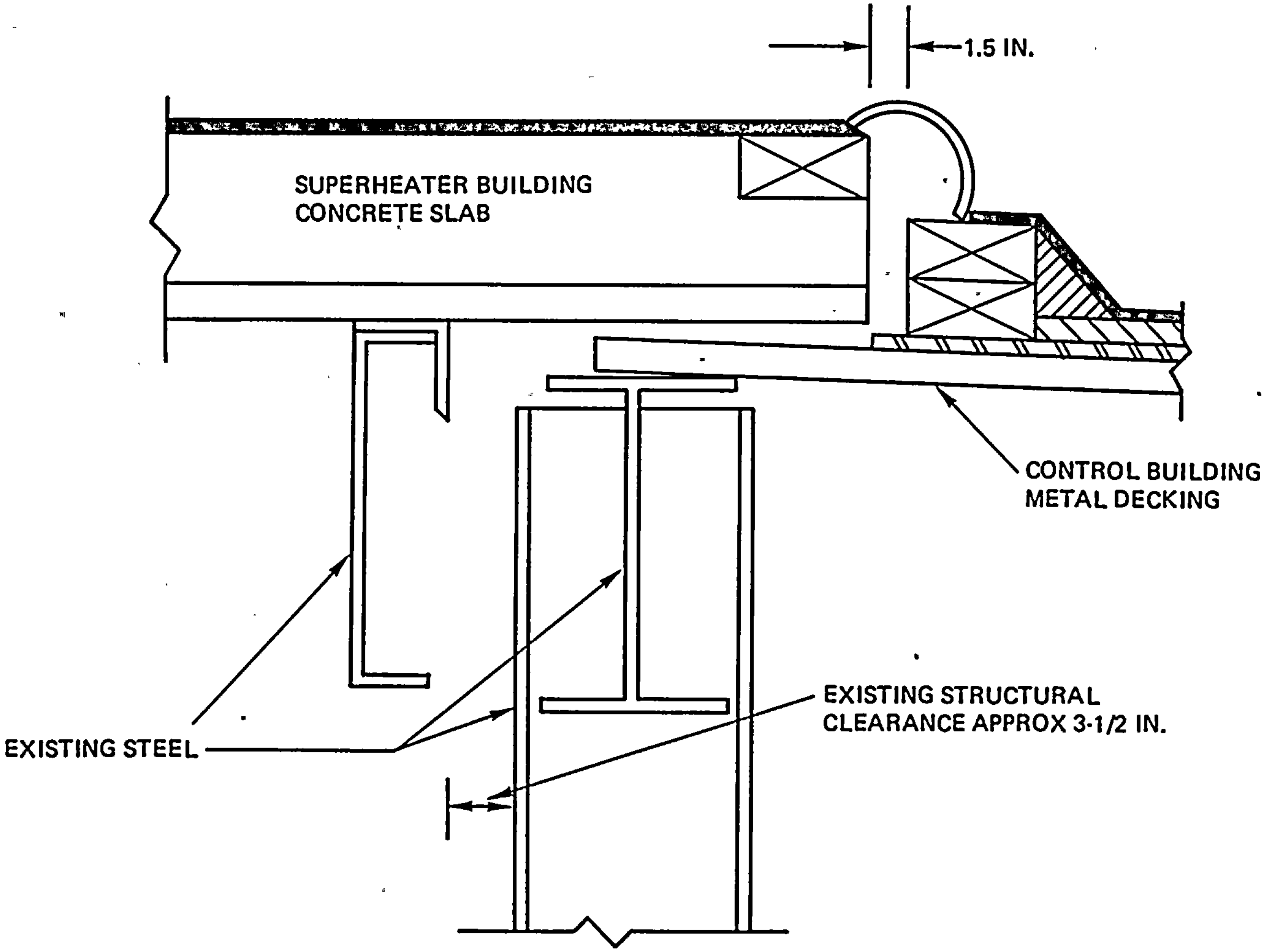


Figure 1. Existing Configuration of Control Building and Superheater Building at Elevation 72'-0 (Indian Point 2)

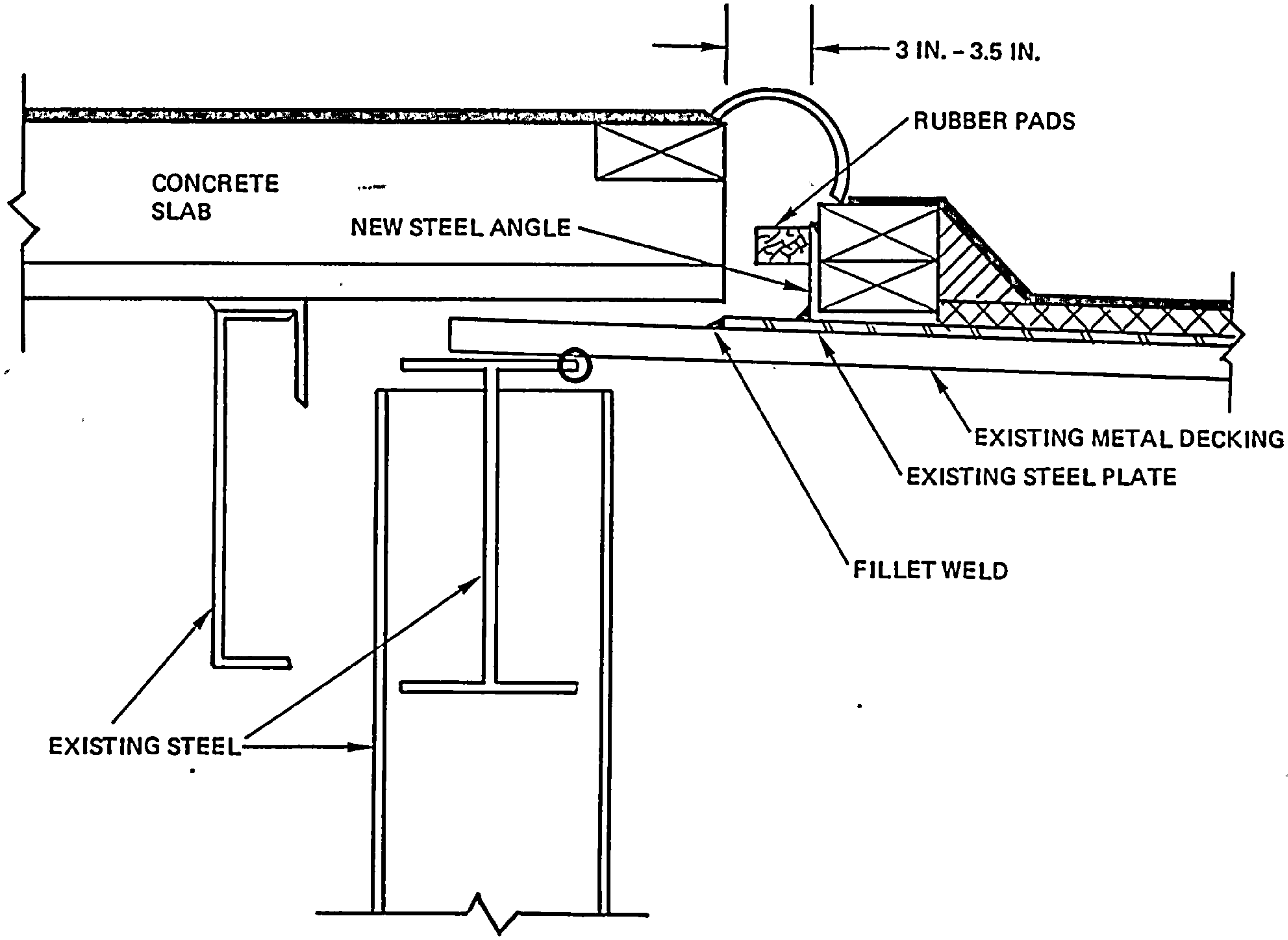


Figure 2. Method for Adding Rubber Pads Between Control Building and Superheater Building (Indian Point 2)

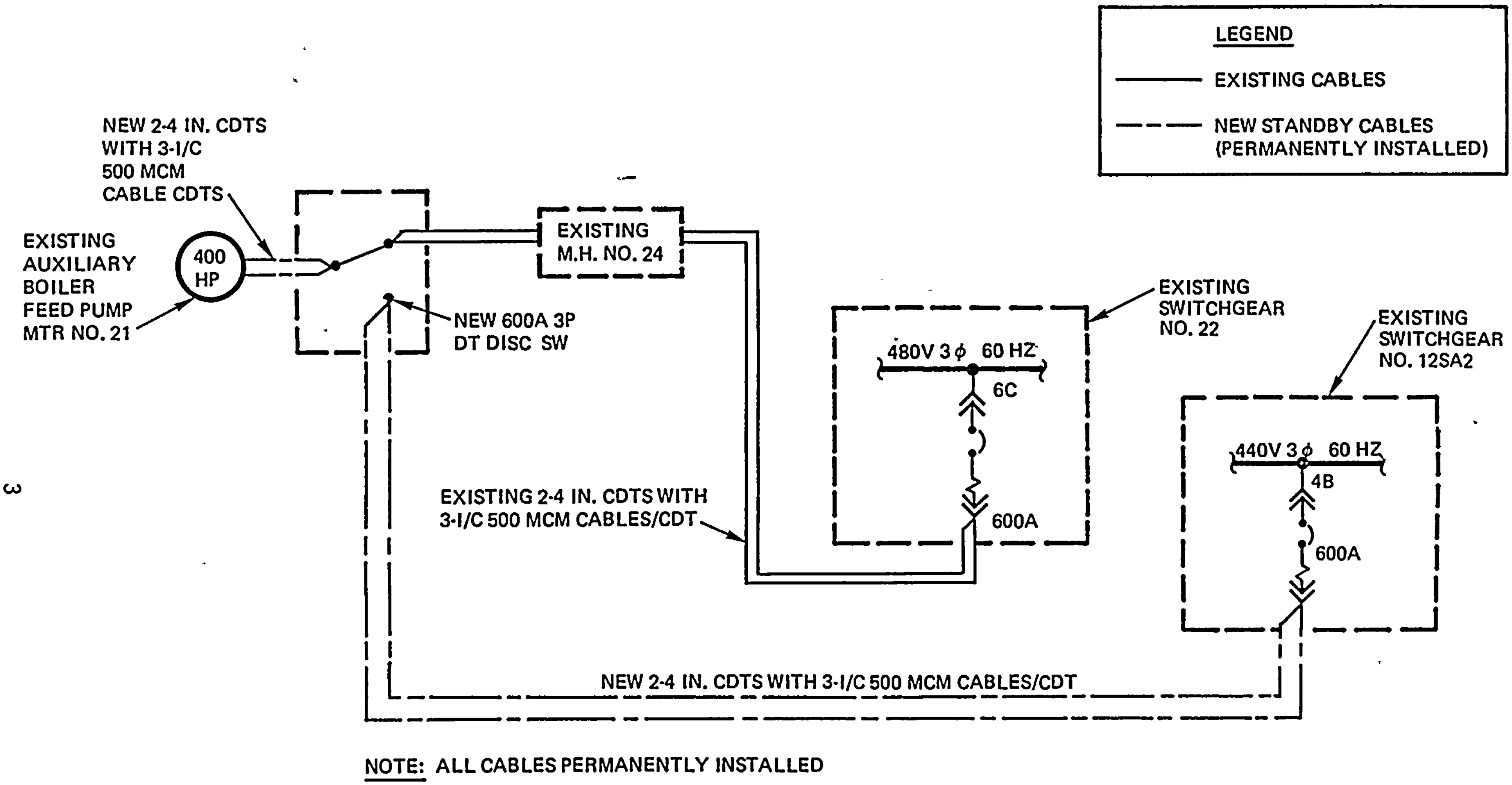


Figure 3. Schematics of the Transfer Switch Installed for AFWS Pump 21 (Indian Point 2)

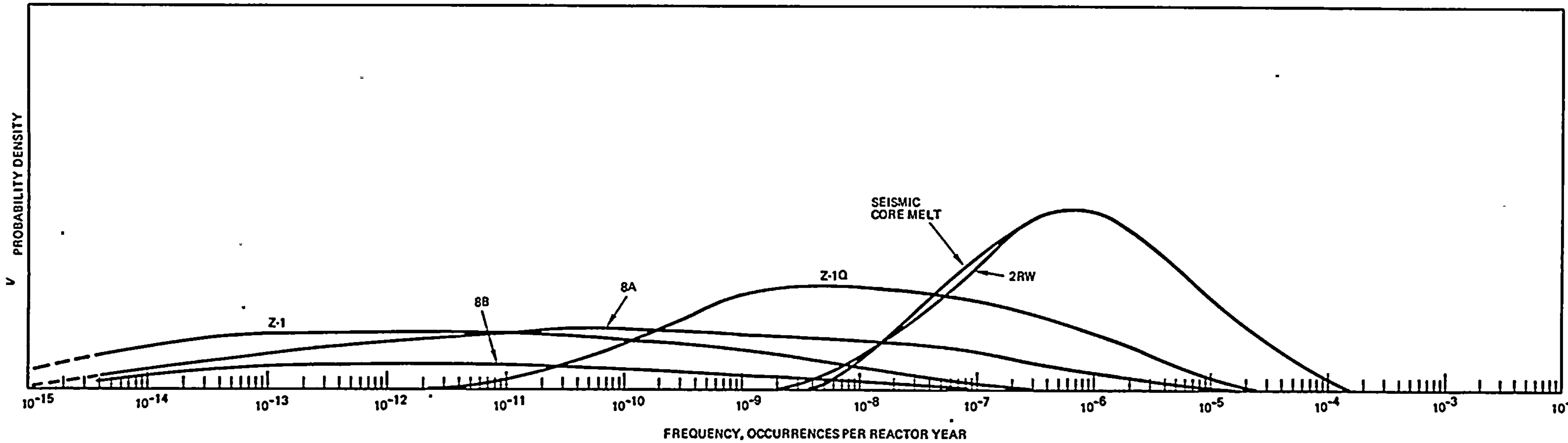


Figure 4. Release Frequency from Seismic Events, Indian Point 2, (After Modification to the Control Building)

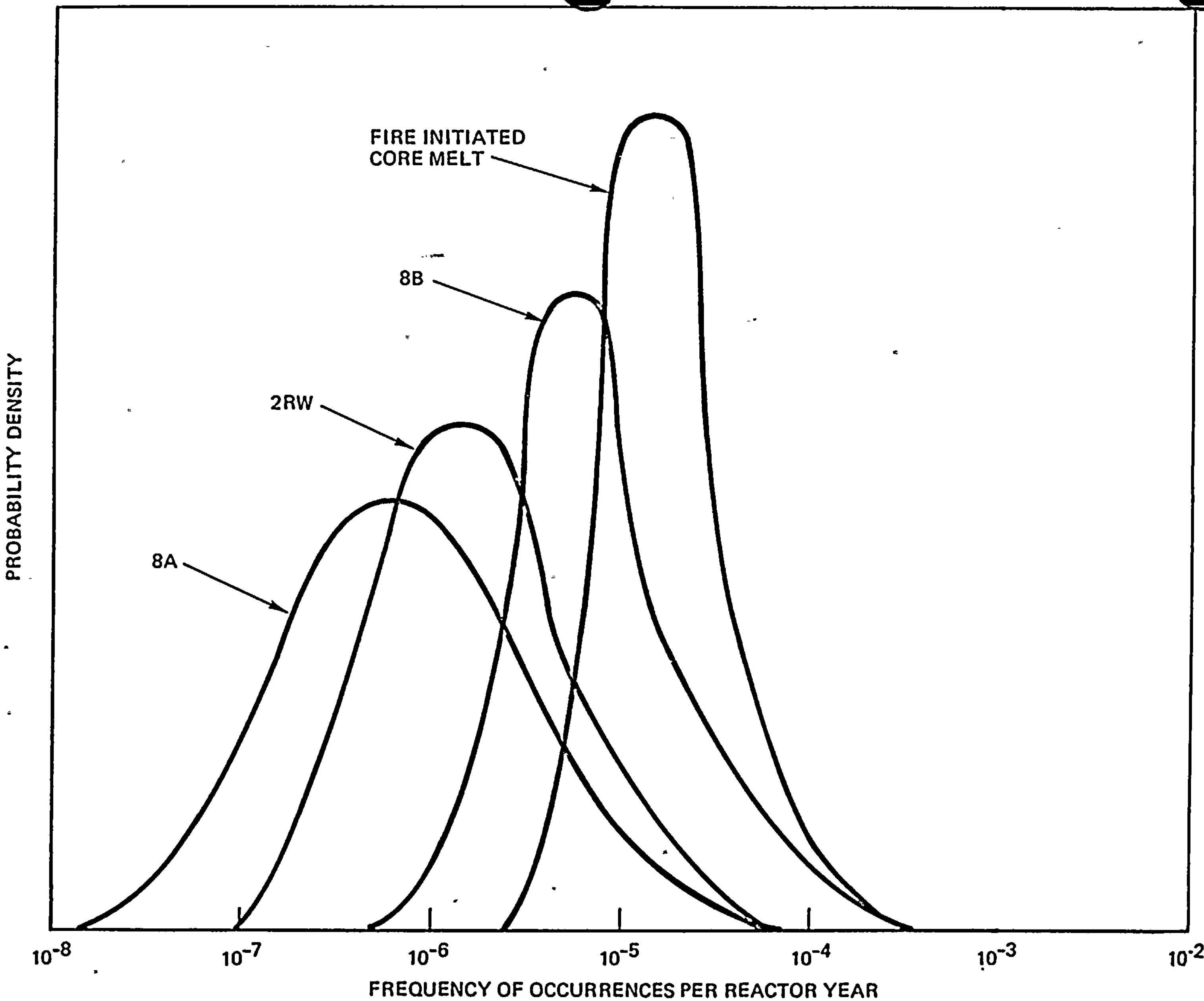


Figure 5. Frequencies of Fire Initiated Releases, Indian Point 2
(After Transfer Switches)

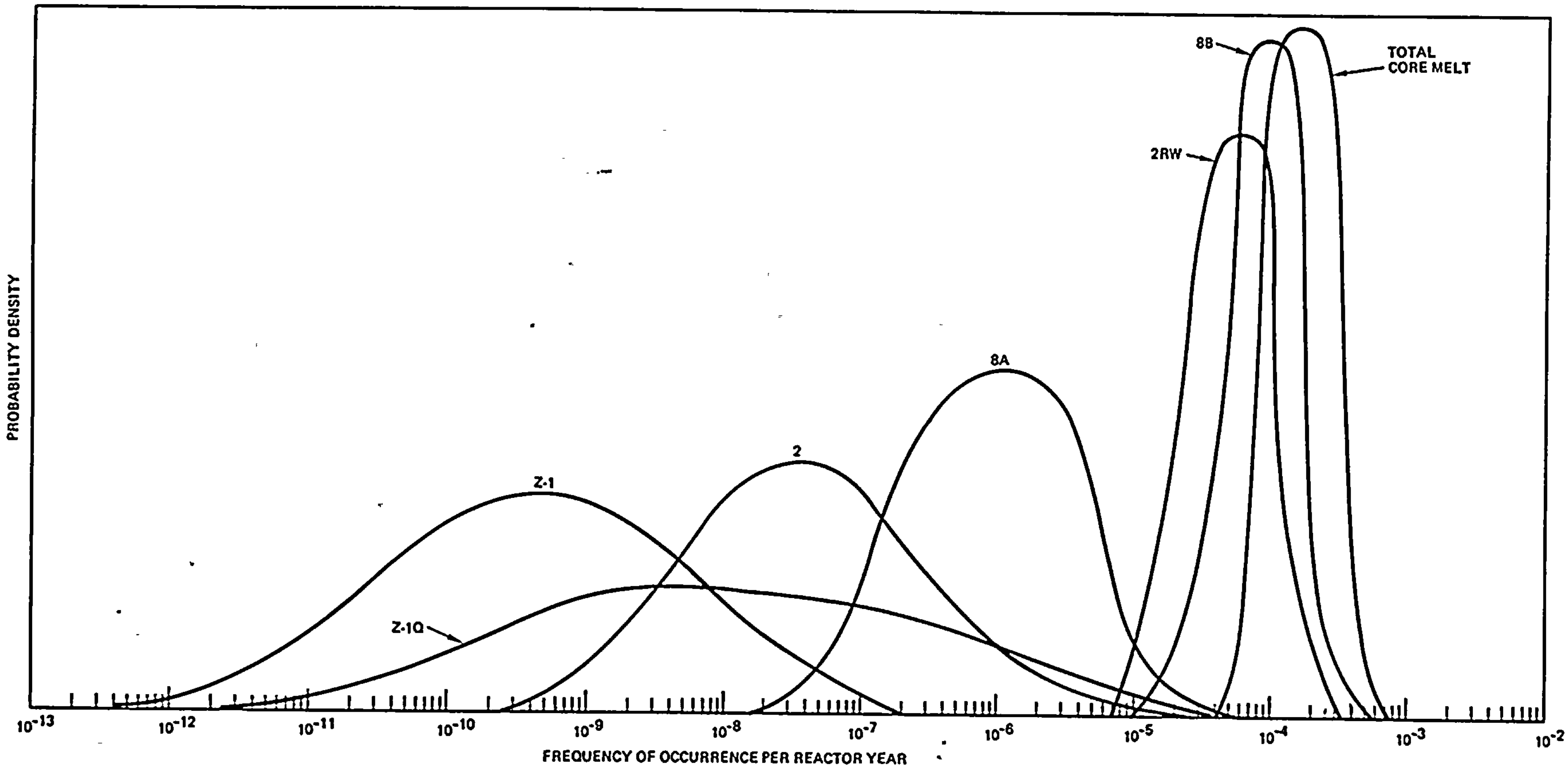


Figure 6. Frequencies of Release Categories, Total From All Sources, Indian Point 2 (After Seismic and Fire Features)

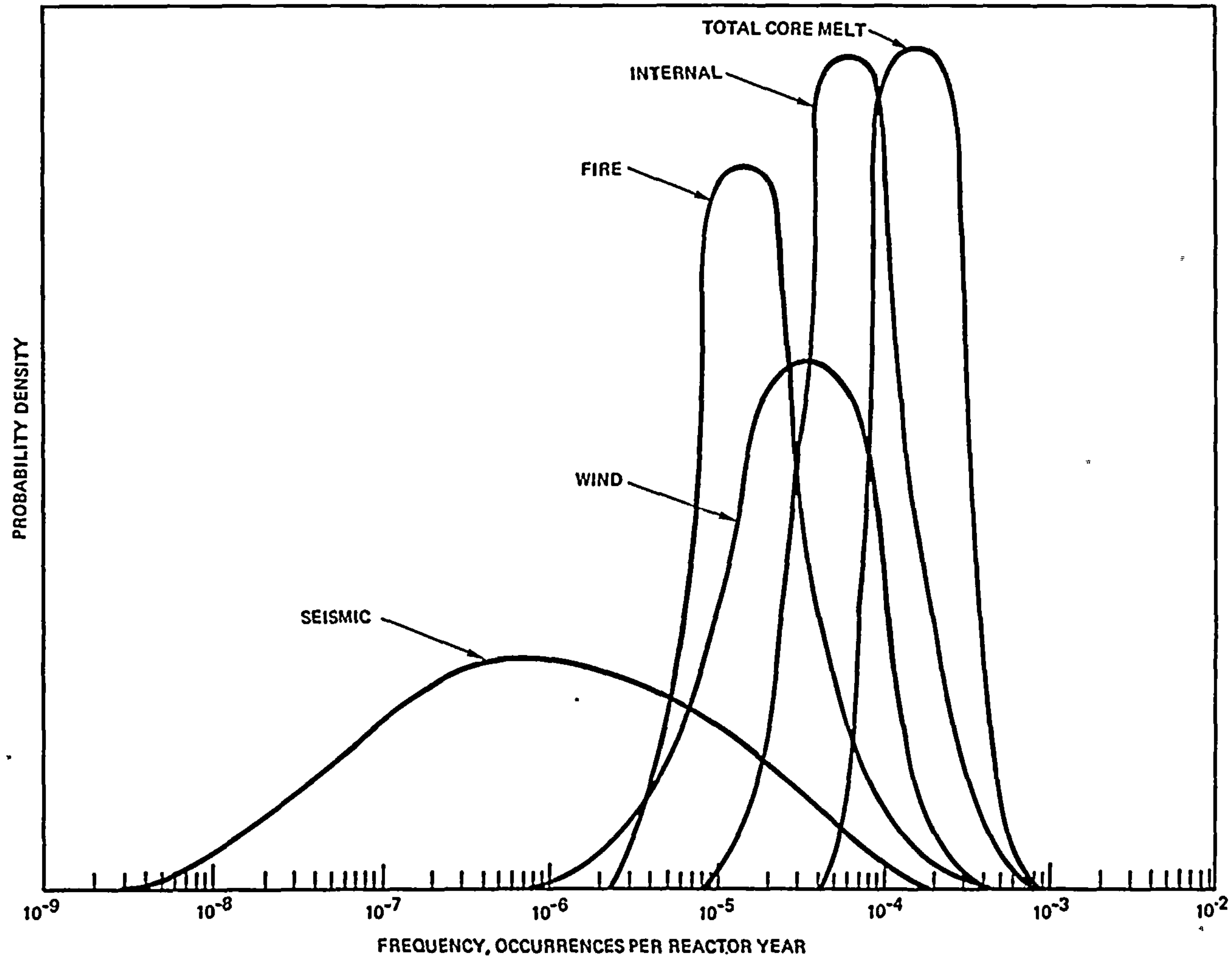
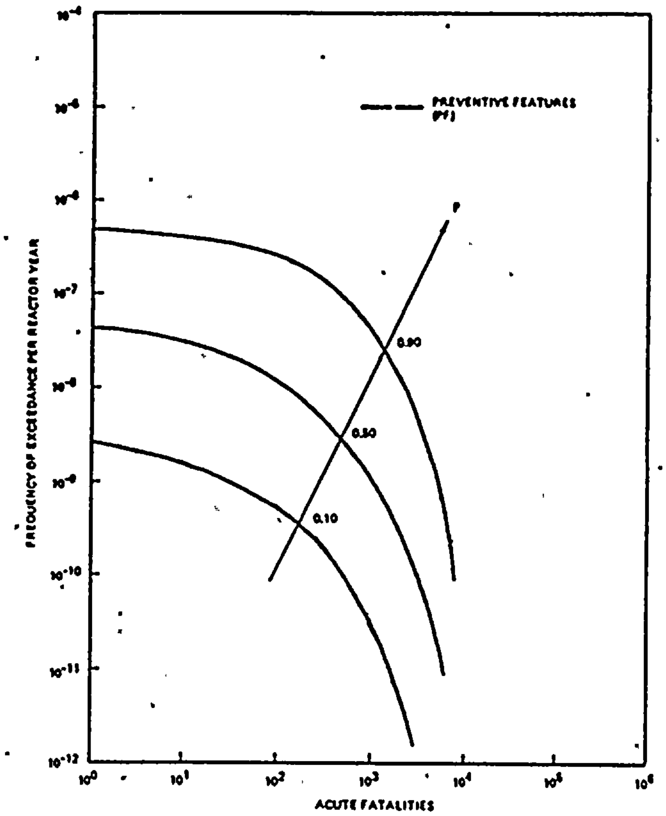
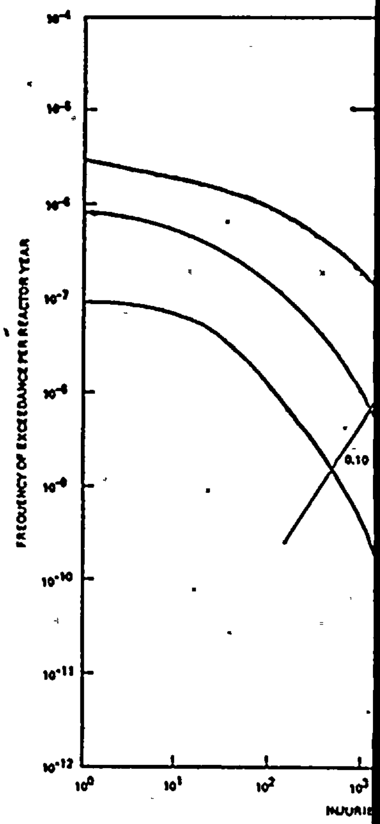
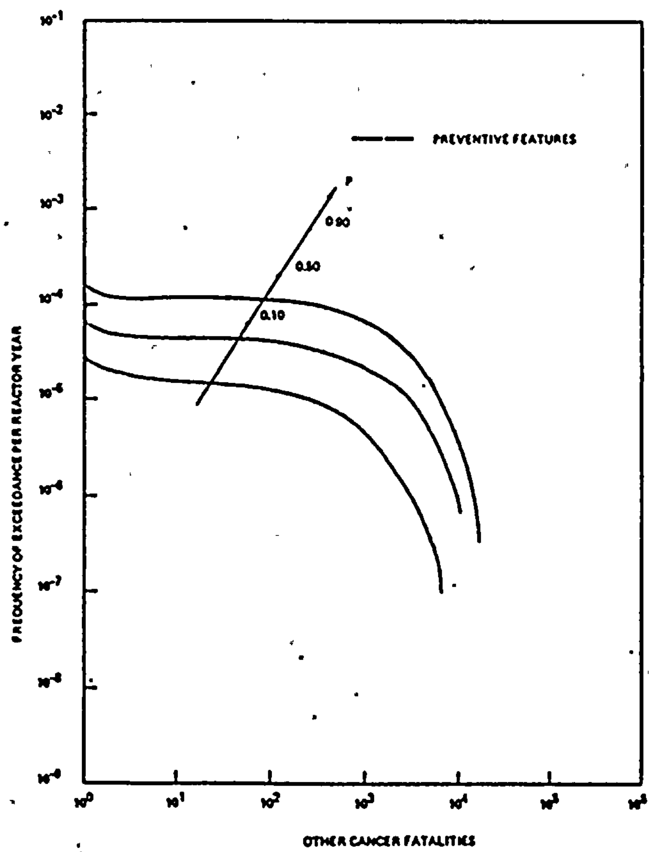
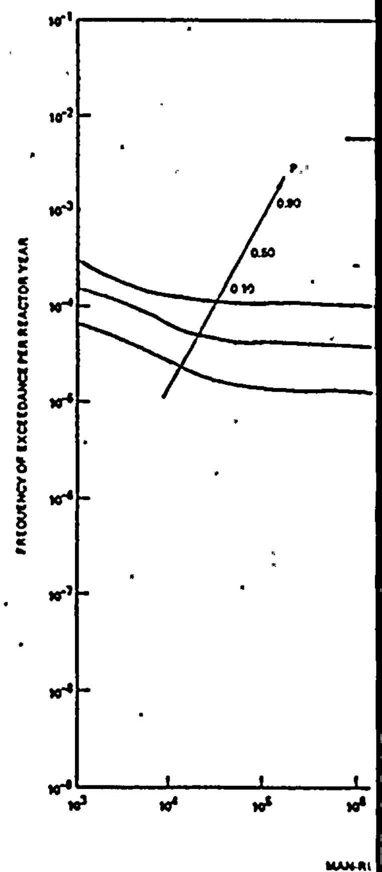


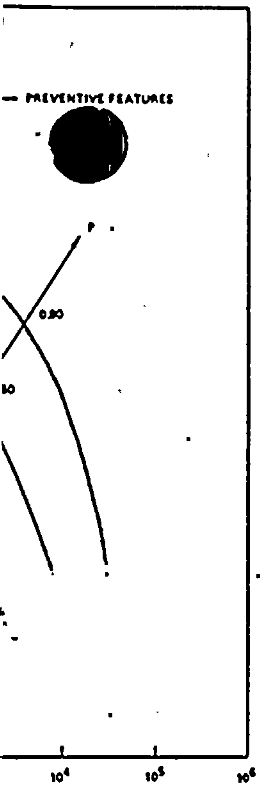
Figure 7. Contribution to Core Melt Frequency From Various Types of Initiating Events, Indian Point 2, (After Seismic and Fire Features)

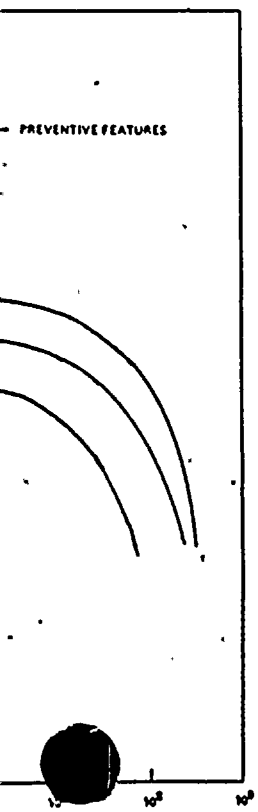

PREVENTIVE FEATURES (PF)
P
0.90
0.50
0.10
FREQUENCY OF EXCEEDANCE PER REACTOR YEAR
ACUTE FATALITIES


0.10
FREQUENCY OF EXCEEDANCE PER REACTOR YEAR


PREVENTIVE FEATURES
P
0.90
0.50
0.10
FREQUENCY OF EXCEEDANCE PER REACTOR YEAR
OTHER CANCER FATALITIES


P
0.90
0.50
FREQUENCY OF EXCEEDANCE PER REACTOR YEAR





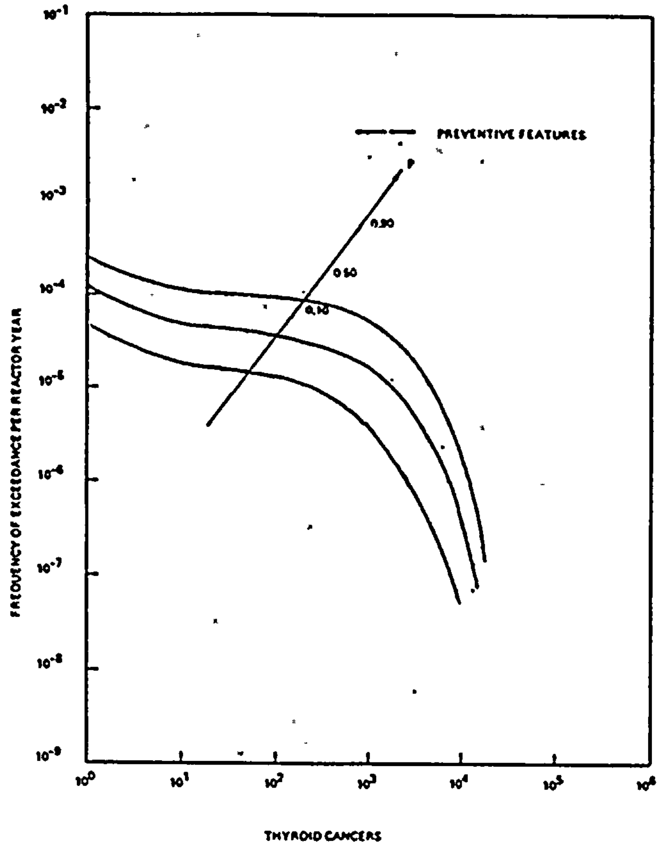


Figure 8. Effect of Combined Features on Public Health Risk, Indian Point 2