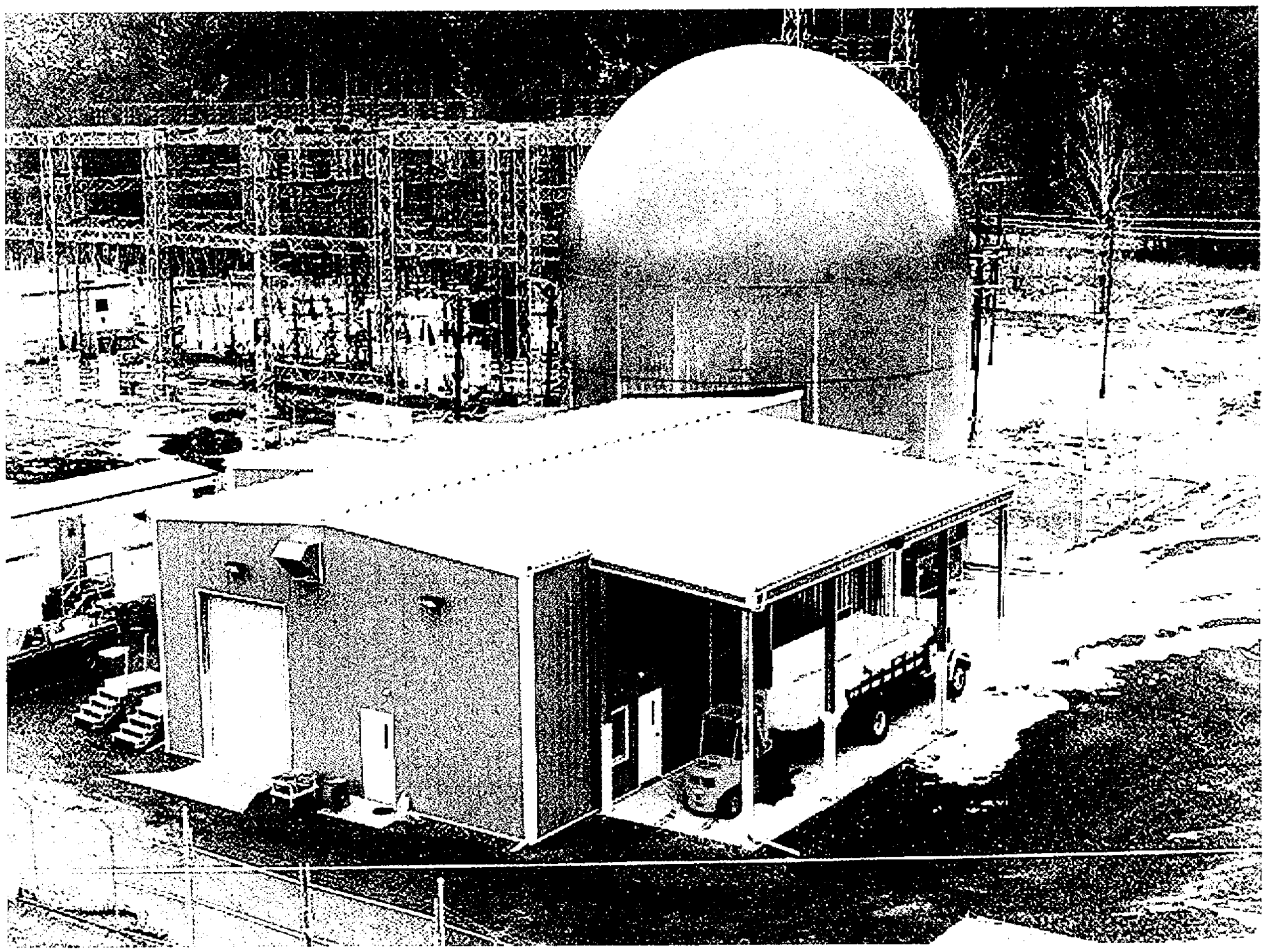
Saxton Nuclear Experimental Corporation Facility

License Termination Plan



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February 2000

Prepared by GPU Nuclear

GPU NUCLEAR

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1920-00-20018
February 2, 2000

U.S. Nuclear Regulatory Agency
Attention: Document Control Desk
Washington. DC 20555

Gentlemen.

Subject: Saxton Nuclear Experimental Corporation (SNEC)
SNEC License Termination Plan (LTP)
Operating License No. DPR-4
Docket No. 50-146

The purpose of this letter is to resubmit the application for the termination of the Saxton Nuclear Experimental Corporation (SNEC) facility license: DPR-4. The original submittal from GPU Nuclear. dated February 23, 1999, was returned by the NRC on April 27, 1999 requesting GPU Nuclear to provide additional information. Public meetings between GPU Nuclear and the NRC were held on July 1, 1999, August 16, 1999 and November 2, 1999. Those meetings constituted a forum in which the GPU Nuclear approach to revising the SNEC LTP could be discussed and consensus sought. GPU Nuclear has incorporated the insights gained from those meetings into the attached LTP. Additionally, included with this submittal are E-size copies of LTP Figures 2-11 and 2-12 to assist in your review.

GPU Nuclear is applying for license termination at this time because it is within two years of completing the decommissioning and remediation activities at the SNEC facility site. Pursuant to the requirements of 10 CFR 50.82(a)(9), this license termination application is accompanied by the facility License Termination Plan which has been designated as Supplement 1 to the SNEC Facility Updated Final Safety Analysis Report.

The license amendment application has been reviewed pursuant to 10 CFR 50.91(a)(1) and an analysis supporting a determination of no significant safety hazards consideration is included.

The License Termination Plan addresses both the criteria of 10 CFR 50.82(a)(9) and 10 CFR Part 20, Subpart E. radiological criteria for unrestricted release of the site.

Pursuant to 10 CFR 50.91(b), a copy of this license amendment application and supporting analysis. which indicates no significant hazards consideration is involved, have been provided to the designated representatives of the Commonwealth of Pennsylvania.

If you have any questions or require additional information regarding this license amendment, please contact Mr. James Byrne at (717) 948-8461.

Sincerely,

G. A. Kuehn, Jr.
Director. SNEC Facility

1. License Amendment Application

GPU Nuclear requests that the following amendment facility license be made to the Saxton Nuclear Experimental Corporation (SNEC) License DPR-4:

2.E. The licensee shall implement the approved SNEC Facility License Termination Plan as approved in the SER dated ______________. The license may make changes to the SNEC Facility License Termination Plan without prior approval provided the proposed changes do not:

(a) involve a change to the Technical Specifications or require NRC approval pursuant to 10 CFR 50.59;

(b) violate the criteria of 10 CFR 50.82(a)(6);

(c) reduce the required final status survey requirements for a specific classification of survey area;

(d) increase the radioactivity level relative to the applicable derived concentration guideline level at which an investigation occurs; or

(e) affect the methodology for statistical treatment of final survey data in a manner that reduces the confidence that the site meets the criteria for unrestricted use.

II. Reasons for the Proposed Changes

SNEC permanently ceased operation of the Saxton facility on May 1, 1972. The objective of the decommissioning of the Saxton facility is to remove the remaining original facility structures and reduce residual radioactivity to the level that permits release of the site for unrestricted use. In accordance with 10 CFR 50.82(a), approval of the License Termination Plan by license amendment is a prerequisite for terminating the license and accomplishing this objective.

The proposed license amendment will ensure that the remainder of decommissioning activities will be performed in accordance with NRC regulations, will not be inimical to the common defense and security or to the health and safety of the public, and will not have a significant effect on the quality of the environment. The License Termination Plan (Attachment 2) conforms to the requirements of 10 CFR 50.82(a)(9). The proposed site release criteria are consistent with the criteria identified of 10 CFR 50.82(a)(9) and 10 CFR Part 20. Subpart E, Section 20.1402.

Overall, the License Termination Plan demonstrates that:

(1) there are adequate funds to complete decommissioning and release the site for unrestricted use,

(2) the site release criteria ensure that exposure to residual levels of radiation is kept As Low As is Reasonably Achievable (ALARA), and

(3) the final status survey will adequately demonstrate that the release criteria have been met.

III. No Significant Hazards Consideration Analysis

The proposed change is necessary to achieve the decommissioning objective of terminating the license and releasing the site for unrestricted use. As such, the proposed change:

1. Will not involve a significant increase in the probability or consequences of an accident previously evaluated since accidents which might occur during the active decommissioning phase of the SNEC facility are bounded by the twelve accidents addressed in section 3.0 of the Updated Safety Analysis Report (USAR). The accident analysis addressed in the USAR demonstrate that no adverse public health and safety impacts are expected from accidents that might occur during decommissioning operations at the SNEC facility. The greater part of radioactively contaminated materials and components originally located in the SNEC facility Containment Vessel are no longer on site, having been shipped as radioactive waste.

   Implementation of the SNEC License Termination Plan involves a continuation of the decommissioning process including the final status survey activity to be performed prior to site closeout at the end of the dismantlement phase. These activities do not involve a significant increase in either the probability or consequences of an accident previously evaluated.

2. Will not create the possibility of a new or different kind of accident from any accident previously evaluated. Accidents previously evaluated in the USAR assess different methods of dispersing radioactive material to the environment, which include a loss of support systems and external events. Remaining dismantlement activities and final status survey work described in the License Termination Plan are similar to those previously performed and will not create the possibility of a new or different kind of accident from any previously evaluated.

3. Will not involve a significant reduction in a margin of safety. The Technical Specifications currently in place at the SNEC facility were developed to safely decommission the SNEC facility. Issuance of the proposed amendment would not

reduce the controls established by the technical specifications for activities performed at the SNEC facility. The proposed License Amendment establishes additional controls to ensure License Termination Plan activities are performed effectively. Thus, this change does not involve a significant reduction in a margin of safety.

IV. Implementation

It is requested that the amendment authorizing this license amendment application be issued expeditiously and become effective as of the date of issue.

SAXTON NUCLEAR EXPERIMENTAL CORPORATION

SAXTON NUCLEAR FACILITY

Operating License No. DPR-4
Docket No. 50-146

SNEC Facility License Termination Plan

COMMONWEALTH OF PENNSYLVANIA)
) SS:
COUNTY OF DAUPHIN)

This information is being provided in regard to the SNEC Facility License Termination Plan. As such, it is submitted in support of Licensee's request to change Appendix A to Operating License No. DPR-4 for Saxton Nuclear Experimental facility.

I, G. A. Kuehn Jr., being duly sworn, state that I am the Vice President Saxton Nuclear Experimental Corporation (SNEC) and Program Director SNEC Facility; that on behalf of SNEC, I am authorized by SNEC to sign, and file with the Nuclear Regulatory Commission, this Application to revise Appendix A and to amend the facility license; that I signed this Application as Vice President of SNEC and Program Director SNEC Facility; and that statements made and the matters set forth therein are true and correct to the best of my knowledge, information and belief.

SAXTON NUCLEAR EXPERIMENTAL CORPORATION

BY: [signature]
Vice President, SNEC & Program Director,
SNEC Facility

[signature] Cynthia J. McElwee

Sworn and Subscribed to before me
This 1st day of February, 2000

Notarial Seal
Cynthia J. McElwee, Notary Public
Londonderry Twp., Dauphin County
My Commission Expires June 5, 2003
Member, Pennsylvania Association of Notaries

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF
SAXTON NUCLEAR EXPERIMENTAL CORPORATION

LICENSE NO. DPR-4
DOCKET NO. 50-146

CERTIFICATE OF SERVICE

This is to certify that the SNEC Facility License Termination Plan, to amend Appendix A to Operating License DPR-4 for the Saxton Nuclear Experimental Corporation Facility as revised, has been filed with executives of Liberty Township, Bedford County, Pennsylvania; Bedford County, Pennsylvania; and the Pennsylvania Department of Environmental Protection, by deposit in the United States mail addressed as follows:

Mr. Donald Weaver, Chairman
Liberty Township Supervisors
R.D. #1
Saxton, PA 16678

Mr. David J. Thompson, Chairman
Bedford County Commissioners
County Courthouse
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Bedford, PA 15522

Director, Bureau of Radiation Protection
PA Department of Environmental Protection
Rachael Carson State Office Bldg., 13th Floor
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Harrisburg, PA 17105-8469
Attn: Kenneth Singh

SAXTON NUCLEAR EXPERIMENTAL CORPORATION

BY: [signature]
Vice President, SNEC &
Program Director, SNEC Facility

DATE: 03/07/00

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1.0 GENERAL INFORMATION

1.1 PURPOSE

The Saxton Nuclear Experimental Corporation (SNEC) Facility License Termination Plan (LTP) has been prepared in accordance with the requirements of 10 CFR 50.82, "Termination of License" (Reference 1-1) and the guidance provided in Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors" (Reference 1-2). The SNEC Facility License Termination Plan is maintained as a supplement to the SNEC Facility Updated Final Safety Analysis Report (USAR) (Reference 1-3) in accordance with 10 CFR 50.82(a)(9)(i).

This plan demonstrates that the remainder of the decommissioning activities at the SNEC Facility site will be performed in accordance with the regulations in 10 CFR 50.82; and will not be inimical to the common defense and security nor to the health and safety of the public; and will not have a significant effect on the quality of the environment.

1.2 HISTORICAL BACKGROUND

The Saxton Nuclear Experimental Corporation (SNEC) facility, is a deactivated pressurized water reactor (PWR), which was licensed to operate at 23.5-megawatt thermal (23.5 MWTh). It is owned by the Saxton Nuclear Experimental Corporation (SNEC) and is supported by GPU Nuclear Inc. The SNEC Facility is maintained under a Title 10 Part 50 License and associated Technical Specifications. In 1972, the license was amended to possess but not operate the SNEC reactor.

The facility was built from 1960 to 1962 and operated from 1962 to 1972 primarily as a research and training reactor. After shutdown in 1972, the facility was placed in a condition equivalent to a status later defined by the NRC as SAFSTOR. Since then, it has been maintained in a monitored condition. The fuel was removed from the Containment Vessel (CV) in 1972 and shipped to the Atomic Energy Commission (AEC) (now Department of Energy) facility at Savannah River, SC., who remains as owner of the fuel. As a result, neither SNEC nor GPU Nuclear has any responsibility relative to the spent fuel from the SNEC Facility. In addition, the control rod blades and the superheated steam test loop assemblies were shipped off-site. Following fuel removal, equipment, tanks, and piping located outside the CV were removed. The buildings and structures that supported reactor operations were partially decontaminated from 1972 through 1974.

Details of the SNEC Facility History are provided in Section 2.2.1 of this LTP.

1.3 PLAN SUMMARY

This SNEC Facility License Termination Plan describes the process by which decommissioning will be completed and the SNEC Facility site released for unrestricted use. The plant activities described in the SNEC Facility License Termination Plan are consistent with the activities that already may be conducted under the approved SNEC Facility Technical Specifications. The following subsections provide a brief summary of the chapters presented in the License Termination Plan.

1.3.1 Summary Of Chapter 1 – General Information

This chapter provides the purpose of and regulatory basis for the SNEC Facility License Termination Plan, as well as a brief overview of each chapter contained in the plan.

1.3.2 Summary Of Chapter 2 – Site Characterization

In accordance with 10 CFR 50.82(a)(9)(ii)(A), this chapter provides a description of the radiological conditions at the SNEC Facility site. The SNEC Facility site characterization incorporates the results of scoping and characterization surveys conducted to quantify the extent and nature of contamination at SNEC Facility. The results of the scoping and characterization surveys have been and continue to be used to identify areas of the site that will require remediation, as well as to plan remediation methodologies and costs.

1.3.3 Summary Of Chapter 3 – Identification Of Remaining Site Dismantlement Activities

In accordance with 10 CFR 50.82(a)(9)(ii)(B), this chapter identifies the major dismantlement and decontamination activities that remain at SNEC Facility. This information includes those areas and equipment that need further remediation to allow an estimation of the radiological conditions that may be encountered during remediation of equipment, components, structures, and outdoor areas.

The majority of radiologically contaminated systems and components have been dismantled and dispositioned as radioactive waste.

1.3.4 Summary Of Chapter 4 – Remediation Plans

In accordance with 10 CFR 50.82(a)(9)(ii)(C), this chapter describes how remediation actions may be applied to various areas on the SNEC Facility site, identifies likely remediation methodologies to be used, and demonstrates that the remediation methodologies are adequate to ensure that the site release criteria of 10 CFR 20.1402 are met. Verification of the site release criteria is detailed further in Chapter 5, Final Survey Plan.

1.3.5 Summary Of Chapter 5 – Final Survey Plan

In accordance with 10 CFR 50.82(a)(9)(ii)(D), the SNEC Facility Final Survey Plan describes the methods and criteria that will be used to demonstrate that the SNEC Facility site meets the radiological release criteria for unrestricted use specified in 10 CFR 20.1402. This plan includes a description of control measures implemented in accordance with approved plant procedures to preclude the recontamination of clean areas. The SNEC Facility Final Survey Plan also incorporates measures to ensure that final survey activities are planned and discussed with the Nuclear Regulatory Commission sufficiently in advance to allow the scheduling of inspection activities.

1.3.6 Summary Of Chapter 6 – Compliance With The Radiological Criteria For License Termination

The decommissioning objective at the SNEC Facility site is to reduce residual radioactivity to a level that permits release of the site for unrestricted use. In accordance with 10 CFR 20 and Regulatory Guide 1.179, this chapter and Chapter 5, Final Survey Plan, demonstrate that the radiological criteria of 10 CFR 20.1402 for unrestricted release will be met.

1.3.7 Summary Of Chapter 7 – Updated Site-Specific Estimate Of Remaining Decommissioning Costs

In accordance with 10 CFR 50.82(a)(9)(ii)(F), this chapter provides an updated site-specific estimate of decommissioning costs, a comparison of these estimated costs with the present funds set aside for decommissioning, and a description of the means for ensuring adequate funds to complete decommissioning.

1.3.8 Summary Of Chapter 8 – Evaluation Of Environmental Effects Of License Termination

In accordance with 10 CFR 50.82(a)(9)(ii)(G), this chapter compares the impacts associated with SNEC Facility site-specific license termination activities as described in the SNEC Facility License Termination Plan with previously analyzed termination activities in the SNEC Facility Environmental Report. The evaluation in this chapter finds that the activities described in the SNEC Facility License Termination Plan result in no significant environmental changes not bounded by the NRC's Generic Environmental Impact Statement. This evaluation satisfies the requirement of 10 CFR 51.53(d)(Reference 1-4), to reflect any new information or significant environmental changes associated with proposed decommissioning activities. Additionally, a revision to the SNEC Facility Environmental Report is submitted to document the current conditions at the SNEC Facility site.

1.4 REFERENCES

1-1 Code of Federal Regulations, Title 10, Part 50.82, "Application for Termination of License."

1-2 Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," January 1999.

1-3 SNEC Facility USAR

1-4 Code of Federal Regulations, Title 10, Part 51.53, "Post-Operating License Stage Environmental Reports."

2.0 SITE CHARACTERIZATION

2.1 INTRODUCTION

2.1.1 Purpose

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(A), (Reference 2-1) and guidance contained in USNRC Regulatory Guide 1.179 (Reference 2-2), this chapter of the SNEC License Termination Plan (LTP) provides a description of the radiological conditions at the SNEC Facility site and its immediate surroundings. The main goal of SNEC Facility characterization activities has been to determine the nature and extent of radiological contamination of the site and where appropriate the immediate surroundings. Extensive soil characterization efforts were undertaken in 1994 in support of the SNEC Soil Remediation Project. These results were provided to the NRC in the "1994 Saxton Soil Remediation Project Report" (Reference 2-3). Characterization of the remaining SNEC Facility structure, the Containment Vessel (CV), which housed the reactor pressure vessel (RPV) and associated Nuclear Steam Supply System (NSSS) components, was completed in 1996 and documented in the report, "SNEC Facility Site Characterization Report" (Reference 2-6). This report was provided to the NRC in July 1996. The environmental radiological status of the site and surrounding environment was provided to the NRC in the SNEC Decommissioning Environmental Report, April 1996 (Reference 2-29).

Supplemental characterization has taken place from 1996 to present and will continue through remediation and during final status survey activities. The characterization information provided in the LTP is intended to show the current radiological status of the SNEC Facility. As such, information on areas that have been remediated is current. Information on systems, components and structures, which have been removed, is not provided in this plan.

2.1.2 Site Characterization Methodology

The purpose of this chapter (2.0) is to describe the results of radiological surveys that have been conducted to characterize the extent and magnitude of contamination at the SNEC facility. Characterization data has been used to classify areas as to the magnitude of radiological impact for Final Status Survey and to guide remediation efforts. General findings are presented and explanation as to the impact on remediation is given.

Surveys and sampling work performed during characterization activities have been conducted using guidance provided by SNEC procedure No. 6575-PLN-5420.06, "SNEC Site Characterization Plan" (Reference 2-4). In addition, field use documents such as SNEC facility "Station Work Instructions" were prepared to obtain samples and provide specific instructions to survey personnel (Reference 2-5). Field and laboratory instruments are calibrated and operated in accordance with written procedures.

Extensive preremediation characterization survey and sampling results are presented in the "SNEC Facility Site Characterization Report" (Reference 2-6) submitted to the NRC, July 1996. The majority of the scoping, characterization surveys, and sample collections were performed at the SNEC facility from May1994 through 1997. However, earlier survey results were reviewed to plan characterization activities. Continued sampling and survey work have been necessary to accurately estimate the type and amount of radioactive material for waste disposal and shipping purposes and to satisfy the information needed for continued remediation. Site characterization surveys and sampling efforts, further defining the extent and magnitude of contamination at the SNEC facility, will continue throughout the decommissioning process.

2.1.3 Data Use

The results of scoping and characterization surveys were used to identify areas of the site that may require remediation. Contamination levels were compared against guideline values to determine if the resulting dose under a given scenario would exceed the site release criteria of ≤25 mrem/year. NUREG-1575 (Reference 2-7) defines these guideline values as Derived Concentration Guideline Levels (DCGL's). For individual radionuclides, DCGL's will generally be derived from the RESRAD, or DandD computer codes as described in CHAPTER 6.0. Other regulatory guidance documents may also be used to define initial estimates. Site characterization survey results have been used in accordance with NUREG-1575 to classify final status survey areas as "Impacted Class 1, 2 or 3" or as "non-impacted". Area classifications are shown in Figure 5-1, these classifications will dictate the survey measurement frequency for final status surveys. Further discussion of area classification is contained in CHAPTER 5.0.

2.2 SNEC FACILITY RADIOLOGICAL STATUS

2.2.1 SNEC Facility History

The Saxton Nuclear Experimental Corporation (SNEC) facility, is a deactivated pressurized water reactor (PWR), which was licensed to operate at 23.5-megawatt thermal power (23.5 MWTh). It is owned by the Saxton Nuclear Experimental Corporation (SNEC) and is supported by GPU Nuclear. The SNEC facility is maintained under a Title 10 Part 50 License and associated Technical Specifications. In 1972, the license was amended to possess but not operate the SNEC facility reactor.

The facility was built from 1960 to 1962 and operated from 1962 to 1972 primarily as a research and training reactor. Three fuel cycles were completed with a total of 1,005.16 effective full power days accumulated. After shutdown in 1972, the facility was placed in a condition equivalent to a status later defined by the NRC as "SAFSTOR". Since then, it has been maintained in a monitored condition. The nuclear fuel was removed from the Containment Vessel (CV) in 1972 and shipped to the Atomic Energy Commission (now U.S. Department of Energy) facility at Savannah River, SC., who remains as the owner of the fuel. Therefore, neither SNEC nor GPU Nuclear has any responsibility relative to the spent fuel from the SNEC facility. In addition, the control rod blades and the superheated steam test loop assemblies were shipped off-site. Following fuel removal, equipment, tanks, and piping located outside the CV were removed. The buildings and structures that supported reactor operations were partially decontaminated from 1972 through 1974. The radiological condition of the facility following shutdown was documented in a report titled "Decommissioned Status of the SNEC Reactor Facility" (Reference 2-8) forwarded to the United States Nuclear Regulatory Commission (NRC) on February 20, 1975.

After the formation of the GPU Nuclear Corporation in 1980, SNEC entered into an agreement with GPU Nuclear to use GPU Nuclear and its resources to maintain, repair, modify, or dismantle SNEC facilities as may be required. Both SNEC and GPU Nuclear are subsidiaries of the same parent company, General Public Utilities Inc., (GPU). While SNEC remains the owner of the facility, a license amendment has been approved designating GPU Nuclear as a co-licensee. GPU Nuclear has responsibility to comply with the license and associated Technical Specifications. GPU Nuclear is carrying out the SNEC facility decommissioning on behalf of the site owner, SNEC.

Decontamination of reactor support structures and buildings was performed in 1987, 1988, and 1989, in preparation for demolition of these structures. This included the decontamination of the Control and Auxiliary Building, the Radioactive Waste Disposal Facility, yard pipe tunnel, the Filled Drum Storage Bunker, and the removal of the Refueling Water Storage Tank. A comprehensive final release survey was conducted from October 1988 to June 1989, to verify that residual contamination was within NRC guidelines for unrestricted use. The final release survey was conducted using the guidance contained in NUREG/CR-2082 (Reference 2-9). Details of the decontamination activities and final survey results were provided to the NRC in the report: "Final Release Survey of Reactor Support Buildings" (Reference 2-10). The NRC contracted with Oak Ridge Associated Universities (now the Oak Ridge Institute for Science and Education) to perform a confirmatory radiological survey in support of their review of the GPU Nuclear final survey. Their report, "Confirmatory Radiological Survey for Portions of the Saxton Nuclear Experimental Facility, Saxton, Pa.", dated June 1991 (Reference 2-11), provides additional radiological information.

In concert with these decommissioning activities, the NRC suggested and GPU Nuclear agreed to contact the U. S. Department of Energy (DOE) to study the feasibility of performing an aerial survey of the SNEC Facility and the surrounding area. At the request of GPU Nuclear, DOE contracted EG&G Energy Measurements to perform *in situ* soil surveys to determine the feasibility of an aerial survey. This work was completed in June 1988 and reported in Reference 2-27. The *in situ* surveys showed no indication of Cs-137, the predominant nuclide, at levels greatly above background. The study recommended additional *in situ* measurements rather than an aerial survey but did say that an aerial survey might be useful in assuring that no significant localized contamination exists as a result of bulk removal of contaminated material from the site. The NRC then requested that DOE have an aerial survey performed. DOE again contracted with EG&G Energy Measurements to perform an aerial survey over the SNEC facility and the surrounding area. This survey was performed in July 1989 and covered an 83-square-kilometer area around the plant. The results were reported in Reference 2-28. This report concluded that, "The Cs-137 activity inferred from aerial data was within the limits of the deposition of worldwide fallout. No other man-made contaminates were detected in the survey area."

The reactor support buildings and structures were demolished in 1992, following acceptance of the final release survey and revision of the Technical Specifications by the NRC. Subsequent pathways analysis of the demolished structures was performed in an effort to correlate their release, which was made under the guidance of NUREG/CR-2082 and REGULATORY GUIDE 1.86 (Reference 2-12), with current dose based criteria (≤25mrem/yr. all pathways). The most conservative radionuclide mix present was used and the demolished building surface areas were assumed to be contaminated to the limit of REGULATORY GUIDE 1.86 for the radionuclide mix present. The pathways analysis was performed using the computer code RESRAD 5.82 (Reference 2-22) with site specific parameters. This conservative analysis results in a 1,000 year Total Effective Dose Equivalent (TEDE) of 3.5×10^{-2} mrem/yr. This is well below the current criteria of ≤25mrem/yr (Reference 2-19).

In November 1994, the SNEC Soil Remediation Project was completed. This was a comprehensive project involving soil surveys, sampling, excavation, packaging and shipment of slightly contaminated site soil. This program successfully reduced radioactive soil contamination levels over the majority of the site to less than NRC current and presently proposed levels required to meet site cleanup criteria for unrestricted use. The project involved extensive surface (0-15cm) and subsurface soil sampling in preparation for remediation. The report of this work, titled "1994 Saxton Soil Remediation Project Report" was forwarded to the NRC, July 1995 (Reference 2-3).

From 1996 through 1997, site preparations were made to support full scale decommissioning efforts. Support systems such as temporary power, compressed air, HEPA filtered exhaust ventilation and lighting were installed. The Decommissioning Support Facility (DSF) was erected south of the Containment Vessel (CV) and was physically connected to the CV. The site layout has not changed appreciably since that time and is shown in detail in Figures 2-11 and 2-12.

The NRC approved the start of full scale decommissioning in April 1998 and operations began in May 1998. Up to that time selected loose materials, spare components, asbestos insulation and electrical components had been removed with the NRC's permission. Following approval in April 1998, the main focus of decommissioning efforts was on making all necessary preparations for the removal of the nuclear steam supply system components, namely the reactor pressure vessel, the single steam generator, the pressurizer and the main coolant pump.

The SNEC Large Component Removal Project (LCRP) was completed November 22, 1998. This involved the preparation, removal, packaging, shipment and disposal of the SNEC Facility Pressurizer (PZR) Steam Generator (S/G) and Reactor Pressure Vessel (RPV). Project planning began in June 1997; the major project milestones are listed below:

- Shipment exemption submittal to USDOT – June 1998
- Remove RPV from CV – October 14, 1998
- Remove S/G from CV – October 16, 1998
- Remove PZR from CV – October 23, 1998
- USDOT approval of exemption application – October 30, 1998
- Road shipment of PZR & S/G to rail siding – November 2, 1998
- Road shipment of RPV to rail siding – November 3, 1998
- All three components depart by train for Barnwell SC – November 16, 1998
- The train carrying the three components arrives at the Chem-Nuclear Systems Waste Consolidation Facility in Barnwell SC – November 20, 1998
- All three components placed in their permanent place in the disposal trench – November 22, 1998

All three vessels were shipped as low specific activity (LSA) packages "or equivalent" under 49 CFR 173. The radiological aspects of the shipment met the "normal conditions of transport" as defined by 49 CFR 173. The shipment of these components removed over 85% of the estimated site radioactive material inventory.

Following removal and shipment of the SNEC Facility large components, decommissioning activities focused on the removal and shipment of the remaining permanent mechanical and electrical equipment, systems and components. This work was completed by May of 1999. All permanent mechanical and electrical systems and components have been removed and shipped off-site for processing/disposal in accordance with all applicable regulations. The only remaining systems are the floor drains in the Containment Vessel and small piping system sections where they penetrate walls, floors and ceilings and site storm drains. The piping remnants will be removed and disposed of. Site storm drains have been radiologically characterized and will be included in the Final Status Survey.

Since May 1999, the focus has been on Containment Vessel concrete remediation work. As of the date of this submittal, over 73% of the concrete surfaces in the Containment Vessel have had their surfaces scabbled to remove a thin layer of concrete and the associated surface layer of contamination. In addition to surface scabbling, more aggressive techniques are being employed in areas of cracks, penetrations, and in areas where poor concrete conditions exist. Diamond wire sawing and core boring have been and are continuing to be employed to remove larger and deeper areas of concrete.

Table 2-1 lists the estimated total site radionuclide inventory as of the date of this submittal.

2.2.2 Effluents

During the operational period from 1962 through 1972 and the period of decommissioning from 1972 through 1974, radioactive liquid and airborne effluents were released in accordance with the Plant Technical Specifications. Airborne effluents were released via an elevated stack through a high efficiency particulate air filtration system. Liquid discharges were via the former Saxton Steam Generating Station discharge tunnel, the SNEC Facility sewage treatment system and storm drain outfall to the Raystown branch of the Juniata River. Effluent releases made during this period were quantified and reported to the Atomic Energy Commission (AEC).

Effluent releases stopped until decommissioning efforts resumed in late 1986. At that time 205,800 gallons of slightly contaminated groundwater from the below grade structures was batch released to the Raystown branch of the Juniata River, this release was completed in January 1987. A total of 115 μCi of Cs-137 was discharged (Reference 2-20).

With the resumption of full scale decommissioning activities in May 1998, airborne effluent releases resumed in accordance with the plant Technical Specifications and the SNEC Offsite Dose Calculation Manual (Reference 2-13). In 1998, gaseous releases from the facility resulted in the following discharges (**curies**):

Co-60	Cs-137	Cs-134	Sb-125	Sr-90	Gross Alpha	H-3
0	1.39E-07	0	0	2.17E-07	0	8.42E-05

Data for 1999 is not available as of the date of this submittal.

No liquid effluent discharges have been made since decommissioning began in 1998.

2.2.3 Operational Events

GPU Nuclear has performed an extensive review of operational events to determine those which could possibly impact decommissioning and unrestricted release of the facility. Primary sources used to determine the SNEC Facility radiological history were plant operating logs and reports, correspondence files, periodic and event reports to the AEC and NRC, press releases, interviews and written questionnaires of plant operating and maintenance personnel. Much greater detail on the historical situation of the facility is presented in the SNEC Facility Historical Site Assessment (Reference 2-14).

The following is a listing of events in chronological order, which have had an impact on the decommissioning of the SNEC Facility site:

Event	Date
Initial Criticality	April 13, 1962
First Electricity Generated	November 16, 1962
Unplanned gas release, <0.002 Curies	August, 1963
Liquid Spill Outside SI Pump House (~1 gal., ~10uCi's)	November 26, 1968
Storage Well Leaks, Possibly Resulting In Extensive Contamination of Internal CV Concrete Structures	1968 Through 1973
Unplanned Gas Releases	
7.32 Curies	May 14, 1970
0.034 Curies	August 26, 1970
80.2 Curies	November 29, 1971
19.7 Curies	December 15, 1971
Experiments With Mixed Oxides Fuel, Fuel Cladding Intentionally "Failed" (Last Fuel Cycle)	December 1969-May 1972
Final Shutdown	May 1, 1972
Nuclear Fuel and Other Removable "Special Nuclear Materials" Shipped Off Site	July - November, 1972
By-Product Material Removed From Site (With Exception of Material in Exclusion Areas)	November 1972-Early 1974
Facility Placed In A "SAFSTOR" Condition	February 1975
Groundwater Removed From RWDF and Yard Pipe Tunnel (115μCi of Cs-137)	Late 1986–January 1987
Event	**Date**
Decontamination of Control & Auxiliary Building RWDF, RWST, and Yard Pipe Tunnel	1987 & 1988
Final Release Survey of C&A Building, RWDF, RWST, and Yard Pipe Tunnel	October 1988-June 1989
EG&G/DOE *in-situ* Soil Survey	July 1988
Pennsylvania State University Soil Characterization	December 1988–January 1989

EG&G/DOE Aerial Survey .... July 1989

Comprehensive Radiological Survey of CV (Scoping Survey) 1991

Demolition of C&A Building, RWDF, RWST Pad and Yard Pipe Tunnel .... May 1992–October 1992

Soil Remediation Project .... June 1994-November 1994

Site Characterization of CV & Remaining Facilities .... 1995 - Present

Construction of Decommissioning Support Facility (DSF) .... August 1996-November 1996

Asbestos Abatement Program .... August 1996 - March 1997

Removal of Non-System Related Loose Materials and Electrical Components in CV .... July-September 1997

Installation of CV Ventilation System .... March 1997 - May 1998

Large Component Removal Project (LCRP) .... March 1997-November 1998

NRC Approval of License Amendment - Start of Decommissioning .... April 1998

Complete Mechanical and Electrical Systems and Component Removal .... May 1998 – May 1999

CV Concrete Remediation .... May 1999 - Present

Characterization to support LTP & MARSSIM .... June 1999 - Present

Remediation & Survey of Remaining Site Facilities & the CV .... Late 1999 to 2001

Of these events, the liquid spill in 1968, the storage well leaks from 1968 to 1973 and the failed fuel experiments from 1969 to 1972 have had the most adverse effect on the site from a radiological perspective.

The liquid spill and likely other non-documented spill events contributed to the widespread soil contamination found in and around the site. Some staged radwaste packages stored for shipment leaked leading to additional soil contamination. As late as 1992 some areas of soil contamination were as high as 10 mrem/hr.

The reactor storage well and spent fuel pool leaks from 1968 to 1973 have occurred through cracks and construction defects in the CV concrete. Since the spent fuel pool and reactor storage well (a common area) is not lined, this allowed leakage to penetrate the concrete surface wherever a crack or surface defect occurred. Contamination has migrated completely through the eighteen-inch (18") thick concrete outer wall of the reactor storage well and spent fuel pool in several locations. The CV outer steel liner prevents further migration into the environment. The four foot six inch (4'-6") inner wall dividing this area from the auxiliary and primary compartments is extensively cracked and had areas of poorly placed concrete. This has lead to extensive contamination through the wall in numerous locations. Other wetted surfaces such as the CV sump do not appear to have significant subsurface contamination.

The failed fuel experiments conducted from December 1969 through plant shut down in May 1972 caused extensive fission product inventory to be distributed through the facility. Since the later fuel loading included "mixed oxide" fuel containing plutonium oxide, the facility has an elevated level of transuranic contamination present, more so than that which would be expected at a conventional nuclear power plant.

Since plant shutdown in May 1972, site decommissioning efforts have significantly reduced the radioactive contamination onsite. The remaining inventory of radioactive materials consists mainly of contaminated and activated concrete in the CV, low level contaminated soil in and near the site, and ground water and sediment in two tunnels. The CV interior concrete was contaminated and activated from operation of the reactor and remediation is in progress. The following section describes in more detail the specific radiological conditions of the CV, soil, tunnels and other site structures.

2.2.4 Radiological Status Of The SNEC Facility And Surroundings

Area Designations

The remaining SNEC Facility consists of eight principal locations (see Figures 2-1 through 2-5), designated as follows:

Area 1 (CV Basement)

Southwest, Southeast, and Northwest Quadrants of Containment Vessel (CV) between elevations 765'-8" (concrete floor) and El. 777'-8" (concrete ceiling) in southwest quadrant, El. 779'-0" (steel platform) in southeast quadrant, and El. 775'-2" (concrete ceiling of the "Rod Room") in northwest quadrant. This area also includes the three and one half-foot deep sump located in the floor, and a 4-foot wide concrete ledge (El. 768'-3") extending around the circumference of the area.

Area 2 - (Primary Compartment)

The Southwest quadrant of the CV between elevations 779'-8" (Concrete Floor) and 814'-6" (Concrete Ceiling).

Area 3 - (Auxiliary Compartment)

The Southeast quadrant of the CV between elevations 781'-4" (steel platform) and 810'-0" (concrete ceiling). One additional steel platform is installed at elevation 795'-2". Both steel platforms extend over the entire area of the quadrant, each containing an 8-foot by 8-foot open hatch. There is a similar opening in the concrete ceiling.

Area 4 - (Operating Floor)

The concrete operating floor of the CV (El. 812'-0" & 818'-0"), and surfaces up to the top of the CV dome. The area includes three access hatches (equipment, personnel, and escape); the concrete walls and platform located in the southwest quadrant; the polar bridge crane; and a steel platform (El. 818′-0″).

Area 5 - (Pipe Tunnel)

The below grade concrete tunnel which wraps around the outer circumference of the containment vessel between azimuths 35 degrees and 270 degrees.

Area 6 - (Reactor Storage Well & Sent Fuel Pool)

This area is comprised of the Northwest and Northeast quadrants (reactor storage well and spent fuel pool, respectively) of the CV between elevations 765′-8″ (concrete floor) and 807′-0″ (concrete ceiling).

Area 7 - (Outside of CV Dome)

The outside of the steel liner of the CV extending from Grade Level (El. 811′) to the top of the CV Dome. This area also includes the concrete shield structure located around the circumference of the CV between azimuths 270° and 35° (El. 811′ to about 822′).

Area 8 - (SNEC Facility Yard Areas)

This area is the exterior of the CV and includes remaining SNEC Facility structures and components.

Figures 2-1 through 2-5 and Tables 2-2 through 2-16 illustrate the radiological conditions of these areas in more detail.

With the CV concrete remediation well under way and most surfaces having been scabbled to remove the top layer of contamination, the characterization performed to evaluate the nature and extent of fixed and loose surface contamination on the CV concrete surfaces is no longer applicable. As part of the characterization however, numerous concrete core bores were obtained to evaluate subsurface contamination and activation of the concrete. In addition, characterization scoping and remediation support surveys have been performed on these surfaces. Figures 2-1 through 2-5 show the CV layout and current radiological conditions.

Figures 2-6 through 2-10 show the location of concrete core bores taken of the CV and other site areas. Tables 2-10, 2-12 and 2-13 provide the results of the analysis of these core bores. As expected, above the operating water level in the reactor storage well, concrete activation including the embedded rebar may require removal to meet release criteria. In addition, leakage through the walls of the reactor storage well and spent fuel pool will require removal of significant portions of the concrete to meet release criteria.

2.2.4.1 Structures

Structures were surveyed to determine general area and contact exposure rate values, loose and total surface contamination. Where needed, core bores were taken to evaluate the extent of penetration of contaminants into porous surfaces such as concrete and to assess activation levels. The surveys employed both systematic location selection and bias selection. Bias sample locations focused on those areas most likely to contain residual radioactivity.

2.2.4.1.1 Containment Vessel (CV)

The SNEC facility Containment Vessel (CV) is the only remaining permanent structure on the SNEC Facility site. This building housed the nuclear steam supply system components. This included the reactor pressure vessel, steam generator, pressurizer, main coolant pump, primary coolant piping and support systems and ventilation equipment. All of this equipment has been removed and shipped off-site for processing and or disposal. Additionally, floor gratings and structural steel has been removed. As such, characterization data for these systems and components is no longer relevant.

What remains of the CV is the outer steel shell and the interior concrete. Much of the concrete has had initial remediation performed. This has removed the outer layer of concrete and with it top layer of loose and fixed surface contamination. In its present state, the most important characterization attributes for the CV are the depth of penetration of contaminants into the concrete, activation of the concrete, and surface contaminants of the steel dome.

Over 45 core bore samples were taken of concrete inside the CV. Comprehensive surveys of the steel dome were taken and paint samples analyzed to determine the radiological condition of the CV. Figures 2-1 through 2-5 provide information on general area and contact radiation along with contamination levels in areas of the CV including the exterior surfaces. Table 2-4 provides the CV paint sample results. Tables 2-10 through 2-13 provide detailed information on the core bore sample results while Figures 2-6 through 2-10 show the core bore locations.

As expected, the characterization results show the need for extensive concrete remediation. The presence of transuranics (TRU) in the radionuclide mix at SNEC has influenced the DCGL. Tables 2-1, 2-7 and 2-8 show the mix. Chapter 4.0 discusses remediation plans for the CV. Chapter 5.0 provides the survey classifications that result from the characterization data.

2.2.4.1.2 Decommissioning Support Facility (DSF)

This "Butler type" prefabricated building was erected in 1996 to support decommissioning operations. The DSF is subdivided into three areas known as the Decommissioning Support Building (DSB), the Material Handling Bay (MHB) and the Personnel Access Facility (PAF). The DSF is in use at this time to support decommissioning and contains radioactive material that precludes characterization sufficient to determine if remediation will be required to meet final release criteria. In addition, the final disposition of this building has not been determined, i.e. will the building be removed prior to the final status survey. Additional surveys will be performed when practical to further characterize this structure. Figure 2-12 shows the location of the DSF. Some characterization information is provided in Table 2-6 following this section. Chapter 4.0 discusses remediation plans for the DSF. Chapter 5.0 provides the preliminary survey classifications that result from the characterization data.

2.2.4.1.3 Penelec Line Shack, Penelec Garage, Penelec Warehouse, Penelec Switchyard Building

These buildings are located off the SNEC facility property but are on adjoining Penelec property. These structures were not directly associated with operation of the SNEC facility. However, they have been used by SNEC for storage, staging and other such activities. These buildings (except the small switchyard building) were included in the scope of the comprehensive final release survey, which was conducted from October 1988 to June 1989. The results of those surveys were reported to the NRC in the report: "Final Release Survey of Reactor Support Buildings" (Reference 2-10).

Since the time of that survey (1989), decommissioning activities may have impacted these structures and as such further characterization was performed. Figures 2-19 through 2-22 show these buildings in detail and give the general area exposure rate measurements taken in each building. Direct and smear surveys for surface contamination were performed in each structure. No surface contamination greater than 1000 dpm/100cm^2 beta/gamma or 20 dpm/100cm^2 alpha was detected. The elevated exposure rate measurements noted in the Penelec Warehouse were previously addressed in the 1990 Final Release Survey of Reactor Support Buildings (Reference 2-10). Laboratory analysis of building structural materials showed an elevated level of naturally occurring radioactive materials in these building materials. Based on the results of characterization surveys, no remediation of these areas is expected, however, due to their classification, they will be included in the final status survey plan. Table 2-6 shows the average values for the surveys taken during characterization. Chapter 5.0 provides the survey classifications that result from the characterization data.

2.2.4.1.4 Saxton Steam Generating Station (SSGS) Discharge Tunnel

The Saxton Steam Generating Station (SSGS) Discharge Tunnel is contaminated as a result of radioactive liquid effluent discharges from the SNEC facility. This tunnel was the routine discharge point for liquid radioactive effluents. The presence of ground water and several inches of silt in this below grade structure have precluded complete characterization. The water and silt may require removal to adequately survey this area for final release. Characterization results to date of this structure indicate that extensive remediation will not be needed to meet final release criteria. However, several piping sections will require removal as they are significantly above initial DCGLs. Figure 2-18 shows this tunnel in detail and contains the general area exposure rate results. Table 2-3 lists some of the sediment and water sample results. Table 2-6 shows the average values for the surveys taken during characterization. One pipe in the east seal chamber was found to contain elevated readings. Specifically, a pipe, believed to be the original SNEC facility liquid effluent discharge line was sampled and had 3668 pCi/g Cs-137 and 50 pCi/g Co-60 inside. Several areas in the western most seal chamber have elevated exposure rate measurements and will require further characterization. Chapter 5.0 provides the preliminary survey classifications that result from the characterization data.

2.2.4.1.5 Systems

Only those systems which will remain following remediation and fall under the final status survey program, were characterized. This precluded characterization of such systems as the CV ventilation system, piping that penetrates the CV into the service tunnel, and temporary systems installed to support decommissioning such as compressed air, electrical power, rigging fixtures, etc. All of these systems will be removed prior to the final status survey and are not included in its scope.

One system that was characterized, as it will remain and be included in the final status survey, is the complex site storm drain system. This system collects surface water and building drains from structures in the Penelec property and directs it to the Raystown Branch of the Juniata River. Because of the history of the site as evidenced by the HSA (Reference 2-14), and the soil contamination on-site, this system was felt to be "impacted" and was surveyed and sampled. Robotics was employed for the majority of this work as the small diameter pipes, confined spaces and presence of water made manned entry difficult. Figures 2-11 and 2-12 show the location of these drains. Table 2-5 lists some of the sample results. Chapter 5.0 provides the survey classifications that result from the characterization data.

2.2.4.2 Soil

In addition to the CV, contaminated soil in and around the SNEC Facility site will require remediation. As described in Section 2.2.1, the SNEC Soil Remediation Project, completed in 1994, removed contaminated soil from the site in an effort to reduce Cs-137 levels to <1pCi/g average. While this project achieved its goal, contaminated soil near the CV and the surrounding support tunnel could not be removed until these structures were removed. Additionally, soil conditions and pervasive ground water near the surface prevented an assessment of soil contamination below about three feet deep in these areas. Also, this project was limited to the SNEC Facility property and the immediately adjoining area.

In order to survey the areas not covered by the 1994 soil project and to investigate potentially impacted areas identified by the HSA (Reference 2-14) a major surface and subsurface soil sampling program was completed in 1999. In addition to random points, biased sample locations were selected based on the HSA and previous survey results. Cs-137 was the only nuclide attributed to licensed operations detected. The surface findings are reported in Table 2-14, while the sample locations are shown on Figures 2-13 and 2-14. Given the site history and previous survey data, the results are unremarkable. The information has been used to classify the survey units as described in Chapter 5.0. The data has resulted in some areas off the SNEC Facility site but within the surrounding Penelec property being classified as "impacted".

In addition to the 55 surface sample locations, 42 subsurface locations were sampled. These were generally biased locations, located in areas where below grade tanks, piping, ducts, spills, and structures were once present. The results of subsurface sampling are presented in Table 2-15. Subsurface sample locations are shown on Figures 2-15 and 2-16. As a compliment to the subsurface sampling, gamma bore logging was performed at these same locations. The use of two different techniques allows for the differentiation of possible soil contamination at a location from the presence of buried radioactive components. The results of the gamma bore logging are presented in Table 2-16. Subsurface gamma bore logging locations are shown on Figures 2-15 and 2-16. Results of the subsurface sampling and gamma logging indicate the need to remediate soil to a depth at least ten (10) feet deep on the north side of the CV. The gamma bore logging results show that some radioactive components are still present at this depth in this location (hole #10 & 13). These are believed to be piping exiting the CV below grade in the area north of the CV. These areas will be remediated prior to the final status survey. Chapter 5.0 provides the survey classifications that result from the characterization data.

2.2.4.3 Pavement

Areas of pavement on and surrounding the SNEC Facility site are indicated on Figures 2-11 and 2-12. These areas have not been completely characterized to date. The pavement area south of the DSF has had subsurface sampling and gamma logging performed (sample location #14 and 15 in tables 2-15 and 2-16). Results of sampling and gamma logging in these two locations showed no activity related to licensed operations. Due to current radwaste storage locations and operational considerations near this pavement, surface surveys in this area may be adversely influenced. Surface scans and surveys of pavement areas will be completed when practical. Chapter 5.0 provides the preliminary survey classifications that result from the characterization data.

2.2.4.4 Environment (REMP)

GPU Nuclear conducts a comprehensive radiological environmental monitoring program (REMP) at SNEC to measure levels of radiation and radioactive materials in the environment. The information obtained from the REMP is then used to determine the effect of SNEC operations, if any, on the environment and the public.

The NRC has established regulatory guides that contain acceptable monitoring practices. The SNEC REMP was designed on the basis of these regulatory guides along with the guidance provided by the NRC Radiological Assessment Branch Technical Position for an acceptable radiological environmental monitoring program (Reference 2-26).

The important objectives of the REMP are:

- To assess dose impacts to the public from the SNEC Facility.
- To verify decommissioning controls for the containment of radioactive materials.
- To determine buildup of long-lived radionuclides in the environment and changes in background radiation levels.
- To provide reassurance to the public that the program is capable of adequately assessing impacts and identifying noteworthy changes in the radiological status of the environment.
- To fulfill the requirements of the SNEC Facility License and associated Technical Specifications.

In addition to its role in determining the effect of operations, the REMP data provides valuable current and historic information on the radiological conditions of the environment surrounding the site. This information will be used to compliment the characterization survey data to assess the classification of off-site areas and the possible need for any remediation.

2.2.4.4.1 Sampling

The program consists of Thermoluminescent dosimeter measurements and collection of samples from the environment, analyzing them for radioactivity content, and then interpreting the results. These samples include, but are not limited to, air, water, sediment, soil, vegetation and groundwater. Thermoluminescent dosimeters (TLDs) are placed in the environment to measure gamma radiation levels. The SNEC Offsite Dose Calculation Manual (ODCM), (Reference 2-13) defines the sample types to be collected and the analyses to be performed.

Sampling locations are established by considering topography, meteorology, population distribution, hydrology, and areas of public interest. The sampling locations are divided into two classes, indicator and control. Indicator locations are those which are expected to show effects from SNEC activities, if any exist. These locations were selected primarily on the basis of where the highest predicted environmental concentrations would occur. The indicator locations are typically within the site boundary, along the perimeter fence or a few miles from the SNEC facility.

Control stations are located generally at distances greater than 10 miles from SNEC. The samples collected at these sites are expected to be unaffected by SNEC operations. Data from control locations provide a basis for evaluating indicator data relative to natural background radioactivity and fallout from prior nuclear weapon tests. Figure 2-24 shows the current sampling locations around the facility. The most recent REMP aquatic sediment sampling results for 1998 are presented in Table 2-19; TLD results are provided in Table 2-20.

2.2.4.4.2 Analysis

In addition to specifying the media to be collected and the number of sampling locations, the ODCM also specifies the frequency of sample collection and the types and frequency of analyses to be performed. Also specified are analytical sensitivities (detection limits) and reporting levels.

Measurement of low radionuclide concentrations in environmental media requires special analysis techniques. Analytical laboratories use state-of-the-art laboratory equipment designed to detect all three types of radiation emitted (alpha, beta, and gamma). This equipment must meet the analytical sensitivities required by the ODCM. Examples of the specialized laboratory equipment used are germanium detectors with multichannel analyzers for determining specific gamma-emitting radionuclides, liquid scintillation counters for detecting tritium (H-3), low level proportional counters for detecting gross alpha and beta radioactivity and alpha spectroscopy for determining specific transuranic isotopes.

Calibrations of the counting equipment are performed by using standards traceable to the National Institute of Standards and Technology (NIST). Computer hardware and software used in conjunction with the counting equipment perform calculations and provide data management.

2.2.4.5 Groundwater

Groundwater monitoring is conducted to check for water leakage, if any, from the SNEC Containment Vessel and residual radioactivity from previously demolished structures. In addition, due to the site history of spills, soil contamination and previously demolished structures, monitoring of ground water is an important element in site characterization. An investigation was performed to define the depth of the bedrock surface and the orientation of the bedrock groundwater flow pathways (Reference 2-15). The site is immediately underlain by a fill-layer composed of flyash, cinders and/or silt and sand-size sediment. A layer of boulders in a silty clay matrix underlies this fill-layer. The surface of the bedrock lies beneath this boulder layer at a depth between approximately 7.5 to 18 feet.

The results of this investigation indicate that the overburden groundwater occurs at a depth ranging from approximately 4 to 16 feet. Groundwater elevation contour maps of this data indicate that the groundwater within the overburden soil flows west toward the Raystown Branch of the Juniata River. Groundwater movement within the bedrock beneath the site is predominately controlled by fractures in the bedrock. There are two major fracture patterns; one trends northeast to southwest, and dips moderately toward the northwest. The second fracture pattern trends northwest to southeast, and dips steeply toward the southwest (Reference 2-16). Groundwater also moves within the spaces (bedding planes) between the individual layers of the siltstone bedrock at Saxton.

In 1994, eight overburden groundwater wells were restored. Four of the wells are hydraulically downgradient of the containment vessel (GEO-3, GEO-6, GEO-7, and GEO-8). The other four wells (GEO-1, GEO-2, GEO-4, and GEO-5), are located hydraulically upgradient of the containment vessel. GEO-9 is not sampled as it is used for level monitoring by means of a piezometer.

Two bedrock wells (MW-1 and MW-2) are also monitored. As part of the analysis performed by the contracted hydrogeologic consultants (GEO Engineering), it was determined that bedrock monitoring wells should be installed at an angle in order to maximize the interception of fractures and bedding planes. The boreholes were drilled into bedrock at an angle of approximately 25 degrees from vertical to accomplish this. Filling the annular space with a sand filter pack, a bentonite pellet seal and cement grout allows these wells to monitor only the significant fractures and bedding planes of the bedrock ground water.

In May of 1998, three additional monitoring wells were drilled. Two bedrock wells (MW-3 and MW-4) were installed to determine if there was subsurface contamination in the vicinity of the former Radwaste Disposal Facility Building. This area was monitored by well GEO-5, which in the past was the only well to show positive tritium levels, the only nuclide associated with licensed operations ever detected in the ground water. An additional overburden well (GEO-10) was installed to supplement the existing monitoring wells to monitor for the possible migration of trace amounts of tritium or other contaminants.

In addition, two off-site (potable water) samples are collected. One site monitors the well water from the Penelec Line Shack located adjacent to the SNEC Facility site. The other sample is collected from a resident in the borough of Saxton. All Saxton borough residents get their water from one of two sources. Putts Hollow reservoir is the primary source, but during low water levels, the township switches to the Seton Plant water supply, which draws from the Juniata River upstream of the SNEC facility. Neither of these samples have ever detected any radioactive contaminates.

2.2.4.5.1 Groundwater Results

Locations of the onsite groundwater stations sampled in 1998 are given in Figure 2-17. The results from the analyses performed on these samples indicated no radioactive contamination from plant-related radionuclides, other than tritium. Of the 53 groundwater samples collected in 1998, eight samples, from wells GEO-1, 5, 10, MW1,3 and 4 contained tritium ranging from 120 to 180 pCi/L, which is considered slightly above ambient concentrations. These results are well below the USEPA's Primary Drinking Water Standard of 20,000 pCi/L (Reference 2-18). Tritium analysis requires a minimum sensitivity of 200 pCi/L. Required sensitivities for Co-60, Cs-134, and Cs-137 (gamma emitting radionuclides) are 15 pCi/L. 1998 groundwater monitoring results are given in Table 2-17. 1999 data was not available at the time of this submittal.

As stated earlier, GEO-5 originally was the only well to show positive tritium levels. The first sample obtained from GEO-5 was collected and analyzed July of 1994. A "Less Than" result for tritium was reported. Gamma analysis performed on this sample yielded "Less Than" activities. The October 1994 sample reported 560 pCi/L tritium. A special collection was performed two weeks later to confirm the positive tritium and a result of 310 pCi/L was obtained. Gamma analysis continued to show no reportable activity.

Quarterly and special collections yielded some positive and some "Less Than" tritium activities. The highest activity of tritium (760 pCi/L) was observed October 1995. Since that time, no concentrations above 200 pCi/L were observed. Table 2-18 is a list of all tritium results that have been performed since the start of GEO-5 monitoring.

Upon review of these results, it appears that the activity in the GEO-5 area can be attributed to pockets of tritiated water trapped in fractures leading to the overburden groundwater. In order to assess the possibility of other contaminates in this area, GPU Nuclear contracted Haley & Aldrich, Inc. (formally GEO Engineering) to add supplemental monitoring wells in this location (Reference 2-17). These new wells showed infrequent tritium activity slightly above the MDA. The new monitoring wells, like the former wells, yielded "Less Than" activities for gamma analysis. Table 2-17 is a list of tritium results from all the monitoring wells sampled in 1998. The results indicate that no other contaminants are present in the groundwater.

Based on the ground water monitoring program results, no contamination of ground water, with the exception of tritium well below the USEPA's Primary Drinking Water Standard of 20,000 pCi/L, has been observed over the monitoring period. The transit times for contaminant movement would indicate that no such contamination will occur as it would have been observed with or shortly following the positive tritium results. Subsurface soils sampling and survey results as reported in Tables 2-15 and 2-16 support this conclusion.

2.2.4.5.2 Surface Water

The Juniata River surface water is monitored for radionuclides of potential SNEC facility origin. Two grab samples, one control and one indicator, are collected on a quarterly basis and analyzed for gamma emitting radionuclides and tritium. The indicator sample was collected at the discharge bulkhead leading into the river, while the control sample was collected upstream of the discharge. No tritium or other radionuclides attributed to SNEC operations were detected above the MDC.

2.3 BACKGROUND DATA

The License Termination Plan and the Final Status Survey activities require that applicable background radiation levels be established surrounding the SNEC site. In support of this need, sampling and surveys were conducted as part of the characterization effort to establish soil background levels and background exposure rates at each sample location. Background sampling locations were established by considering topography, meteorology, population distribution and areas of public interest.

The Background Soil Study program was designed on the basis of applicable NRC guidance and direction provided by the NRC Radiological Assessment Branch Technical Position for an acceptable environmental monitoring program (Reference 2-26).

Background stations are generally located at distances greater than 10 miles from the SNEC facility. The samples collected at these locations are expected to be unaffected by SNEC operations. Data from background locations provide a basis for evaluating indicator data relative to natural background radioactivity and the effects of fallout from atmospheric nuclear weapons tests.

2.3.1 Summary Of Soil Results

Locations approximately 10 miles from the site were selected in each of the 16 directional sectors. During the week of July 13, 1999, sampling and survey work was conducted. Exposure rate measurements were taken using a Bicron MicroRem meter. Twenty soil grab samples were taken and split between SNEC and the GPUN Environmental Radioactivity

Laboratory (ERL) (now owned by AmerGen). Table 2-21 lists the ERL analysis results of the typical isotopes seen in the environment. Table 2-22 provides a list of the exposure rate measurements.

Per Table 2-21, the average specific activity (pCi/g) in the soil background for each of the typical nuclides is listed as follows with the associated two-sigma uncertainty value:

K-40	Cs-137	Ra-226	Th-232
14 +/- 15.5	**0.28** +/- 0.39	**1.8** +/- 1.1	**0.9** +/- 0.5

As shown in Table 2-22, the average of the exposure rate measurements is **7 +/- 3 (2σ) uRem/hr.**

2.3.2 Concrete Background Data

Major portions of the CV interior concrete are expected to remain intact and will be subjected to survey under the Final Status Survey program. As with the background soil surveys, it is necessary to collect information on the background radioactivity characteristics of concrete similar to that used in the SNEC facility.

To gather this data core bore samples were taken from surrounding Penelec property and from locations in and around the town of Saxton. These two groups of samples are believed to be from the same construction time period as that of the SNEC facility, and are considered to be representative of concrete background for relevant nuclides. Tables 2-9 and 2-10 present sample locations and results for these two groups. This data will be used in conjunction with final status survey results to determine the radionuclide inventory in concrete remaining at the site.

2.3.3 Additional Surveys

Future work will expand on the samples and surveys taken to date to further establish background radioactivity levels for site specific materials such as structural steel. Also, measurements are planned using a pressurized ion chamber to establish equivalency between dose rate measurements and exposure rate measurements.

2.4 SURVEY INSTRUMENTATION

A variety of survey instrumentation has been used in support of site characterization surveys. The following are the principal instruments employed:

1. Low-level exposure rate measurements, Bicron MicroRem meter, scintillation based exposure rate instrument.

2. Dose rate measurements higher than the range of the Bicron MicroRem meter, Eberline RO-2 or equivalent, ion chamber instrument.

3. Beta/gamma scans and fixed points for fixed and loose contamination, Eberline E-140N, Geiger-Mueller thin window detector.

4. Alpha smear counting, Eberline SAC-4, scintillation based scaler.

5. Field alpha contamination surveys, Eberline ASP-1, scintillation based detector.

6. Beta/gamma smear counting, Ludlum-2000, Geiger-Mueller thin window scaler.

7. Photon Spectral Analysis, Canberra and EG&G Ortec HpGe systems.

8. Tritium, Beckman low energy beta liquid scintillation counter.

2.5 QA/PROCEDURES

The SNEC facility has been in a decommissioning mode for some time. These efforts, including the majority of the characterization process, predate the MARSSIM process. Previous characterization efforts used NUREG/CR-2082 (Reference 2-9) and NUREG/CR-5849 (Reference 2-23) to direct the characterization effort. These references do not employ the "Data Quality Objective" process when planning characterization activities. Under these guidance documents, characterization surveys and sampling is performed on an "as needed" basis, considering site conditions and operational history. The overall purpose of such a program is to establish the nature and extent of radioactive contamination. However, a retrospective review of the SNEC Facility site characterization process shows that the intent of the Data Quality Objective (DQO) process has been met.

The characterization program has been conducted using the SNEC procedure No. 6575-PLN-5420.06, "SNEC Site Characterization Plan" (Reference 2-4). This comprehensive plan provided an organized approach to specifying survey and sample locations and lower tier implementing procedures specified sampling and survey technique as well as laboratory analyses.

In concert with the DQO process, criteria or goals for characterization were established and survey and sampling plans developed to achieve these goals. Those goals closely follow those established by MARSSIM to provide the quality data needed to support the final status survey. Some of those goals are:

1. To collect information from locations where little is known about radiological conditions.

2. Sample those areas indicated in the HSA as suspect.

3. Provide information on the relative concentrations of radionuclides of concern and provide input to initial DCGL development.

4. Provide sufficient repeat and duplicate analysis to ensure confidence in sample results.

5. To provide information to support timely and adequate remediation.

6. To provide accurate and timely information about site conditions to stakeholders during the decommissioning process (the public, regulators, licensee management, etc.)

The principal study questions for all SNEC Facility site characterization work have been:

1. Are contaminants present at the site as a result of licensed activities?, and if present,

2. Are contaminant concentrations above background levels and to what degree do they approach postulated DCGL values?

The SNEC Facility Decommissioning Quality Assurance Plan (Reference 2-25) ensures that all survey activities are performed in a manner that assures the results are accurate and that uncertainties have been adequately considered. All sampling, analysis and surveys have been performed under written procedures, which are reviewed and approved in a rigorous fashion. These activities are carried out by trained and qualified individuals. Radiological survey instrumentation and laboratory equipment is operated in accordance with SNEC procedure 6575-QAP-4220.01, "Quality Assurance Program for Radiological Instruments", (Reference 2-24). Characterization data, as well as calibration and source check records are maintained in accordance with approved procedures that comply with NRC and industry requirements. All characterization activities have been and continue to be conducted under the auspices of a comprehensive quality assurance program, specifically 1000-PLN-3000.05, "SNEC Facility Decommissioning Quality Assurance Plan" (Reference 2-25).

2.6 CONCLUSIONS

The SNEC Facility site has been comprehensively characterized. The results support decisions related to remediation required and the classification of land areas, systems and structures as to non impacted or impacted status. The data also supports the classification of areas if impacted, and the establishment of initial DCGLs.

In general, the characterization results support the continued remediation of the Containment Vessel (CV) and the pipe tunnel surrounding the CV. The CV interior concrete is contaminated on surfaces and in areas where cracks and defects have allowed contaminants to reach subsurface areas. Areas of CV concrete in the reactor storage well that are above the operating water level, are activated from neutron flux and will also require remediation and additional surveys. The CV pipe tunnel contains slightly contaminated water. This resulted from cross contamination of ground water that has flooded the tunnel. A thin layer of contaminated silt is present on the tunnel floor. These conditions prevent the CV pipe tunnel from being adequately surveyed at this time, however, it is scheduled to be completely removed prior to the final status survey. Following removal, the soil beneath the service tunnel will need to be characterized as it is currently inaccessible.

Soil, particularly that surrounding the CV will require remediation. Some subsurface samples and surveys indicate that remediation of soil and/or buried piping north of the CV may be required to a depth of at least ten (10) feet. Some soil sample results offsite but on surrounding Penelec property indicate the area has been impacted by SNEC facility operations. These areas will be classified as "impacted" and included in the final status survey. Initial characterization data indicates that remediation of these areas may not be required.

The Saxton Steam Generating Station (SSGS) discharge tunnel is contaminated as a result of routine radioactive liquid effluent discharges from the SNEC facility. The presence of ground water and several inches of silt in this below grade structure have precluded complete characterization. The water and silt may require removal to adequately survey this area for final release. Characterization results to date of this structure indicate that extensive remediation will not be needed to meet final release criteria. However, several piping sections will require removal as they are significantly above initial DCGLs.

The Decommissioning Support Facility (DSF) is in use at this time to support decommissioning and contains radioactive material that precludes characterization sufficient to determine if remediation will be required to meet final release criteria. In addition, the final disposition of this building has not been determined, i.e. will the building be removed prior to the final status survey. Additional surveys will be performed when practical to further characterize this structure.

Other buildings, structures and systems offsite but on the surrounding Penelec property (excepting the SSGS discharge tunnel described above) will likely not require remediation to meet final release criteria. However, they have been impacted by the operation of the SNEC facility and will be included in the final status survey process. This includes the Penelec garage (Figure 2-19), the Penelec warehouse (Figure 2-20) and the Penelec "line shack" (Figure 2-21).

The REMP data and characterization of offsite environmental areas indicate that remediation of offsite areas including effluent release pathways will not be required. The liquid effluent discharge points to the Raystown Branch of the Juniata River have been impacted by SNEC facility operations and these areas will be classified as "impacted" and included in the final status survey.

2.7 REFERENCES

2-1 Code of Federal Regulations, Title 10 Part 50.82, "Application for Termination of License."

2-2 USNRC Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for nuclear Power Reactors," January 1999.

2-3 GPU Nuclear, "1994 Saxton Soil Remediation Project Report".

2-4 SNEC procedure No. 6575-PLN-5420.06, "SNEC Site Characterization Plan".

2-5 Station Work Instructions:

2-5.1 SWI-94-001, "Remove Core Bore Samples from Saxton Containment Vessel Bldg. Structures", Rev 2.

2-5.2 SWI-94-002, "Bulk Sample Collection from SNEC Site Facilities in Preparation for Offsite Analysis".

2-5.3 SWI-94-003, "System Sampling at SNEC Facilities".

2-5.4 SWI-99-065, "Collecting Samples of Scabbled Concrete in the SNEC CV.

2-5.5 SWI-99-068, "Characterization of the Remaining On-Site Structures"

2-5.6 SWI-99-069, "Saxton Coal Fired Steam Plant Discharge Tunnel Area".

2-5.7 SWI-99-070, "SNEC Site Sub-surface Soil Gamma Logging and Sampling".

2-5.8 SWI-99-071, "Saxton Out-falls and Other Remote Areas".

2-6 "SNEC Facility Site Characterization Report", May 1996.

2-7 NUREG-1575, "Multi-Agency Radiation Survey and Site investigation Manual (MARSSIM)," December 1997.

2-8 SNEC Report, "Decommissioned Status of the SNEC Reactor Facility" dated February 20, 1975.

2-9 NUREG/CR-2082, "Monitoring for Compliance With Decommissioning Termination Survey Criteria"

2-10 "Saxton Nuclear Power Plant Final Release Survey of Reactor Support Buildings", GPU Nuclear Corporation report, Revision 3, March 1992.

2-11 "Confirmatory Radiological Survey for Portions of the Saxton Nuclear Experimental Facility, Saxton, Pa.", June 1991, Oak Ridge Associated Universities.

2-12 USNRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear reactors," June 1974.

2-13 "SNEC Facility Offsite Dose Calculation Manual", "6575-PLN-4542.08"

2-14 GPU Nuclear Report, "SNEC Facility Historical Site Assessment", Draft January 2000.

2-15 GEO Engineering "Phase I Report of Findings – Groundwater Investigation." November 18, 1992.

2-16 GEO Engineering "Summary of Field Work." June 7, 1994.

2-17 Haley and Aldrich "Summary of Field Work." July 24, 1998.

2-18 United States Environmental Protection Agency, Primary Drinking Water Standard, 40CFR141.

2-19 CoPhysics Corp. report, "Review of the Final Release Survey of the Reactor Support Buildings at the Saxton Nuclear Experimental Facility", 12/14/99

2-20 Minutes of the February 2, 1987 SNEC briefing to NRC Region 1.

2-21 TLG Services, Inc. report, "The Saxton Facility Reactor Vessel, internals, Ex-Vessel Lead, Structural Steel and Reactor Compartment Concrete Shield Wall Radionuclide Inventory", December, 1995 (TLG Document No. G01-1192-003).

2-22 RESRAD, Version 5.82, United States Department of Energy and Argonne National Laboratory, April 1998.

2-23 NUREG/CR-5849, "Manual for Conducting Radiological Surveys in support of License Termination", draft of June 1992.

2-24 SNEC procedure 6575-QAP-4220.01, "Quality Assurance Program for Radiological Instruments".

2-25 GPU Nuclear Plan, 1000-PLN-3000.05, "SNEC Facility Decommissioning Quality Assurance Plan".

2-26 United States Nuclear Regulatory Commission Branch Technical Position. "An Acceptable Radiological Environmental Monitoring Program." Revision 1, November 1979.

2-27 June 1988 "*In-situ* Survey General Public Utilities Facility and Surrounding Area", conducted by EG&G Energy Measurements for the DOE/NRC, report number DOE/ONS-8806 dated September 1990.

2-28 July 1989 "Aerial Radiological Survey of the Saxton Nuclear Experimental Corporation Facility" conducted by EG&E Energy Measurements for the DOE/NRC, report number EGG-10617-1132 dated October 1991.

2-29 "Saxton Nuclear Experimental Corporation Facility Decommissioning Environmental Report," GPU Nuclear, April 1996.

Table 2-1

Radionuclide Inventory for the SNEC Facility (2000)

CURIE TOTAL ESTIMATE – SNEC FACILITY		
Nuclides	**Curies**	**Percent**
Am-241	1.12E-02	**1.29%**
Cm-243/Cm-244	1.73E-04	0.02%
Co-60	7.68E-02	**8.85%**
Cs-134	1.99E-04	0.02%
Cs-137	4.24E-01	**48.81%**
C-14	5.89E-03	0.68%
Eu-152	1.49E-03	0.17%
Eu-154	5.98E-04	0.07%
Eu-155	1.62E-04	0.02%
Fe-55	1.01E-03	0.12%
H-3	1.09E-01	**12.60%**
Nb-94	2.50E-04	0.03%
Ni-59	5.08E-03	0.59%
Ni-63	1.60E-01	**18.46%**
Pu-238	1.54E-03	0.18%
Pu-239/Pu-240	3.67E-03	0.42%
Pu-241	5.36E-02	**6.17%**
Pu-242	7.71E-06	0.00%
Sb-125	5.54E-04	0.06%
Sr-90	1.17E-02	**1.35%**
Tc-99	7.83E-04	0.09%
U-234	6.79E-06	0.00%
U-235	6.79E-06	0.00%
U-238	6.79E-06	0.00%
Totals=>	**0.87**	**100.00%**

Note: Values in **Bold** are those nuclides greater than one percent (1%) of the mix.

Table 2-2
Radionuclide Concentrations - CV Pipe Tunnel Water and Sediment

Sample Number	Cs-137	Co-60
SX856950167-SD (Liquid)	3.44E-7 uCi/ml	1.16E-7 uCi/ml
SX856950167-SD (Solids)	2.94E-4 uCi/g	6.39E-6 uCi/g

Table 2-3
Radionuclide Concentrations - SSGS Discharge Tunnel - Water and Sediment

Sample Number	H-3	Cs-137	Co-60	Ni-63	TRU
SX10SD99002 2	2.1E-4 uCi/g	2.1E-5 uCi/g	< 3E-6 uCi/g	< 3E-5 uCi/g	< 7.2E-5 uCi/g
SX10SD99003 1	NR	1.2E-4 uCi/g	8.4E-7 uCi/g	NR	NR
SX10SD99003 3	NR	4.8E-3 uCi/g	3.0E-5 uCi/g	5.5E-5 uCi/g	9.6E-6 uCi/g
SX10SD99003 4	NR	6.2E-5 uCi/g	< 9E-uCi/g	NR	< 2.4E-7 uCi/g
SX5DW99017 7 (Liquid)	2.0E-7 uCi/ml	2.0E-8 uCi/ml	NR	NR	NR

NR = Not Reported

Table 2-4
Radionuclide Concentrations - CV Paint On Inside Dome Surface

Sample Number	Cs-137	Co-60	TRU
SX4PC990093	3.2E-5 uCi/g	< 2E-6 uCi/g	3.5E-8 uCi/g
SX4PC990098	5.7E-4 uCi/g	3.8E-5 uCi/g	NR
SX4PC990104	3.0E-3 uCi/g	4.0E-4 uCi/g	1E-5 uCi/g

NR = Not Reported

Table 2-5
Radionuclide Concentrations – Yard Drains

Sample Number	Cs-137	Co-60
SX10SD99002 4	1.6E-7 uCi/g	< 6E-8 uCi/g
SX8SD990027	4.7E-7 uCi/g	< 1.4E-7 uCi/g
SX10SD99003 2	3.5E-6 uCi/g	< 2E-7 uCi/g

Table 2-6

Summary Results of Characterization for Near Site Structures

		Exposure rate survey data	Direct Frisk Data	Beta Gamma Smear Data	Alpha Smear Data
Structure	**Location**	**GA urem/hr**	**Net cpm Direct Frisk**	**dpm/100 cm^2**	**dpm/100 cm^2**
Penelec Garage (Fig. 2-19)	Interior	6.3	70	< 227	< 8.6
Penelec Garage (Fig. 2-19)	Roof	5.1	60	< 227	< 8.6
Penelec Line Shack (Fig. 2-21)	Interior	4.8	20	< 231	< 10.9
Penelec Line Shack (Fig. 2-21)	Roof	5.3	20	< 231	< 10.9
Penelec Switch Yard Bldg. (Fig. 2-22)	Interior	4	10	< 231	< 10.9
Penelec Switch Yard Bldg. (Fig. 2-22)	Roof	Not Done	0	< 231	< 10.9
Penelec Warehouse (Fig. 2-20)	Interior	8	40	< 231	< 9.9
Penelec Warehouse (Fig. 2-20)	Roof	5.3	50	< 231	< 9.9
MHB (DSF)	Interior	18	20	< 236	< 11.6
DSB (DSF)	Interior	28	60	< 236	< 11.6
PAF (DSF)	Interior	6	10	< 227	< 9.9
SSGS Discharge Tunnel (Fig. 2-18)	Interior	4	30	< 229	< 12.3

Note: These are the average results of the characterization surveys performed.

Table 2-7

SNEC Facility Surface Contamination Analysis Results

Composited Smears of January 1995

NUCLIDES	AREA 1 (uCi's)	% OF TOTAL	AREA 2 (uCi's)	% OF TOTAL	AREA 3 & 4† (uCi's)	% OF TOTAL
C-14	3.0E-5*	0.0081	2.0E-5*	0.0242	2.0E-5*	0.2319
Ni-59	3.0E-4*	0.0814	3.0E-4*	0.3628	3.0E-4*	3.4781
Sr-90	**6.8E-4**	**0.1845**	**1.0E-3**	**1.2094**	**3.0E-5**	**0.3478**
Fe-55	5.0E-4*	0.1356	4.0E-4*	0.4838	3.0E-4*	3.4781
Tc-99	4.0E-5*	0.0109	3.0E-5*	0.0363	4.0E-5*	0.4637
I-129	5.0E-5*	0.0136	4.0E-5*	0.0484	7.0E-5*	0.8116
Co-60	**2.87E-3**	**0.7786**	**8.31E-4**	**1.0050**	**2.59E-4**	**3.0028**
Zn-65	3.0E-4*	0.0814	8.0E-5*	0.0968	1.0E-5*	0.1159
Ru-106	3.0E-3*	0.8139	1.0E-3*	1.2094	9.0E-5*	1.0434
Cs-134	2.0E-4*	0.0543	4.0E-5*	0.0484	6.0E-6*	0.0696
Cs-137	**3.56E-1**	**96.5780**	**7.66E-2**	**92.6432**	**6.26E-3**	**72.5768**
Ce-144	2.0E-3*	0.5426	5.0E-4*	0.6047	4.0E-5*	0.4637
H-3	5.0E-4*	0.1356	5.0E-4*	0.6047	8.0E-4*	9.2750
Ni-63	**1.2E-3**	**0.3255**	**5.4E-4**	**0.6531**	**8.9E-5**	**1.0318**
Pu-238	**4.6E-5**	**0.0125**	**3.1E-5**	**0.0375**	**4.0E-6**	**0.0464**
U-234	1.1E-6*	0.0003	1.0E-6*	0.0012	1.1E-6*	0.0128
U-235	1.1E-6*	0.0003	1.0E-6*	0.0012	1.1E-6*	0.0128
U-238	1.1E-6*	0.0003	1.0E-6*	0.0012	1.1E-6*	0.0128
Am-241	**1.8E-4**	**0.0488**	**1.3E-4**	**0.1572**	**1.2E-5**	**0.1391**
Cm-242	1.3E-6*	0.0004	**2.6E-6**	**0.0031**	1.3E-6*	0.0151
Cm-244	2.2E-6*	0.0006	1.0E-6*	0.0012	9.5E-7*	0.0110
Pu-239	**1.0E-4**	**0.0271**	**8.3E-5**	**0.1004**	**8.6E-6**	**0.0997**
Pu-241	**6.1E-4**	**0.1655**	**5.5E-4**	**0.6652**	2.8E-4*	3.2462
Pu-242	9.9E-7*	0.0003	1.2E-6*	0.0015	1.2E-6*	0.0139
TOTALS	**3.69E-1**	**100%**	**8.27E-2**	**100%**	**8.63E-3**	**100%**

*** Reported as "Less Than" values (values in bold were positively identified)**

Note: Because of similar nuclide compositions, smear results from AREA 3 and 4 (Table 2-8) were combined prior to analysis.

Nuclides with half-lives of < 100 days or naturally occurring isotopes e.g. K-40, Ra-226 and Th-228, were not included in the percent of total columns. These nuclides are not present in sufficient quantity to be significant. "Less than" values are assumed valid for calculations related to curie evaluations.

Table 2-8
SNEC Facility Surface Contamination Analysis Results
Composited Smears of June 1995

NUCLIDES	AREA 2 (uCi's)	% OF TOTAL	AREA 6 (uCi's)	% OF TOTAL
C-14	**1.1E-5**	**0.0017**	**1.1E-5**	**0.0001**
Ni-59	1.0E-3*	0.1585	**1.7E-3**	0.0096
Sr-90	**1.2E-2**	**1.9021**	**2.3E-2**	**0.1304**
Fe-55	5.0E-4*	0.0793	**2.5E-2**	**0.1418**
Tc-99	**3.2E-5**	**0.0051**	**6.2E-4**	**0.0035**
I-129	2.0E-5*	0.0032	2.0E-5*	0.0001
Mn-54	3.0E-4*	0.0476	4.0E-2*	0.2268
Co-60	**1.49E-2**	**2.3618**	**7.18E+0**	**40.7143**
Zn-65	7.0E-4*	0.1110	1.0E-1*	0.5671
Nb-94	3.0E-4*	0.0476	5.0E-2*	0.2835
Ru-106	5.0E-3*	0.7925	4.0E-1*	2.2682
Ag-110m	4.0E-4*	0.0634	7.0E-2*	0.3969
Sb-125	3.0E-3*	0.4755	1.0E-1*	0.5671
Cs-134	3.0E-4*	0.0476	5.0E-2*	0.2835
Cs-137	**5.63E-1**	**89.2394**	**9.03E+0**	**51.2048**
Ce-144	3.0E-3*	0.4755	3.0E-1*	1.7012
Np-237	1.0E-3*	0.1585	8.0E-2*	0.4536
H-3	6.0E-4*	0.0951	**2.0E-3**	**0.0113**
Ni-63	**1.9E-2**	**3.0116**	**1.3E-1**	**0.7372**
Pu-238	**3.5E-4**	**0.0555**	**3.1E-3**	**0.0176**
U-234	1.0E-6*	0.0002	9.0E-7*	0.0000
U-235	1.0E-6*	0.0002	9.0E-7*	0.0000
U-238	1.0E-6*	0.0002	9.0E-7*	0.0000
Am-241	**8.5E-4**	**0.1347**	**1.3E-2**	**0.0737**
Cm-242	**7.4E-6**	**0.0012**	**1.0E-4**	**0.0006**
Cm-244	**1.9E-5**	**0.0030**	**3.0E-4**	**0.0017**
Pu-239	**8.9E-4**	**0.1411**	**8.2E-3**	**0.0465**
Pu-241	**3.7E-3**	**0.5865**	**2.8E-2**	**0.1588**
Pu-242	**4.8E-6**	**0.0008**	**2.4E-5**	**0.0001**
TOTALS	**6.31E-1**	**100%**	**1.76E+1**	**100%**

*** Reported as "Less Than" values (values in bold were positively identified)**

Nuclides with half-lives of < 100 days or naturally occurring isotopes e.g. K-40, Ra-226 and Th-228, were not included in the percent of total columns. These nuclides are not present in sufficient quantity to be significant. "Less than" values are assumed to be valid for calculations related to curie evaluations.

Table 2-9

Off-Site Core Bore Locations and Counting Results

Core Bore Sample No.	Location	Core Length	pCi/g Co-60	pCi/g Cs-137	pCi/g Eu-152
SX895010090 Slice 1	Saxton IGA Supermarket Sidewalk West Side	8.7 cm	<0.31	<0.31	<0.32
Slice 2	(same as above)	--	<0.26	<0.27	<0.28
SX895010091 Slice 1	Saxton IGA Supermarket Sidewalk East Side	8.7	<0.30	<0.28	<0.26
Slice 2	(same as above)	--	<0.34	<0.21	<0.29
SX895010092 Slice 1	Tussey Mountain High School, Front Sidewalk, West Side	9.8	<0.26	<0.25	<0.29
Slice 2	(same as above)	--	<0.23	<0.26	<0.27
SX895010093 Slice 1	Tussey Mountain High School, Front Sidewalk, East Side	8.4	<0.30	<0.29	<0.33
Slice 2	(same as above)	--	<0.28	<0.26	<0.25
SX895010095 Slice 1	South East Corner of Penelec Property, Concrete Slab #1	14.6	<0.25	<0.27	<0.28
Slice 2	(same as above)	--	<0.27	<0.23	<0.28
SX895010096 Slice 1	South East Corner of Penelec Property, Concrete Slab #2	10.8	<0.25	<0.27	<0.27
Slice 2	(same as above)	--	<0.33	<0.25	<0.28
SX895010097 Slice 1	Old Westinghouse Air Sample Station Pad, Penelec Property-NE	30.5	<0.26	<0.40	<0.26
Slice 2	(same as above)	--	<0.37	<0.27	<0.29
SX895010098 Slice 1	Penelec Line Shack, Front Sidewalk North Side	7.9	<0.28	<0.29	<0.26
Slice 2	(same as above)	--	<0.26	<0.24	<0.28
SX895010099 Slice 1	Penelec Line Shack, Front Sidewalk South Side	7.6	<0.28	<0.27	<0.29
Slice 2	(same as above)	--	<0.27	<0.21	<0.28

Concrete sample counting results from on-site, but outside of the containment vessel are reported in the following table.

Table 2-10

Counting Results, On-Site Core Bore Locations Outside Of CV.

Core Bore Sample No.	Location	Core Length	pCi/g Co-60	pCi/g Cs-137	pCi/g Eu-152
SX871950001 Slice 1	Concrete Slab Below Personnel Airlock At CV	11.9 cm	<0.32	1.09 ±0.30	<MDA**
Slice 2	(same as above)	--	<0.29	<0.24	<MDA
SX872950002* Subsurface Slice	Concrete Shield Wall External To CV (Used As Bkgnd Blank)	~10 cm	<0.28 (Avg.)	<0.30 (Avg.)	<0.27 (Avg.)
SX871950003 Slice 1	Concrete Ledge Adjacent To Northeast Side Of CV	11.6 cm	<0.23	2.00±0.40	<MDA
Slice 2	(same as above)	--	<0.29	<0.26	<MDA
SX871950004 Slice 1	Concrete Pad WNW Of CV - Former HEPA/Vent System	15 cm	<0.91	156.1±19.9	<MDA
Slice 2	(same as above)	--	<0.30	<0.38	<MDA
SX881950101 Slice 1	Concrete Core From Weir Floor	15.3 cm	<0.34	<0.34	<MDA
Slice 2	(same as above)	--	<0.36	<0.28	<MDA
SX882950102 Slice 1	Weir, Through Concrete Divider Wall (West End)	19.4 cm	<0.32	<0.33	<MDA
Slice 2	(same as above)	--	<0.27	<0.24	<MDA
Slice 8	Through Concrete Divider Weir Wall (East End)	--	<0.30	<0.25	<MDA
Surface Slice Slice 9	(same as above)	--	<0.34	0.73 ±0.24	<MDA
SX852950103 Slice 1	Through Concrete Support Wall In Tunnel (West End)	23.8 cm	<0.34	8.51 ±1.22	<MDA
Slice 2	(same as above)	--	<0.26	0.37 ±0.16	<MDA
Slice 3	(same as above)	--	<0.31	<0.27	<MDA
Slice 7	Through Concrete Support Wall In Tunnel (East End)	--	<0.36	<0.26	<MDA
Slice 8	(same as above)	--	<0.30	<0.27	<MDA
Surface Slice Slice 9	(same as above)	--	<0.34	2.72 ±0.51	<MDA

Table 2-10

Counting Results, On-Site Core Bore Locations Outside Of CV (Continued)

Core Bore Sample No.	Location	Core Length	pCi/g Co-60	pCi/g Cs-137	pCi/g Eu-152
SX853950104 Slice 1	Through Concrete Ceiling Of Tunnel (Top End-Outside)	37.3 cm	<0.33	12.56 ±1.76	<MDA
Slice 2	(same as above)	--	<0.33	<0.37	<MDA
Slice 3	(same as above)	--	<0.31	<0.28	<MDA
Slice 7	Through Concrete Ceiling Of Tunnel (Bottom End-Inside)	--	<0.29	<0.22	<MDA
Slice 8	(same as above)	--	<0.23	<0.22	<MDA
Surface Slice Slice 9	(same as above)	--	<0.29	0.58 ±0.20	<MDA
SX852950105 Slice 1	Tunnel Wall At South Entrance Hatch	15.9 cm	<0.31	1.35 ±0.31	<MDA
Slice 2	(same as above)	--	<0.26	<0.27	<MDA
Slice 3	(same as above)	--	<0.27	<0.24	<MDA
SX801950106 Slice 1	Westinghouse Area Concrete Pad Below SNEC Office Trailer	6.8 cm	<0.35	<0.37	<MDA
Slice 2	(same as above)	--	<0.34	<0.31	<MDA
SX801950107 Slice 1	Westinghouse Area Concrete Pad Below SNEC Office Trailer	9.7 cm	<0.29	<0.29	<MDA
Slice 2	(same as above)	--	<0.28	<0.25	<MDA
SX871950108 Slice 1	Shield Wall Adjacent To CV, NW Side (High n-Flux Region)	18.8 cm	<0.30	<0.33	<MDA
Slice 2	(same as above)	--	<0.30	<0.30	<MDA
Slice 9 Taken At A Depth Of ~17.5 to 18.8 cm Below Exposed Surface	(same as above)	--	<0.23	<0.17	<MDA

* This core was used as a background blank sample and counted frequently throughout the core bore analysis program.

** All <MDA values are approximately the same as that obtained for the blank or background core slice for this isotope.

Table 2-11

SNEC CV Concrete Core Bore Sample Locations.

SNEC Sample Number	Location
SX841950008	CV Floor, 818' El., West Side
SX841950009	CV Floor, 818' El., East Of 008
SX841950012	CV Floor Plug, 818' El.
SX842950013	Wall, Between 812' & 818' El., East Side
SX842950014	Wall Between 812' & 818' El., By Steps
SX842950015	Wall Between 812' & 818' El., North Side
SX841950016	CV Floor, 812' El., West Side Under Platform
SX841950017	CV Floor, 812' El., NE Of Reactor Cavity
SX841950018	CV Floor, 812' El., West Side By Platform
SX832950019	SW Wall, ~799' El., Above Water Line
SX832950020	CV Outer Wall, ~802" El.
SX832950021	CV SW Wall, ~791'6" El., At Water Line
SX832950022	North Wall, ~788' El.
SX832950023	North Wall, ~786' El.
SX812950024	CV Outer Wall, Rod Room, ~768' El.
SX811950025	CV Floor, Below RV, ~765'-8" El.
SX811950026	CV Floor, SE Corner Of Sump, ~765'-8" El.
SX811950027	CV Floor, Between Drain Pumps, ~765'-8" El.
SX811950028	CV Ledge, West Of Drain Tank, ~768' El.
SX812950029	CV Outer Wall, West Of Drain Tank, ~770' El.
SX812950030	Ledge/Wall, South Of Filter Cubicle, ~766' El.
SX822950031	SW Wall, ~10' East Of Hot Leg Penetration, ~789' El.
SX821950032	CV Floor Under S/G, ~779' El.
SX821950033	CV Floor Under S/G, ~779' El.
SX822950034	Wall East Of Non-Regen Heat Exchanger, ~782' El.
SX822950035	CV Outer Wall NW Of S/G, ~798' El.
SX822950036	SW Wall Next To Hot Leg, ~790'-8" El., At Water Line
SX822950037	SW Wall 8'-3" East Of Hot leg, ~799' El.
SX861950056	Storage Well Floor, ~765'-8" El.
SX861950057	Storage Well Floor, `765'-8" El.
SX862950058	Storage Well, Outer Wall, ~771' El.
SX862950059	Storage Well, Outer Wall, ~771' El.
SX862950060	Storage Well, Inner Wall, East Of Rx, ~768' El.
SX862950061	Storage Well, Inner Wall, East Of Rx, ~768' El.
SX862950062	Reactor Cavity Area, South Wall, 797' El.
SX862950063	Reactor Cavity Area, South Wall, 797' El.
SX862950064	Reactor Cavity, Shield Wall North West Of RV, 784' El.
SX862950065	Reactor Cavity, Shield Wall North East Of RV, 784' El.
SX861950066	Reactor Cavity Floor, ~779'-8" El.
SX862950119	CV Outer Wall, NE Of RV, In Hi-Flux Region, ~795' El.
SX841950120 To SX841950125	Reactor Cavity Shield Blocks, 1 To 6, ~812' to 807' El.

These locations are identified on Figures 2-6 through 2-10.

Table 2-12

Composite Results - Concrete Core Bore Sample SX862950119.

Isotope	As % Of Total Activity
Ag-108m	0.0266
Am-241	0.0464
Ce-144	0.0924
Co-60	**2.4443**
Cs-134	0.0213
Cs-137	**7.5581**
C-14	2.3263
Eu-152	**3.5327**
Eu-154	**0.1996**
Eu-155	0.0489
H-3	**63.5044**
I-129	0.4071
Nb-94	0.0204
Ni-59	**0.7042**
Ni-63	**18.6422**
Ru-106	0.1540
Sb-125	0.0506
Tc-99	0.2206

Note: Isotopes listed above in bold text were positively identified.

Table 2-13

Comparison Of SNEC and B&W Concrete Analysis Results (pCi/g)

No.	Core Bore Sample No.	SNEC Number	Co-60 SNEC	Cs-137 SNEC	Eu-152 SNEC	Eu-154 SNEC	Co-60 B&W	Cs-137 B&W	Eu-152 B&W	Eu-154 B&W
1	0091	0127	<0.29	<0.24	<0.27	N/R	<0.01	0.12	<0.11	<0.04
2	0026, 0027	0128	<0.96	1717	<1.87	N/R	0.5	1480	<0.35	<0.09
3	0032, 0033	0129	8.14	5836	<2.56	N/R	6.37	4690	0.73	<0.13
4	0021	0130	<0.84	12.16	<0.65	N/R	0.26	58.6	<0.14	<0.15
5	0021	0131	2.07	6.87	<0.38	N/R	1.32	14.2	<0.44	<0.10
6	0021	0132	<0.31	0.36	<0.29	N/R	0.03	1.24	<0.18	<0.06
7	0016, 0017, 0018	0133	<0.61	15.01	<0.65	N/R	0.1	13.5	<0.14	<0.05
8	0103	0134	<0.31	3.05	<0.3	N/R	0.03	3.06	<0.13	<0.05
9	0056, 0057	0135	24.69	10668	<4.29	N/R	31.9	13800	<4.49	<0.51
10	0056, 0057	0136	<1.17	665.2	<2.34	N/R	2.15	945	<0.64	<0.14
11	0025	0137	3.25	6074	<6.7	N/R	1.9	7180	2.16	<0.23
12	0025	0138	<0.51	1419	<3.04	N/R	0.29	1870	2.61	<0.10
13	0025	0139	<0.38	18.34	<0.47	N/R	0.21	31.4	1.18	<0.15
14	0025	0140	<0.36	2.82	<0.33	N/R	0.05	11.5	<0.48	<0.15
15	0031	0141	<0.65	108.8	<1.28	N/R	0.16	127	<0.17	<0.05
16	0031	0142	14.8	195.8	<1.08	N/R	14.5	246	<0.89	<0.15
17	0031	0143	<0.4	6.55	<0.37	N/R	0.12	13.8	<0.18	<0.07
18	0031	0144	<0.33	4.77	<0.32	N/R	<0.03	8.98	<0.18	<0.06
19	0037	0145	<0.65	106.4	<0.79	N/R	0.09	132	<0.15	<0.05
20	0037	0146	3.41	29.22	7.09	N/R	2.67	27.8	9.31	0.59
21	0037	0147	<0.36	17.28	<0.53	N/R	0.1	32.1	0.33	<0.08
22	0037	0148	<0.99	7.63	5.1	N/R	0.88	14.9	7.57	0.37
23	0125	0149	1.4	3.43	5.91	N/R	1.47	6.47	10.7	0.64
24	0125	0150	<0.68	0.39	6.01	N/R	0.92	1.62	9.05	0.61
25	0125	0151	<0.33	0.19	2.22	N/R	0.32	1.08	3.3	<0.14
26	0125	0152	<0.23	0.23	<0.26	N/R	0.08	1.89	0.48	<0.04
27	0066	0153	14.97	498.6	<2.49	N/R	11.8	513	<0.78	<0.13
28	0066	0154	<0.32	1.06	<0.28	N/R	0.13	3.66	<0.26	<0.09
29	0062	0155	11.22	127.3	5.67	N/R	8.81	119	8.4	0.59
30	0062	0156	0.97	35.86	6.45	N/R	1.25	46.7	10.2	0.37
31	0063	0157	25.72	211.2	4.92	N/R	15.7	261	7.81	0.56
32	0063	0158	1.12	0.41	6.8	N/R	1.7	3.94	10.6	0.53
33	0065	0159	<1.23	36.82	<0.79	N/R	1.09	37.4	<0.16	<0.05
34	0065	0160	<0.38	0.6	<0.27	N/R	0.12	1.39	<0.23	<0.07
35	0119	0161	11.53	279.9	22.99	<3.27	9.02	233	31.5	1.94
36	0119	0162	53.39	0.83	25.89	<2.12	92.896	5.67	46.99	3.34
37	0119	0163	4.02	0.69	37.37	<2.25	4.42	2.19	60.8	2.67
38	0119	0164	2.12	0.56	22.56	<1.96	2.59	1.66	32	1.32

Note: SNEC number 0162 above, is the composite results from the rebar and concrete sample materials. Presence of rebar affected the SNEC counting results for this sample (slice 6, SX862950119). A rebar locator was used to avoid rebar in all other sampling locations.
N/R - Not Reported.

Table 2-14

Surface Soil Samples

Sample Location #	SNEC Sample Number	Grid Location (LL PIN)	Cs-137 (pCi/gm)
37	SX-9-SL-99-0037	AV-127	0.12
38	SX-9-SL-99-0038	BA-127	0.2
39	SX-9-SL-99-0039	BA-125	0.24
41	SX-10-SL-99-0041	BC-124	2.2
42	SX-12-SL-99-0042	BD-101	0.09
43	SX-12-SL-99-0043	BB-108	0.09
44	SX-10-SL-99-0044	BD-129	1.3
45	SX-10-99-0045	BK-137	1.3
46	SX-10-SL-99-0046	BC-129	0.9
47	SX-10-SL-99-0047	BD-130	0.92
48	SX-10-SL-99-0048	AV-125	0.6
49	SX-10-SL-99-0049	BA-127	<MDA (0.05)
50	SX-10-SL-99-0050	AV-129	<MDA (0.05)
51	SX-10-SL-99-0051	BC-125	1.7
52	SX-9-SL-99-0052	AU-125	0.66
53	SX-11-SL-99-0053	AJ-107	<MDA (0.07)
54	SX-11-SL-99-0054	BK-112	<MDA (0.07)
55	SX-11-SL-99-0055	AE-103	1
56	SX-11-SL-99-0056	AK-92	0.16
57	SX-11-SL-99-0057	AE-102	0.92
58	SX-10-SL-99-0058	BD-122	0.14
59	SX-10-SL-99-0059	AH-119	<MDA (0.07)
60	SX-11-SL-99-0060	BL-91	0.5
61	SX-11-SL-99-0061	AN-94	1.2
62	SX-11-SL-99-0062	AK-112	<MDA (0.08)
63	SX-11-SL-99-0063	BP-143	0.4
64	SX-9-SL-99-0064	BA-126	0.73
65	SX-10-SL-0065	BO-137	0.13
66	SX-10-SL-0066	BD-126	1
67	SX-11-SL-0067	AE-136	<MDA (0.09)
68	SX-10-SL-0068	BD-124	0.6
69	SX-10-SL-0069	BC-140	1.1
70	SX-11-SL-0070	BJ-117	0.9
71	SX-11-SL-0071	BP-95	0.3
72	SX-10-SL-0072	AY-119	0.18
73	SX-11-SL-0073	BK-130	0.11
74	SX-12-SL-0074	AU-99	1.1
75	SX-11-SL-0075	BO-110	<MDA (0.08)
76	SX-11-SL-0076	AJ-146	1.3
77	SX-12-SL-0077	AB-146	<MDA (0.09)
78	SX-11-SL-0078	BA-115	0.6

Note: Cs-137 was the only positively identified radionuclide resulting from licensed operations.
See Figures 2-13 and 2-14 for surface soil sampling locations.

Table 2-14

Surface Soil Samples (Continued)

Sample Location #	SNEC Sample Number	Grid Location (LL PIN)	Cs-137 (pCi/gm)
79	SX-11-SL-0079	BF-123	1.1
80	SX-10-SL-0080	AM-127	0.7
81	SX-11-0081	AP-120	<MDA (0.09)
82	SX-11-0082	BO-137	0.25
83	SX-11-0083	BC-107	0.04
84	SX-11-0084	BD-122	1.2
85	SX-11-0085	AP-144	1.2
86	SX-11-0086	AN-126	2.1
87	SX-10-0087	BF-143	1.7
88	SX-11-0088	BE-141	0.7
89	SX-11-0089	BE-140	1
90	SX-10-0090	AN-140	0.8
91	SX-10-0091	BC-138	1.3
92	SX-11-0092	BI-106	<MDA (0.1)

Note: Cs-137 was the only positively identified radionuclide resulting from licensed operations.
See Figures 2-13 and 2-14 for surface soil sampling locations.

Table 2-15
SNEC Subsurface Soil Sample Results

Sample Location	SNEC Sample Number	Sample Depth (Feet)	Cs-137 (pCi/g)
Sample #AK112	SX-11-SL-99-221	0 to 3	<MDA (0.21)
Sample #AK112	SX-11-SL-99-140	3 to 6	<MDA (0.25)
Sample #M-1	SX-9-SL-99-206	0 to 3	<MDA (0.18)
Sample #M-1	SX-9-SL-99-194	4 to 8	0.66
Sample #M-1	SX-9-SL-99-207	9 to 16	0.17
Sample #M-2	SX-9-SL-99-195	0 to 3	1.8
Sample #M-2	SX-9-SL-99-196	4 to 6	0.54
Sample #M-2	SX-9-SL-99-197	7 to 12	0.49
Sample #1	SX-11-SL-99-229	0 to 3	0.47
Sample #1	SX-9-SL-99-208	4 to 6	0.45
Sample #2	SX-11-SL-99-233	0 to 3	0.33
Sample #2	SX-9-SL-99-204	4 to 6	<MDA (0.06)
Sample #3	SX-11-SL-99-226	0 to 3	<MDA (0.2)
Sample #3	SX-9-SL-99-205	4 to 6	<MDA (0.11)
Sample #4	SX-11-SL-99-230	0 to 4	0.21
Sample #5	SX-11-SL-99-251	0 to 1	<MDA (0.2)
Sample #6	SX-10-SL-99-167	0 to 3	0.5
Sample #7	SX-12-SL-99-241	0 to 4	0.22
Sample #7	SX-11-SL-99-235	4 to 5	<MDA (0.14)
Sample #9	SX-10-SL-99-170	4 to 6	<MDA (0.14)
Sample #9	SX-10-SL-99-169	7 to 12	<MDA (0.08)
Sample #10	SX-9-SL-99-201	0 to 7	0.51
Sample #10	SX-9-SL-99-210	8 to 12	1.4
Sample #11	SX-9-SL-99-209	0 to 3	0.79
Sample #11	SX-9-SL-99-202	4 to 6	9.3
Sample #11	SX-9-SL-99-203	7 to 12	0.34
Sample #12	SX-9-SL-99-218	0 to 3	<MDA (0.11)
Sample #12	SX-10-SL-99-222	4 to 9	<MDA (0.18)
Sample #13	SX-9-SL-99-185	0 to 3	1.5
Sample #13	SX-9-SL-99-186	10 to 14.5	3.3
Sample #14	SX-9-SL-99-228	0 to 3	<MDA (0.12)
Sample #14	SX-9-SL-99-224	4 to 5	<MDA (0.08)
Sample #15	SX-9-SL-99-242	0 to 4	<MDA (0.10)
Sample #15	SX-9-SL-99-236	4 to 5	<MDA (0.06)
Sample #16	SX-10-SL-99-171	0 to 3	0.1
Sample #16	SX-10-SL-99-181	3 to 6	<MDA (0.12)
Sample #17	SX-10-SL-99-182	0 to 3	<MDA (0.19)
Sample #17	SX-10-SL-99-165	3 to 6	<MDA (0.14)
Sample #18	SX-9-SL-99-211	0 to 2	0.48
Sample #19	SX-9-SL-99-213	0 to 3	<MDA (0.2)
Sample #19	SX-9-SL-99-215	3 to 4	0.32
Sample #20	SX-9-SL-99-216	0 to 3	0.27
Sample #20	SX-9-SL-99-220	4 to 8	<MDA (0.2)
Sample #20	SX-9-SL-99-214	9 to 12	<MDA (0.2)

Note: Cs-137 was the only positively identified radionuclide resulting from licensed operations.
See Figures 2-15 and 2-16 for sub-surface soil sampling locations.

Table 2-15
SNEC Subsurface Soil Sample Results (Continued)

Sample Location	SNEC Sample Number	Sample Depth (Feet)	Cs-137 (pCi/g)
Sample #21	SX-9-SL-99-200	0 to 3	<MDA (0.2)
Sample #21	SX-9-SL-99-212	4 to 6	0.12
Sample #22	SX-10-SL-99-173	0 to 3	<MDA (0.15)
Sample #22	SX-11-SL-99-190	0 to 3	0.33
Sample #22	SX-11-SL-99-193	4 to 6	<MDA (0.07)
Sample #23	SX-11-SL-99-192	0 to 3	<MDA (0.120
Sample #23	SX-11-SL-99-174	4 to 6	0.1
Sample #24	SX-10-SL-99-191	0 to 4	0.57
Sample #24	SX-10-SL-99-198	0 to 4	0.38
Sample #24	SX-10-SL-99-187	5 to 6	0.078
Sample #25	SX-11-SL-99-232	3 to 6	<MDA (0.18)
Sample #25	SX-11-SL-99-238	0 to 3	0.2
Sample #26	SX-11-SL-99-237	0 to 4	<MDA (0.13)
Sample #26	SX-11-SL-99-240	4 to 6	<MDA (0.16)
Sample #27	SX-11-SL-99-239	0 to 3.5	0.97
Sample #28	SX-10-SL-99-199	0 to 3	1.4
Sample #28	SX-9-SL-99-217	7 to 12	0.69
Sample #28	SX-9-SL-99-227	4 to 6	0.42
Sample #29	SX-9-SL-99-219	0 to 5	0.59
Sample #30	SX-11-SL-99-141	0 to 3	<MDA (0.2)
Sample #30	SX-11-SL-99-142	3 to 6	<MDA (0.18)
Sample #30	SX-11-SL-99-168	3 to 5	<MDA (0.13)
Sample #31	SX-11-SL-99-138	0 to 3	<MDA (0.17)
Sample #31	SX-11-SL-99-139	3 to 6	<MDA (0.24)
Sample #33	SX-10-SL-99-172	0 to 3	<MDA (0.19)
Sample #33	SX-10-SL-99-188	4 to 6	<MDA (0.11)
Sample #34	SX-10-SL-99-166	0 to 3	0.16
Sample #34	SX-10-SL-99-189	4 to 6	<MDA (0.080
Sample #35	SX-11-SL-99-231	0 to 4	<MDA (0.11)
Sample #35	SX-11-SL-99-234	0 to 3	<MDA (0.13)
Sample #36	SX-9-SL-99-245	4 to 8	0.69
Sample #36	SX-9-SL-99-248	0 to 4	1.1
Sample #36	SX-9-SL-99-249	8 to 12	0.36
Sample #36	SX-9-SL-99-250	0 to 6	0.44
Sample #37	SX-10-SL-99-244	0 to 4	<MDA (0.1)
Sample #37	SX-10-SL-99-246	4 to 6	<MDA (0.12)
Sample #38	SX-10-SL-99-243	1 to 2	<MDA (0.17)
Sample #39	SX-10-SL-99-247	0 to 2	<MDA (0.07)

Note: Cs-137 was the only positively identified radionuclide resulting from licensed operations.

See Figures 2-15 and 2-16 for sub-surface soil sampling locations.

Table 2-16
SNEC Subsurface Gamma Logging Results

Hole	Depth* (ft)	Cs137 (pCi/g)				Co60 (pCi/g)		
		Conc.	"±2σ"	MDA		Conc.	"±2σ"	MDA
1	1	0.8	0.3	0.2		<MDA	0.1	0.3
1	2	0.2	0.2	0.2		<MDA	0.1	0.3
1	3	<MDA	0.2	0.2		<MDA	0.1	0.3
1	4	<MDA	0.2	0.2		<MDA	0.1	0.3
1	5	<MDA	0.2	0.3		<MDA	0.2	0.4
1	6	<MDA	0.2	0.3		<MDA	0.1	0.4
1	1d	0.7	0.4	0.3		<MDA	0.1	0.4
2	1	0.6	0.3	0.2		<MDA	0.1	0.3
2	2	<MDA	0.1	0.2		<MDA	0.1	0.3
2	3	<MDA	0.2	0.3		<MDA	0.2	0.4
3	1	0.2	0.2	0.2		<MDA	0.1	0.3
3	2	<MDA	0.2	0.2		<MDA	0.1	0.4
3	3	<MDA	0.2	0.3		<MDA	0.2	0.4
3	4	<MDA	0.2	0.3		<MDA	0.1	0.5
3	5	<MDA	0.2	0.3		<MDA	0.1	0.5
3	6	<MDA	0.2	0.3		<MDA	0.1	0.4
3	7	<MDA	0.2	0.3		<MDA	0.1	0.4
3	2d	<MDA	0.2	0.3		<MDA	0.2	0.4
4	1	<MDA	0.3	0.5		<MDA	0.2	0.7
4	2	<MDA	0.3	0.3		<MDA	0.2	0.5
4	3	<MDA	0.2	0.3		<MDA	0.1	0.4
4	4	<MDA	0.2	0.3		<MDA	0.1	0.4
4	5	<MDA	0.2	0.3		<MDA	0.1	0.4
5	1	<MDA	0.2	0.2		<MDA	0.1	0.3
5	2	<MDA	0.2	0.3		<MDA	0.2	0.4
6	1	0.9	0.3	0.2		<MDA	0.1	0.3
6	2	0.6	0.3	0.2		<MDA	0.1	0.3
6	3	<MDA	0.2	0.2		<MDA	0.1	0.3
7	1	0.3	0.2	0.2		<MDA	0.1	0.3
7	2	0.4	0.2	0.2		<MDA	0.1	0.4
7	3	<MDA	0.2	0.2		<MDA	0.1	0.3
7	4	<MDA	0.2	0.3		<MDA	0.2	0.4
9	1	0.8	0.3	0.1		<MDA	0.1	0.2
9	2	0.8	0.4	0.3		<MDA	0.2	0.5
9	3	<MDA	0.3	0.3		<MDA	0.2	0.5
9	4	<MDA	0.3	0.3		<MDA	0.2	0.5
9	5	<MDA	0.3	0.4		<MDA	0.2	0.5
9	6	<MDA	0.2	0.3		<MDA	0.1	0.4
9	7	<MDA	0.2	0.3		<MDA	0.1	0.4
9	8	0.2	0.1	0.1		<MDA	0.1	0.2
9	9	<MDA	0.2	0.3		<MDA	0.2	0.4
9	10	<MDA	0.3	0.4		<MDA	0.2	0.5

Table 2-16, SNEC Subsurface Gamma Logging Results (Continued)

Hole	Depth* (ft)	Cs137 (pCi/g)				Co60 (pCi/g)		
		Conc.	"±2σ"	MDA		Conc.	"±2σ"	MDA
9	11	<MDA	0.3	0.3		<MDA	0.2	0.5
9	12	<MDA	0.2	0.3		<MDA	0.2	0.5
9	13	<MDA	0.2	0.3		<MDA	0.2	0.5
10	1	<MDA	0.2	0.2		<MDA	0.1	0.3
10	2	1.5	0.5	0.3		<MDA	0.1	0.4
10	3	1.4	0.5	0.3		<MDA	0.2	0.4
10	4	3.7	1.0	0.3		<MDA	0.2	0.5
10	5	0.9	0.4	0.3		<MDA	0.2	0.5
10	6	7.9	2.0	0.4		<MDA	0.2	0.5
10	7	28.6	7.2	0.7		<MDA	0.4	0.9
10	8	17.0	4.2	0.4		<MDA	0.2	0.6
10	9	2.8	0.8	0.2		<MDA	0.2	0.3
10	10	0.9	0.4	0.3		<MDA	0.2	0.5
10	11	<MDA	0.3	0.3		<MDA	0.2	0.5
10	12	<MDA	0.3	0.3		<MDA	0.2	0.5
10	4d	3.2	1.0	0.4		<MDA	0.2	0.5
11	1	0.2	0.2	0.2		<MDA	0.1	0.3
11	2	2.0	0.6	0.2		<MDA	0.1	0.3
11	3	0.5	0.3	0.3		<MDA	0.1	0.4
11	4	1.1	0.4	0.2		<MDA	0.1	0.3
11	5	5.5	1.5	0.3		<MDA	0.1	0.4
11	6	109.9	23.2	0.3		<MDA	0.2	0.4
11	7	17.4	4.1	0.4		<MDA	0.2	0.5
11	8	1.6	0.5	0.3		<MDA	0.1	0.4
11	9	0.2	0.2	0.2		<MDA	0.1	0.3
11	10	0.3	0.2	0.3		<MDA	0.1	0.4
11	11	<MDA	0.2	0.3		<MDA	0.1	0.4
11	12	0.2	0.2	0.2		<MDA	0.1	0.3
11	13	0.5	0.3	0.3		<MDA	0.2	0.4
12	1	<MDA	0.2	0.2		<MDA	0.1	0.3
12	2	<MDA	0.2	0.4		<MDA	0.2	0.5
12	3	<MDA	0.2	0.3		<MDA	0.2	0.5
12	4	<MDA	0.2	0.3		<MDA	0.2	0.4
12	5	<MDA	0.2	0.4		<MDA	0.1	0.5
12	6	<MDA	0.3	0.4		<MDA	0.2	0.5
12	7	<MDA	0.2	0.4		<MDA	0.2	0.5
12	8	<MDA	0.2	0.3		<MDA	0.2	0.4
12	9	<MDA	0.3	0.3		<MDA	0.1	0.5
12	2d	<MDA	0.3	0.4		<MDA	0.2	0.5
13	0	0.6	0.2	0.1		<MDA	0.1	0.2
13	1	0.1	0.1	0.1		<MDA	0.1	0.2
13	2	0.5	0.2	0.2		<MDA	0.1	0.3

Table 2-16, SNEC Subsurface Gamma Logging Results (Continued)

Hole	Depth* (ft)	Cs137 (pCi/g)				Co60 (pCi/g)		
		Conc.	"±2σ"	MDA		Conc.	"±2σ"	MDA
13	3	3.6	1.0	0.3		<MDA	0.1	0.4
13	4	5.3	1.4	0.4		<MDA	0.2	0.5
13	5	2.7	0.7	0.2		<MDA	0.1	0.3
13	6	2.1	0.6	0.2		<MDA	0.1	0.3
13	7	2.2	0.7	0.2		<MDA	0.1	0.3
13	8	12.7	3.2	0.3		<MDA	0.1	0.5
13	9	66.2	14.0	0.2		<MDA	0.2	0.3
13	10	8.9	2.1	0.2		<MDA	0.1	0.3
13	11	0.2	0.2	0.2		<MDA	0.1	0.4
13	12	0.2	0.2	0.2		<MDA	0.1	0.3
13	13	0.4	0.3	0.2		<MDA	0.1	0.3
13	14	0.3	0.2	0.3		<MDA	0.2	0.4
13	1S	<MDA	0.2	0.2		<MDA	0.1	0.3
13	9d	63.8	14.5	0.5		<MDA	0.3	0.8
14	1	<MDA	0.2	0.2		<MDA	0.2	0.3
14	2	<MDA	0.2	0.3		<MDA	0.2	0.4
14	3	<MDA	0.1	0.2		<MDA	0.1	0.3
15	1	0.2	0.1	0.2		<MDA	0.1	0.3
15	2	<MDA	0.2	0.4		<MDA	0.1	0.5
15	3	<MDA	0.2	0.3		<MDA	0.1	0.4
16	1	0.4	0.2	0.2		<MDA	0.1	0.3
16	2	<MDA	0.2	0.3		<MDA	0.1	0.4
16	3	<MDA	0.2	0.3		<MDA	0.1	0.4
16	4	<MDA	0.2	0.2		<MDA	0.1	0.3
17	1	0.3	0.2	0.2		<MDA	0.1	0.3
17	2	0.5	0.3	0.3		<MDA	0.1	0.4
17	3	<MDA	0.2	0.3		<MDA	0.1	0.4
18	1	4.7	1.3	0.3		<MDA	0.2	0.4
18	2	0.2	0.2	0.2		<MDA	0.1	0.3
18	1d	5.1	1.4	0.3		<MDA	0.2	0.4
19	1	0.3	0.2	0.3		<MDA	0.2	0.4
19	2	<MDA	0.2	0.3		<MDA	0.2	0.4
19	3	<MDA	0.2	0.3		<MDA	0.2	0.5
20	1	0.7	0.3	0.2		<MDA	0.1	0.3
20	2	<MDA	0.2	0.3		<MDA	0.2	0.4
20	3	0.4	0.3	0.3		<MDA	0.2	0.4
20	4	0.4	0.3	0.3		<MDA	0.1	0.5
20	5	0.4	0.3	0.3		<MDA	0.2	0.5
20	6	0.3	0.2	0.3		<MDA	0.2	0.4
20	7	<MDA	0.2	0.3		<MDA	0.1	0.4
20	8	<MDA	0.2	0.3		<MDA	0.2	0.4
21	1	<MDA	0.2	0.2		<MDA	0.1	0.3

Table 2-16, SNEC Subsurface Gamma Logging Results (Continued)

Hole	Depth* (ft)	Cs137 (pCi/g)				Co60 (pCi/g)		
		Conc.	"±2σ"	MDA		Conc.	"±2σ"	MDA
21	2	0.2	0.2	0.2		<MDA	0.1	0.4
21	3	<MDA	0.2	0.2		<MDA	0.1	0.3
21	4	<MDA	0.2	0.2		<MDA	0.1	0.4
21	5	<MDA	0.2	0.3		<MDA	0.1	0.4
21	2d	<MDA	0.2	0.3		<MDA	0.2	0.4
22	1	<MDA	0.1	0.2		<MDA	0.1	0.3
22	2	<MDA	0.1	0.2		<MDA	0.1	0.3
22	3	<MDA	0.2	0.2		<MDA	0.1	0.3
22	4	<MDA	0.1	0.2		<MDA	0.1	0.3
23	1	<MDA	0.1	0.2		<MDA	0.1	0.3
23	2	<MDA	0.1	0.1		<MDA	0.1	0.2
23	3	<MDA	0.1	0.2		<MDA	0.1	0.3
24	1	0.5	0.2	0.1		<MDA	0.1	0.2
24	2	0.7	0.3	0.2		<MDA	0.1	0.2
24	3	0.6	0.3	0.2		<MDA	0.1	0.3
24	4	0.3	0.2	0.2		<MDA	0.1	0.2
24	5	0.2	0.1	0.1		<MDA	0.1	0.2
24	1d	0.6	0.3	0.2		0.3	0.1	0.3
25	1	<MDA	0.2	0.3		<MDA	0.1	0.4
25	2	<MDA	0.3	0.5		<MDA	0.3	0.7
25	3	<MDA	0.3	0.4		<MDA	0.2	0.6
26	1	<MDA	0.2	0.2		<MDA	0.1	0.4
26	2	<MDA	0.2	0.3		<MDA	0.1	0.4
26	3	<MDA	0.2	0.3		<MDA	0.1	0.4
26	4	<MDA	0.2	0.3		<MDA	0.2	0.4
26	5	<MDA	0.2	0.3		<MDA	0.2	0.5
26	6	<MDA	0.2	0.3		<MDA	0.2	0.5
27	1	0.8	0.3	0.2		<MDA	0.1	0.3
27	2	<MDA	0.2	0.3		<MDA	0.1	0.4
27	1d	0.9	0.3	0.2		<MDA	0.1	0.4
28	1	0.2	0.2	0.2		<MDA	0.1	0.3
28	2	3.7	1.0	0.3		<MDA	0.2	0.4
28	3	2.0	0.6	0.2		<MDA	0.2	0.4
28	4	0.5	0.3	0.2		<MDA	0.1	0.3
28	5	<MDA	0.2	0.2		<MDA	0.1	0.3
28	6	0.4	0.2	0.2		<MDA	0.1	0.3
28	7	0.7	0.3	0.3		<MDA	0.1	0.4
28	8	1.1	0.4	0.2		<MDA	0.1	0.3
28	9	2.0	0.6	0.3		<MDA	0.1	0.4
28	10	1.6	0.5	0.2		<MDA	0.2	0.4
28	11	1.0	0.4	0.2		<MDA	0.1	0.4
28	12	0.1	0.1	0.1		<MDA	0.1	0.2

Table 2-16, SNEC Subsurface Gamma Logging Results (Continued)

Hole	Depth* (ft)	Cs137 (pCi/g)				Co60 (pCi/g)		
		Conc.	"±2σ"	MDA		Conc.	"±2σ"	MDA
29	1	1.0	0.3	0.2		<MDA	0.1	0.2
29.	2	1.7	0.5	0.2		<MDA	0.1	0.3
29	3	5.7	1.4	0.3		<MDA	0.2	0.4
29	4	0.8	0.3	0.3		<MDA	0.1	0.4
29	5	<MDA	0.1	0.2		<MDA	0.1	0.2
30	1	<MDA	0.1	0.2		<MDA	0.1	0.2
30	2	<MDA	0.1	0.2		<MDA	0.1	0.3
30	3	<MDA	0.1	0.2		<MDA	0.1	0.3
30	4	<MDA	0.1	0.2		<MDA	0.1	0.2
31	1	0.2	0.2	0.2		<MDA	0.1	0.3
31	2	<MDA	0.2	0.4		<MDA	0.1	0.6
31	3	<MDA	0.3	0.5		<MDA	0.2	0.7
31	4	<MDA	0.3	0.4		<MDA	0.2	0.7
31	5	<MDA	0.3	0.4		<MDA	0.2	0.6
31	6	<MDA	0.3	0.4		<MDA	0.2	0.7
31	4d	<MDA	0.3	0.4		<MDA	0.2	0.6
33	1	<MDA	0.2	0.3		<MDA	0.1	0.4
33	2	<MDA	0.2	0.3		<MDA	0.1	0.4
33	3	<MDA	0.1	0.2		<MDA	0.1	0.3
34	1	<MDA	0.2	0.2		<MDA	0.1	0.3
34	2	<MDA	0.2	0.2		<MDA	0.1	0.3
34	3	<MDA	0.2	0.3		<MDA	0.1	0.4
34	1d	0.3	0.3	0.2		<MDA	0.1	0.4
35	1	0.2	0.2	0.2		<MDA	0.1	0.3
35	2	0.3	0.2	0.2		<MDA	0.1	0.4
35	3	<MDA	0.1	0.1		<MDA	0.1	0.2
36	1	0.9	0.4	0.3		<MDA	0.2	0.5
36	2	<MDA	0.2	0.3		<MDA	0.2	0.5
36	3	<MDA	0.2	0.3		<MDA	0.1	0.5
36	4	<MDA	0.2	0.3		<MDA	0.2	0.5
36	5	<MDA	0.2	0.3		<MDA	0.2	0.4
36	6	<MDA	0.2	0.3		<MDA	0.2	0.5
36	7	0.3	0.3	0.2		<MDA	0.1	0.4
36	8	<MDA	0.2	0.3		<MDA	0.2	0.5
36	9	<MDA	0.2	0.3		<MDA	0.1	0.4
36	10	<MDA	0.2	0.3		<MDA	0.2	0.4
36	11	<MDA	0.2	0.3		<MDA	0.1	0.4
37	1	<MDA	0.1	0.2		<MDA	0.1	0.3
37	2	<MDA	0.2	0.3		<MDA	0.2	0.5
37	3	<MDA	0.2	0.3		<MDA	0.2	0.5
37	4	<MDA	0.2	0.3		<MDA	0.2	0.5
37	5	<MDA	0.2	0.3		<MDA	0.2	0.5

Table 2-16, SNEC Subsurface Gamma Logging Results (Continued)

Hole	Depth* (ft)	Cs137 (pCi/g)				Co60 (pCi/g)		
		Conc.	"±2σ"	MDA		Conc.	"±2σ"	MDA
38	1	<MDA	0.2	0.3		<MDA	0.1	0.5
39	1	<MDA	0.2	0.3		<MDA	0.1	0.4
AK112	1	<MDA	0.1	0.2		<MDA	0.1	0.3
AK112	3	<MDA	0.2	0.3		<MDA	0.1	0.4
M1	1	<MDA	0.2	0.2		<MDA	0.1	0.3
M1	2	0.4	0.3	0.3		<MDA	0.2	0.5
M1	3	0.3	0.2	0.3		<MDA	0.1	0.4
M1	4	0.4	0.3	0.4		<MDA	0.2	0.6
M1	5	0.3	0.2	0.2		<MDA	0.1	0.3
M1	6	0.4	0.3	0.3		<MDA	0.2	0.4
M1	7	0.6	0.3	0.2		<MDA	0.1	0.4
M1	8	<MDA	0.1	0.3		<MDA	0.1	0.4
M1	9	0.4	0.3	0.3		<MDA	0.1	0.4
M2	1	<MDA	0.2	0.2		<MDA	0.1	0.3
M2	2	2.5	0.7	0.3		<MDA	0.1	0.4
M2	3	<MDA	0.2	0.3		<MDA	0.1	0.5
M2	4	<MDA	0.2	0.3		<MDA	0.1	0.4
M2	5	<MDA	0.1	0.1		<MDA	0.1	0.2
M2	6	<MDA	0.1	0.2		<MDA	0.1	0.3
M2	7	0.5	0.3	0.3		<MDA	0.1	0.4
M2	8	2.3	0.7	0.3		<MDA	0.1	0.4
M2	9	1.7	0.5	0.3		<MDA	0.1	0.4
M2	10	0.8	0.3	0.2		<MDA	0.1	0.3
M2	11	<MDA	0.3	0.3		<MDA	0.1	0.4
M2	12	0.2	0.2	0.2		<MDA	0.2	0.3
M2	13	<MDA	0.2	0.3		<MDA	0.1	0.4
M2	14	<MDA	0.2	0.3		<MDA	0.1	0.4
M2	15	<MDA	0.2	0.3		<MDA	0.1	0.4
M2	2d	2.2	0.7	0.3		<MDA	0.2	0.5

* Depth to Bottom of interval, e.g., 1 is 0' to 1', 2 is 1' to 2', etc.
"d" In the "Depth" column represents a duplicate or repeat measurement at that depth.
Note: Cs-137 and Co-60 were the only positively identified radionuclides resulting from licensed operations.

See Figures 2-15 and 2-16 for sub-surface gamma logging locations.

Table 2-17

Groundwater Monitoring Results

1998 Tritium Results of Groundwater Analysis
Activity ± 2σ
pCi/l

Monitoring Well	First Qtr 01/08/98	Second Qtr 04/15/98	Third Qtr 07/09/98	Fourth Qtr 10/08/98
GEO-1	< 150	120 ± 80	< 120	150 ± 80
GEO-2	< 150	< 120	< 120	< 120
GEO-3	< 150	< 120	< 120	*
GEO-4	< 150	< 120	< 120	*
GEO-5	< 150	140 ± 80	< 120	< 130
GEO-6	< 150	< 120	< 120	< 120
GEO-7	< 150	< 120	< 120	< 120
GEO-8	< 150	< 120	< 120	*
GEO-10	*	< 120**	< 120	140 ± 80
SX-GW-MW1	< 150	< 140	180 ± 80	*
SX-GW-MW2	< 150	< 140	< 120	< 120
SX-GW-MW3	*	150 ± 80**	< 120	150 ± 80
SX-GW-MW4	*	140 ± 80**	< 120	< 120
SX-GW-E1-1	< 150	< 120	< 120	< 120
SX-GW-G1-1	< 150	< 120	< 120	< 120

Note: Tritium (H3) was the only positively identified radionuclide resulting from licensed operations.

- * No sample collected
- ** Sampled on 05/28/98

See Figure 2-17 for well locations.

Table 2-18

Historical Groundwater Monitoring Results for well GEO-5

TRITIUM RESULTS

Activity ± 2σ

Date	**Result** (pCi/L)
7/13/94	MDA (<170)
10/06/94	560 ∓130
10/27/94	310 ∓120
1/12/95	MDA (<190)
4/05/95	MDA (<180)
5/30/95	270 ∓120
6/13/95	370 ∓130
7/13/95	370 ∓110
8/17/95	390 ∓130
9/15/95	410 ∓130
10/18/95	760 ∓140
11/17/95	MDA (<200)
1/25/96	MDA (<190)
4/03/96	MDA (<150)
7/10/96	MDA (<140)
10/03/96	MDA (<140)
1/08/97	MDA (<140)
4/16/97	MDA (<150)
7/09/97	MDA (<150)
10/01/97	180 ∓100
1/08/98	MDA (<150)
4/15/98	140 ∓80
7/09/98	MDA (<120)
10/08/98	MDA (<130)

Table 2-19

Quarterly Results of Aquatic Sediment Analysis

Activity ± 2σ
pCi/g dried

	First Qtr 01/08/98	Second Qtr 04/15/98	Third Qtr 07/09/98	Fourth Qtr 10/08/98
Cs-137				
A1-1(I)	1.5 ± 0.2	1.8 ± 0.2	0.96 ± 0.10	1.5 ± 0.1
C1-6(I)	2.0 ± 0.2	1.5 ± 0.1	0.58 ± 0.06	1.1 ± 0.1
A1-4(I)	0.047 ± 0.013	0.081 ± 0.015	0.13 ± 0.2	0.17 ± 0.02
Q1-2(C)	0.17 ± 0.04	0.027 ± 0.010	0.051 ± 0.027	0.036 ± 0.015
Cs-134				
A1-1(I)	< 0.02	< 0.02	< 0.020	< 0.04
C1-6(I)	< 0.06	< 0.05	< 0.04	< 0.03
A1-4(I)	< 0.011	< 0.012	< 0.015	< 0.016
Q1-2(C)	< 0.04	< 0.009	< 0.03	< 0.016
Co-60				
A1-1(I)	< 0.03	< 0.03	< 0.02	< 0.05
C1-6(I)	< 0.07	< 0.07	< 0.05	< 0.03
A1-4(I)	< 0.012	< 0.012	< 0.018	< 0.017
Q1-2(C)	< 0.04	< 0.011	< 0.04	< 0.018

(I) = Indicator Station (C) = Control Station

See Figure 2-24 for REMP sample locations.

Table 2-20

REMP TLD Results

1998 SNEC TLD Summary
Field Cycle: January 8, 1998 to January 19, 1999

mR/std month	MEAN	MINIMUM	MAXIMUM
Average Offsite Indicator Stations	5.42	3.96 @ E1-17	8.34 @ E2-1
Average Control Stations	5.08	4.35 @ H10-1	5.84 @ G10-1

Table 2-21

Soil Background Results

SNEC Soil Background Study 1999

Sample	Location	K-40 (pCi/gm)			Cs-137 (pCi/gm)			Ra-226 (pCi/gm)			Th-232 (pCi/gm)		
SX12-SL-0001E	17	22	+/-	2	<MDA			2.3	+/-	0.1	1.1	+/-	0.1
SX12-SL-0002E	16	9.5	+/-	0.9	0.042	+/-	0.022	1.4	+/-	0.4	0.72	+/-	0.09
SX12-SL-0003E	14	11	+/-	1	0.58	+/-	0.06	1.6	+/-	0.5	0.86	+/-	0.13
SX12-SL-0004E	15	4.8	+/-	0.6	0.72	+/-	0.07	1.6	+/-	0.6	0.54	+/-	0.13
SX12-SL-0005E	13	9.2	+/-	0.9	0.3	+/-	0.03	1.8	+/-	0.4	0.8	+/-	0.12
SX12-SL-0006E	12	17	+/-	2	0.33	+/-	0.03	1.7	+/-	0.5	1.2	+/-	0.1
SX12-SL-0007E	11	16	+/-	2	0.25	+/-	0.04	1.8	+/-	0.6	1.2	+/-	0.1
SX12-SL-0008E	10	15	+/-	1	0.055	+/-	0.018	1.4	+/-	0.5	0.9	+/-	0.1
SX12-SL-0009E	19	26	+/-	3	0.19	+/-	0.04	3	+/-	0.7	1.1	+/-	0.2
SX12-SL-0010E	18	11	+/-	1	0.12	+/-	0.02	2.4	+/-	0.5	1.5	+/-	0.2
SX12-SL-0011E	20	11	+/-	1	0.25	+/-	0.06	3	+/-	0.9	0.9	+/-	0.23
SX12-SL-0012E	1	37	+/-	4	0.56	+/-	0.06	1.7	+/-	0.7	0.77	+/-	0.15
SX12-SL-0013E	2	18	+/-	2	0.3	+/-	0.04	1.2	+/-	0.5	0.88	+/-	0.13
SX12-SL-0014E	3	17	+/-	2	0.046	+/-	0.022	1.3	+/-	0.6	1.0	+/-	0.13
SX12-SL-0015E	4	8.2	+/-	0.8	0.31	+/-	0.03	1.4	+/-	0.5	0.63	+/-	0.1
SX12-SL-0016E	5	6.7	+/-	0.7	0.31	+/-	0.03	1.7	+/-	0.4	0.7	+/-	0.09
SX12-SL-0017E	6	14	+/-	1	0.12	+/-	0.02	1.8	+/-	0.5	0.96	+/-	0.1
SX12-SL-0018E	7	4.5	+/-	0.4	0.28	+/-	0.03	0.83	+/-	0.48	0.41	+/-	0.08
SX12-SL-0019E	8	12	+/-	1	0.059	+/-	0.034	1.2	+/-	0.6	0.94	+/-	0.17
SX12-SL-0020E	9	9.3	+/-	0.9	0.5	+/-	0.06	1.9	+/-	0.9	0.99	+/-	0.2
AVERAGE		**14**	**+/-**	**15.5**	**0.28**	**+/-**	**0.39**	**1.8**	**+/-**	**1.1**	0.9	**+/-**	**0.5**

See Figure 2-23 for soil background sample locations.

Table 2-22

Background Exposure Rate Measurements

SNEC Exposure Rate Background Study 1999

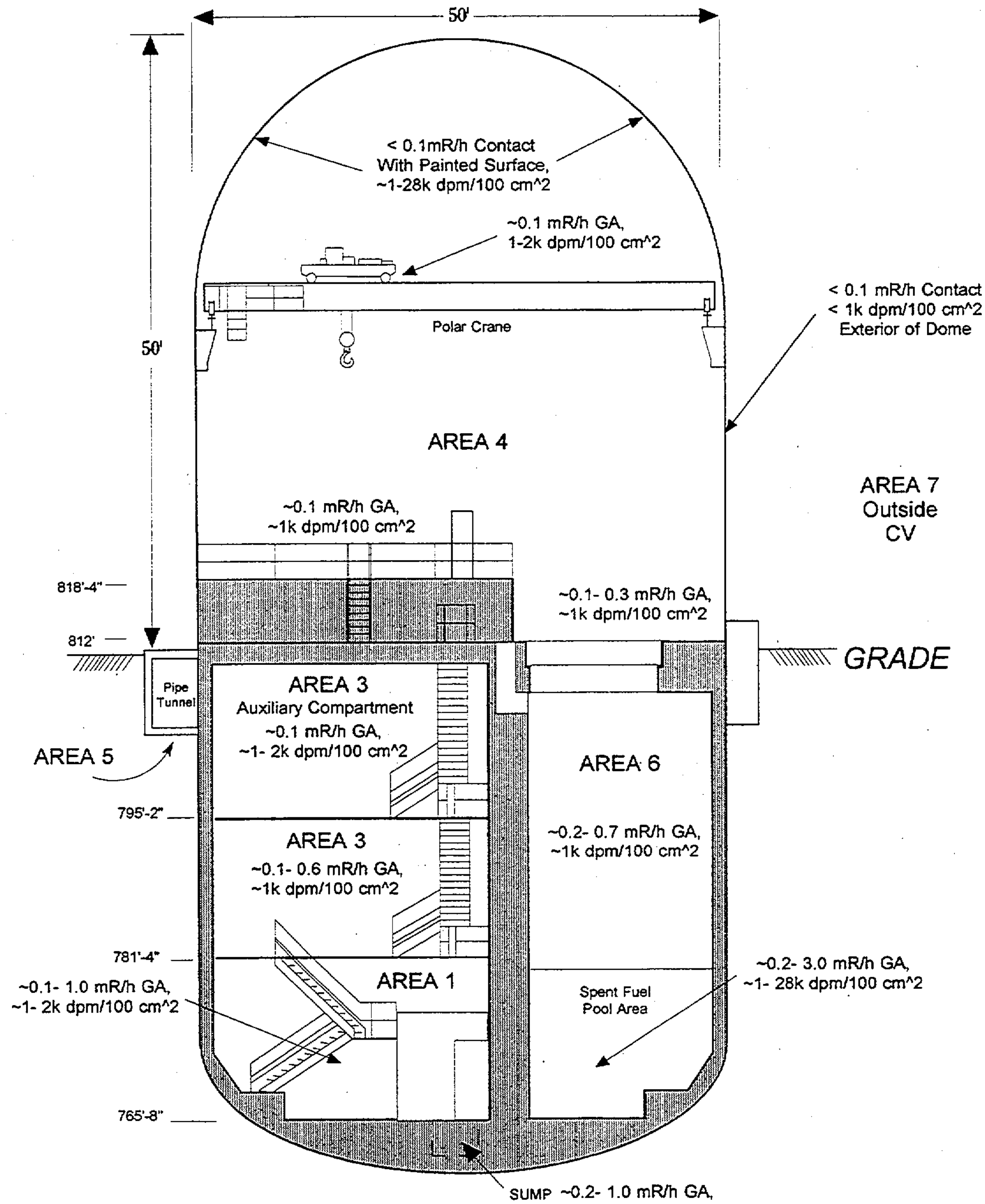
Survey location	Sector	Exposure Rate (uR/hr) 1m > Sample Site
1	A	9
2	B	7
3	C	8
4	D	6
5	E	5
6	F	6
7	G	6
8	H	6
9	H	6
10	J	11
11	J	7
12	K	7
13	K	8
14	L	7
15	L	6
16	M	6
17	N	9
18	P	7
19	Q	8
20	R	5
	Average +/- 2σ	**7+/-3**

See Figure 2-23 for background survey locations.

Figure 2-1

SNEC FACILITY SITE AREA LOCATIONS
Average Contamination Levels and
General Area Exposure Rates

(All dpm/100 cm^2 values represent smearable activity)

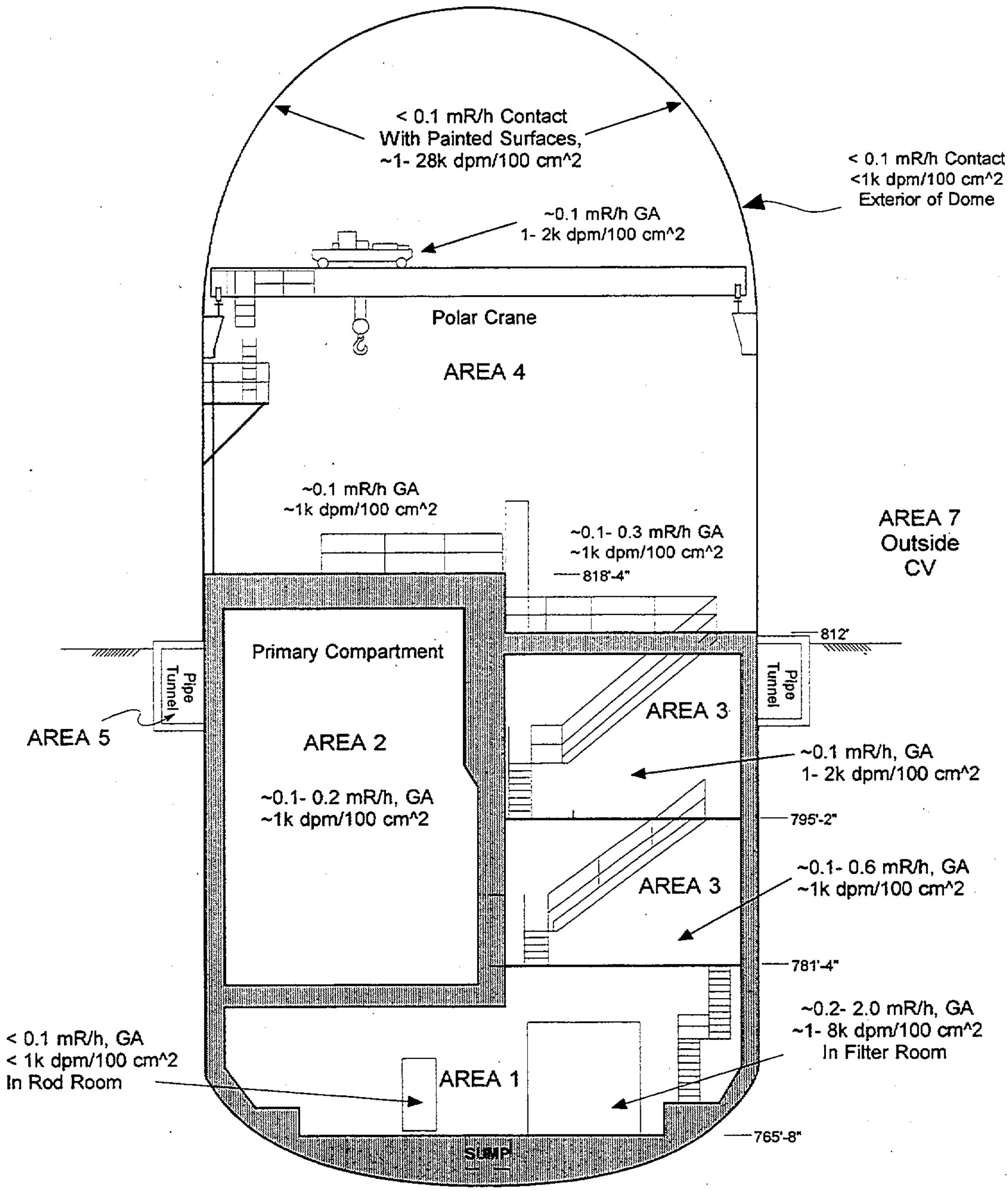


SNEC FACILITY SITE AREA LOCATIONS
Rotary Bridge Crane, Sectional View
(Looking West)

Figure 2-2

SNEC FACILITY SITE AREA LOCATIONS
Average Contamination Levels and
General Area Exposure Rates

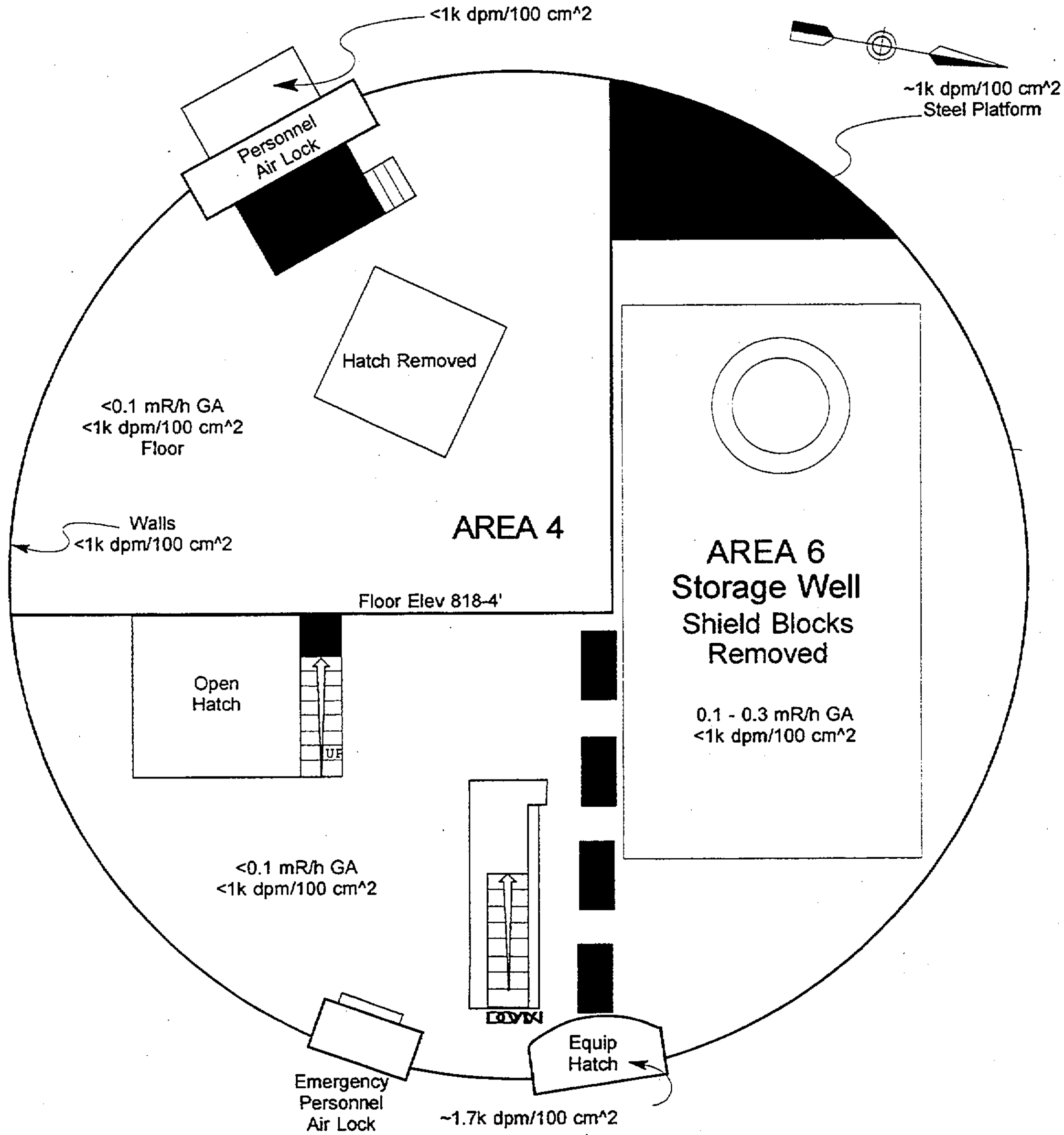
(All dpm/100 cm^2 values represent smearable activity)



SNEC FACILITY AREA LOCATIONS
Containment Vessel, Sectional View
(Looking North)

Figure 2-3

SNEC FACILITY AREA LOCATIONS
Average Contamination Levels and
General Area Exposure Rates

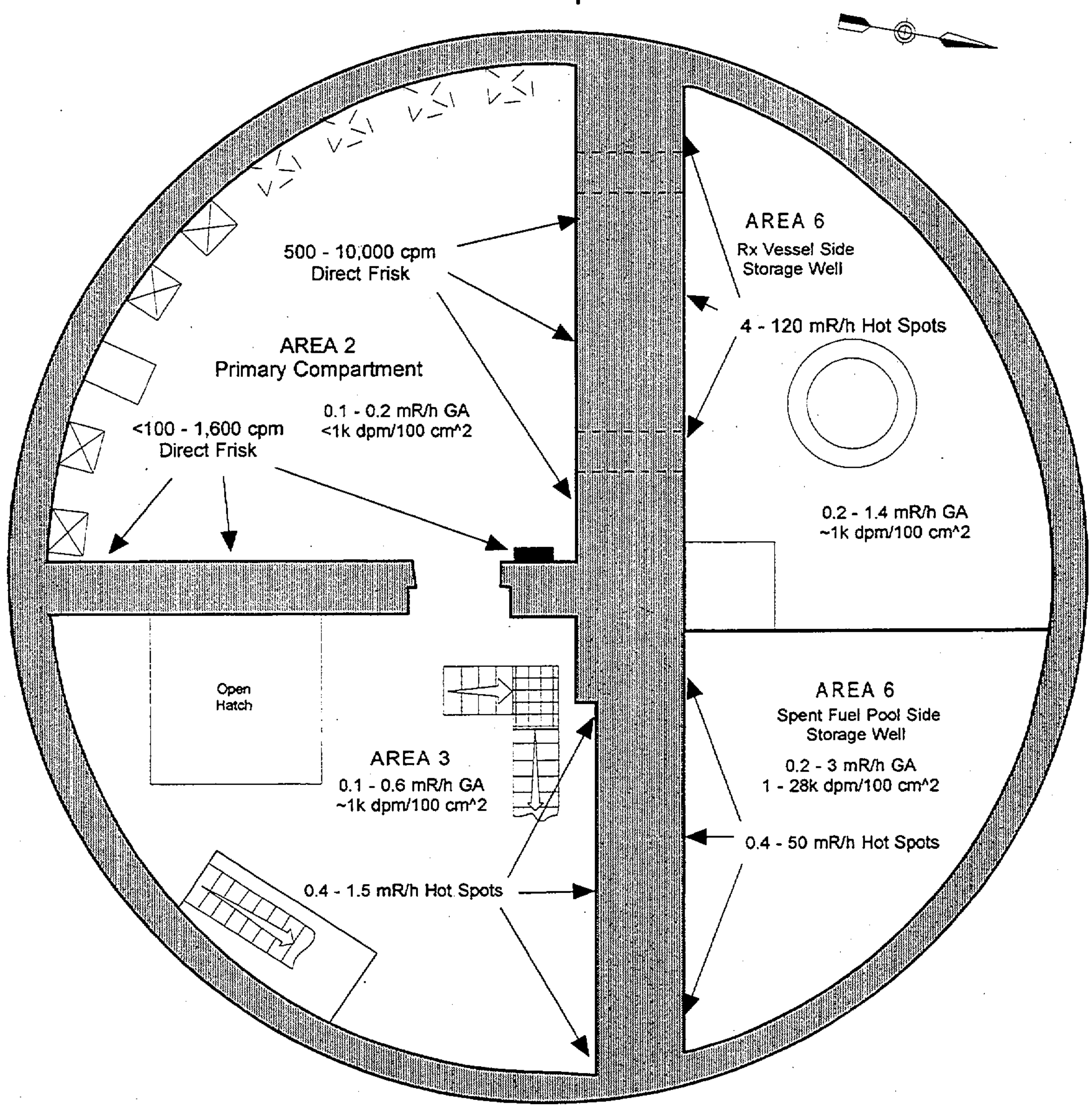


CONTAINMENT VESSEL (CV) -- Plan View Above
Operating Floor Elev 812'-0"

(All dpm/100 cm^2 values represent smearable activity)

Figure 2-4

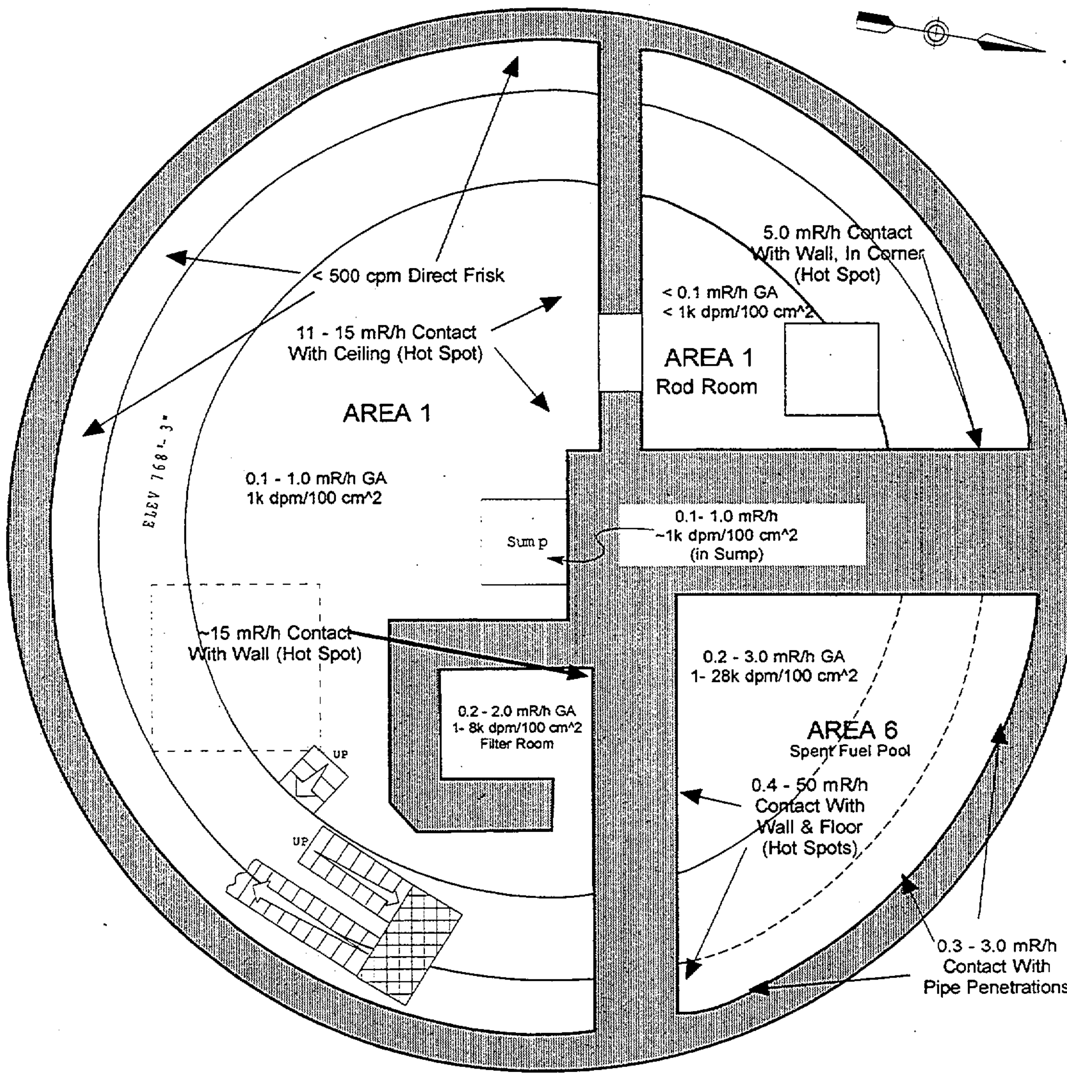
SNEC FACILITY SITE AREA LOCATIONS
Average Contamination Levels and
General Area Exposure Rates



CONTAINMENT VESSEL (CV) -- Areas by Quadrants
Plan Above Operating Floor Elev 781'-4"
(All dpm/100 cm^2 values represent smearable activity)

Figure 2-5

SNEC FACILITY SITE AREA LOCATIONS
Average Contamination Levels and
General Area Exposure Rates



CONTAINMENT VESSEL (CV) -- Areas by Quadrant
Plan Above Operating Floor Elev 765'-8"

(All dpm/100 cm^2 values represent smearable activity)

Figure 2-6

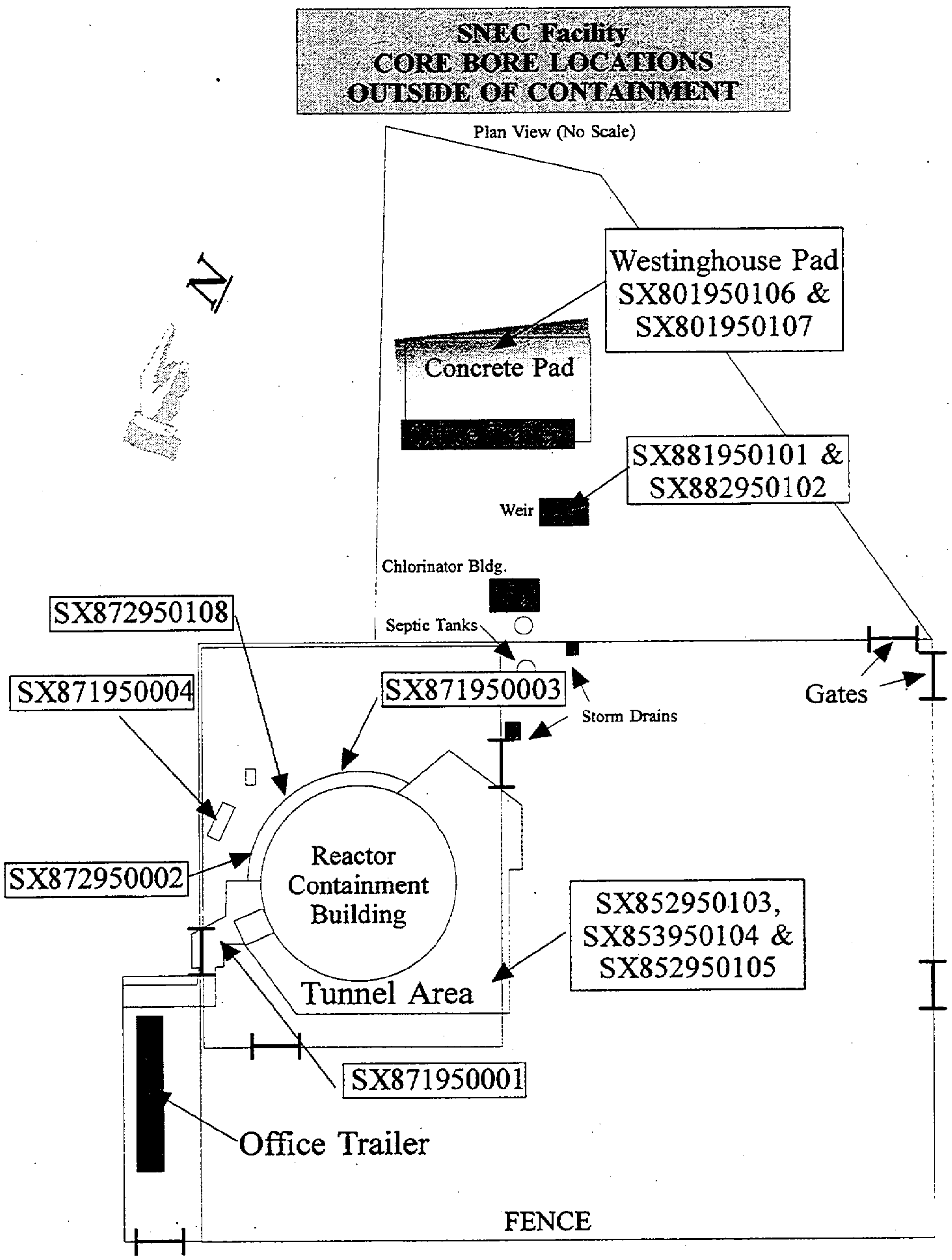
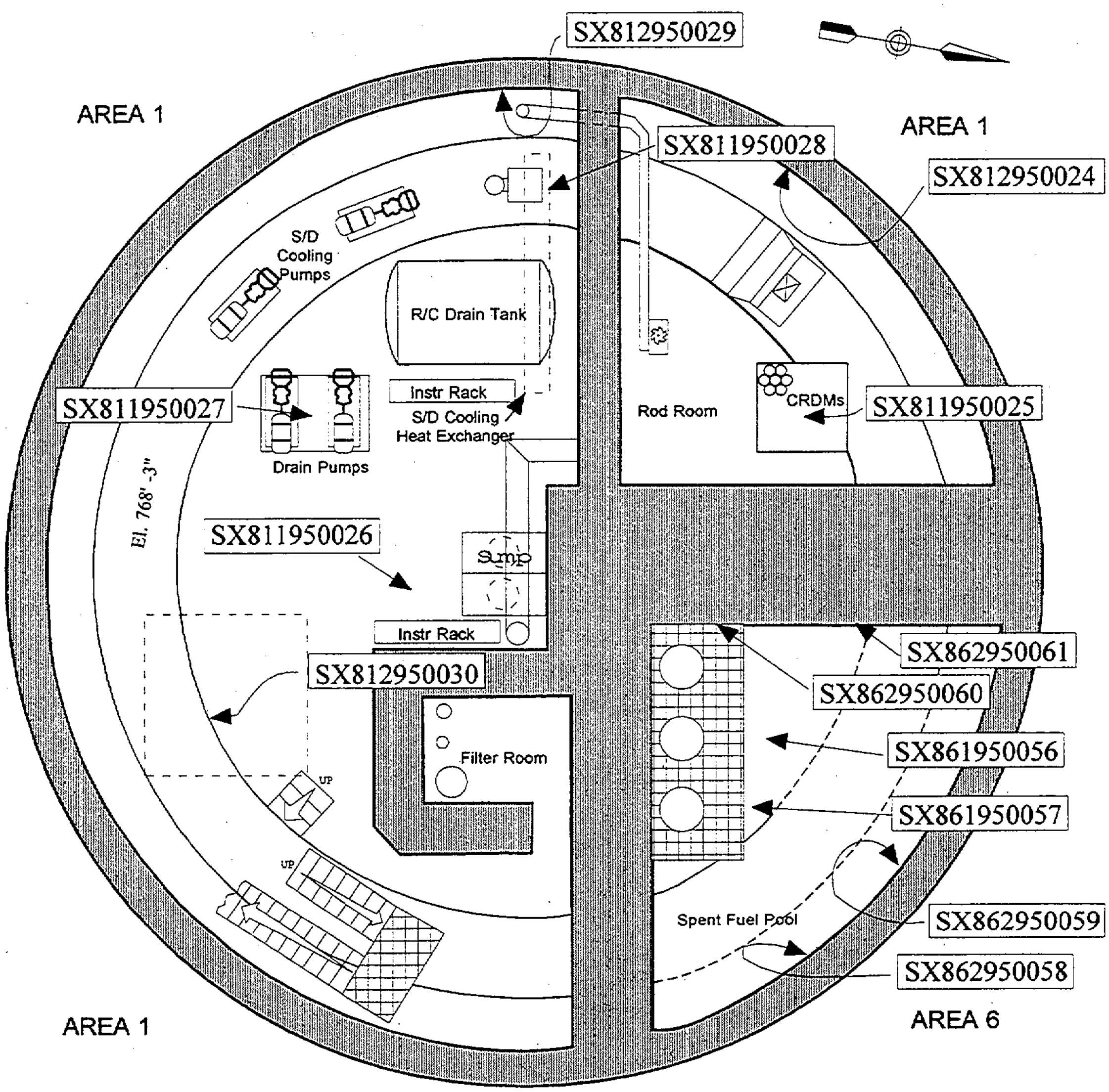

SNEC Facility
CORE BORE LOCATIONS
OUTSIDE OF CONTAINMENT
Plan View (No Scale)
N
Westinghouse Pad
SX801950106 &
SX801950107
Concrete Pad
SX881950101 &
SX882950102
Weir
Chlorinator Bldg.
Septic Tanks
SX872950108
SX871950004
SX871950003
Storm Drains
Gates
Reactor
Containment
Building
SX872950002
SX852950103,
SX853950104 &
SX852950105
Tunnel Area
SX871950001
Office Trailer
FENCE

Figure 2-7

SNEC FACILITY AREA MAP AND
CORE BORE SAMPLE LOCATIONS

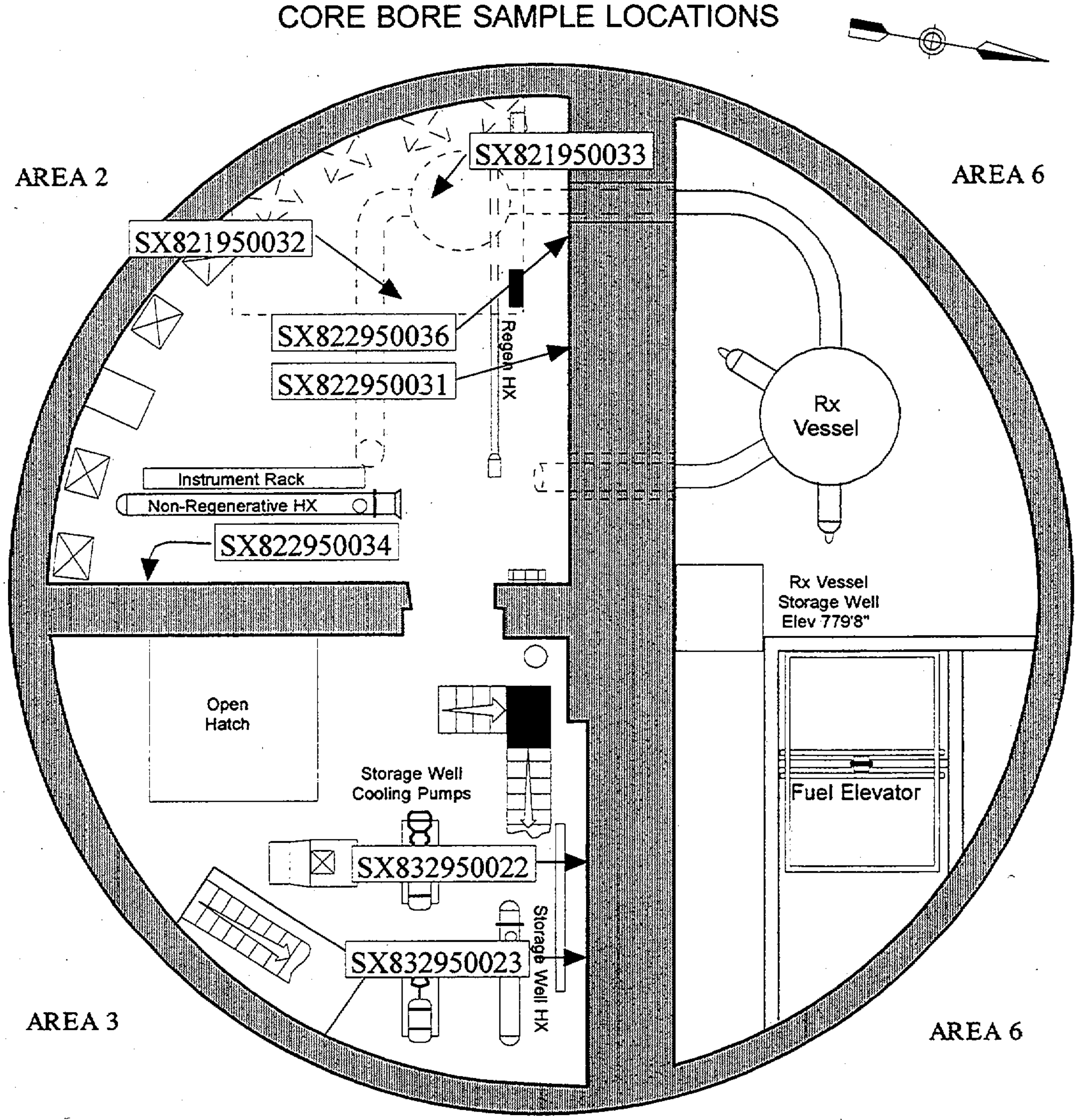


CONTAINMENT VESSEL (CV) – Areas by Quadrant
Plan Above Operating Floor Elev 765'-8"

NO SCALE

Figure 2-8

SNEC FACILITY AREA MAP AND
CORE BORE SAMPLE LOCATIONS

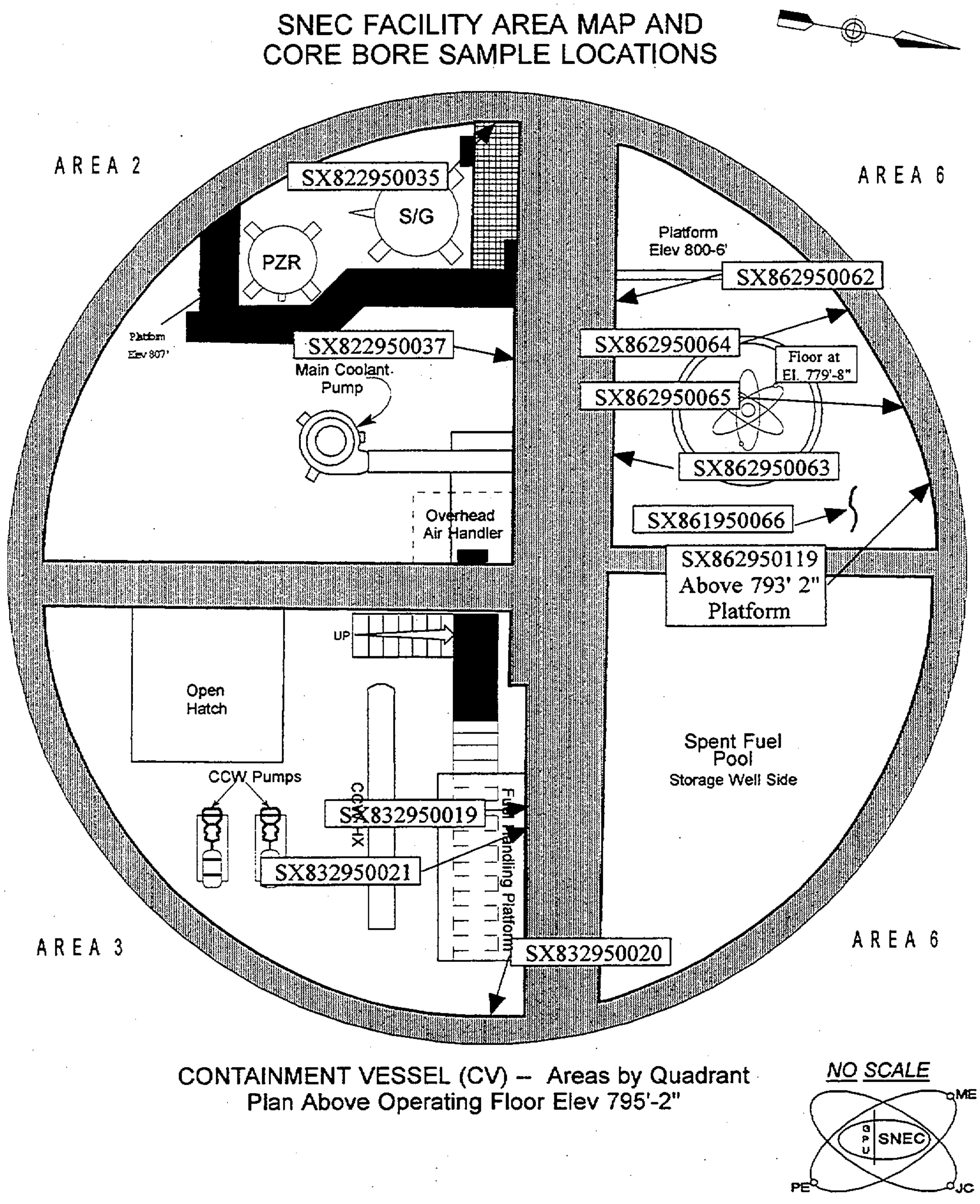


CONTAINMENT VESSEL (CV) -- Areas by Quadrants
Plan Above Operating Floor Elev 781'-4"

NO SCALE

Figure 2-9

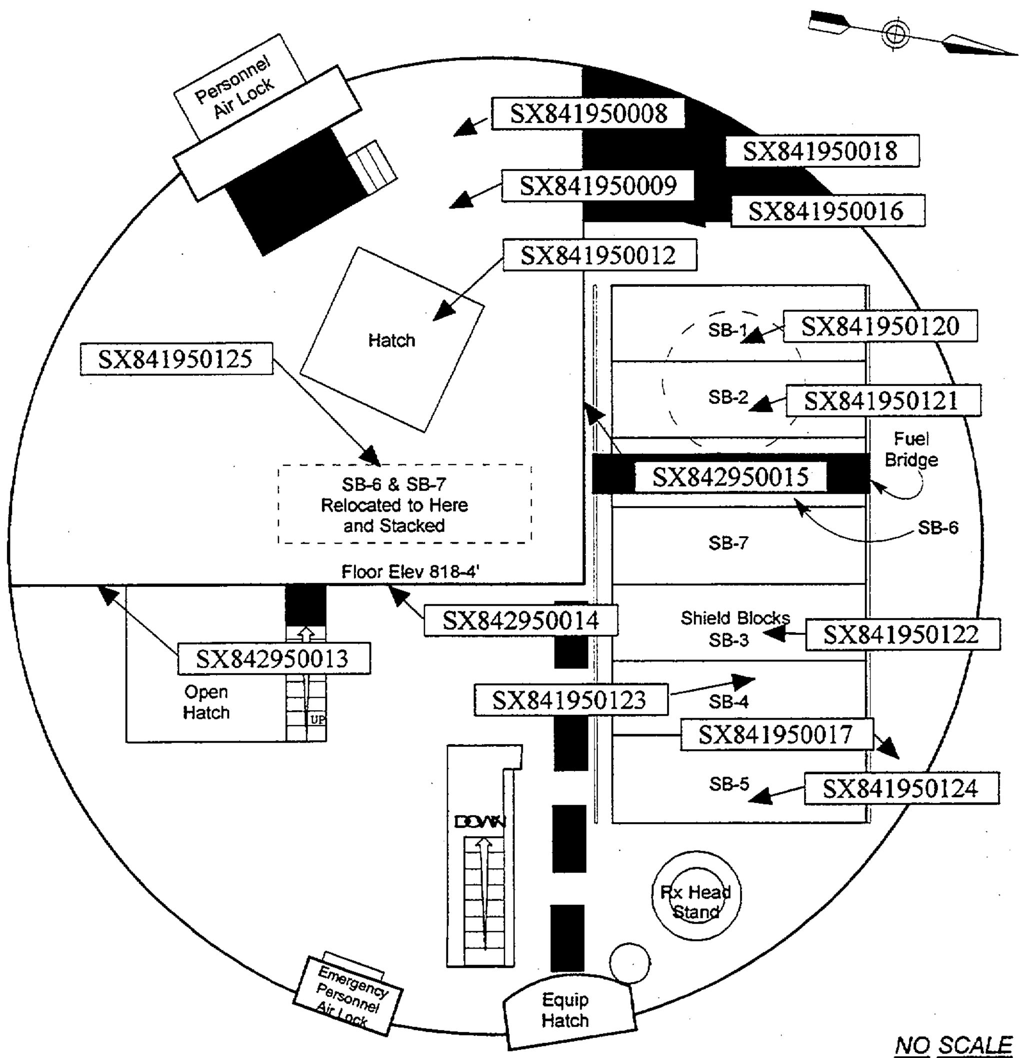
SNEC FACILITY AREA MAP AND
CORE BORE SAMPLE LOCATIONS



CONTAINMENT VESSEL (CV) -- Areas by Quadrant
Plan Above Operating Floor Elev 795'-2"

Figure 2-10

SNEC FACILITY AREA MAP AND
CORE BORE SAMPLE LOCATIONS



ALL AREA 4

CONTAINMENT VESSEL (CV) -- Plan View Above
Operating Floor Elev 812'-0"

OVERSIZE PAGE(S)

****

NOT CONVERTED INTO ELECTRONIC IMAGE FORM.

****

PAPER COPY IS AVAILABLE IN NRC FILE CENTER.

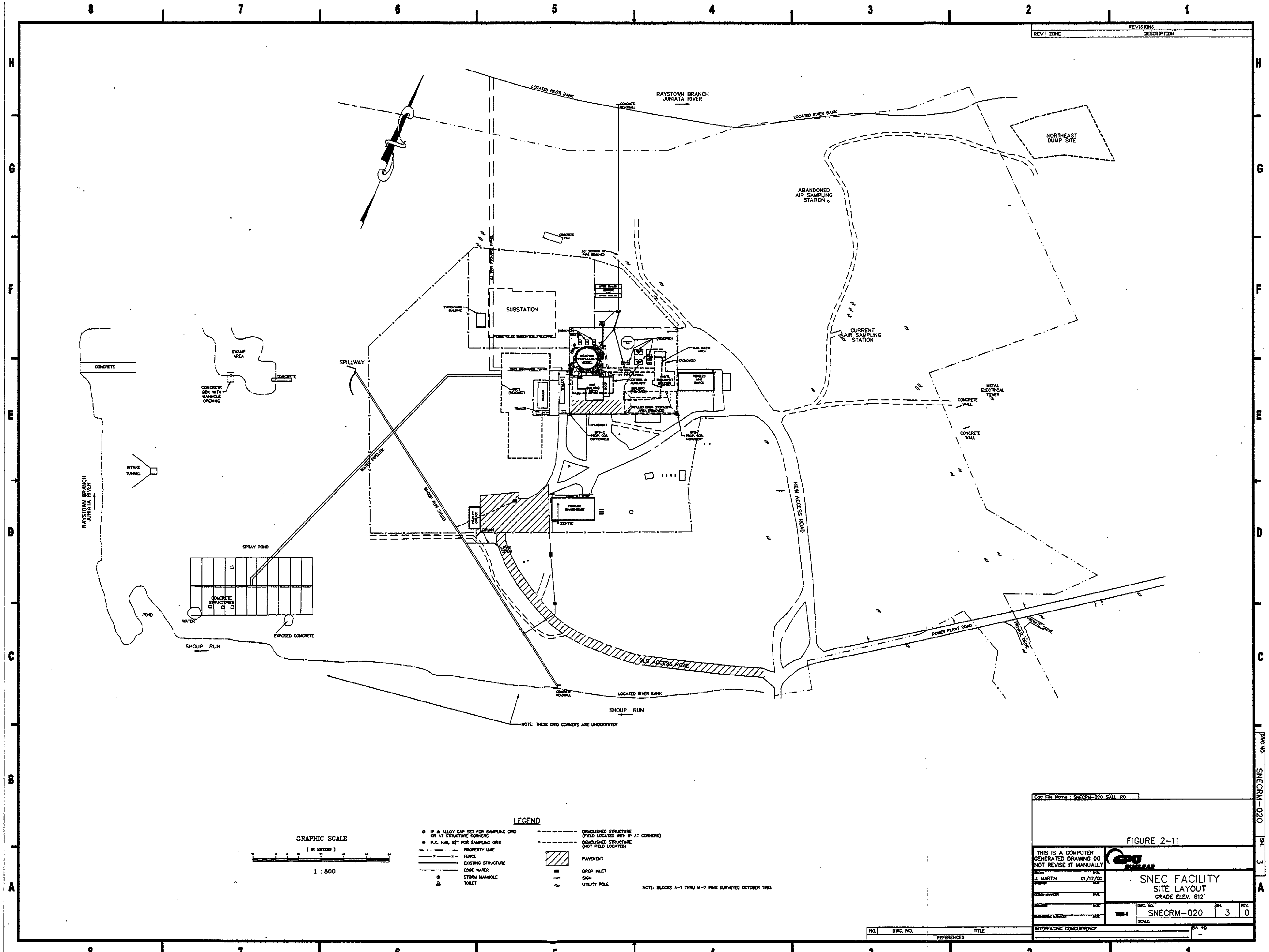
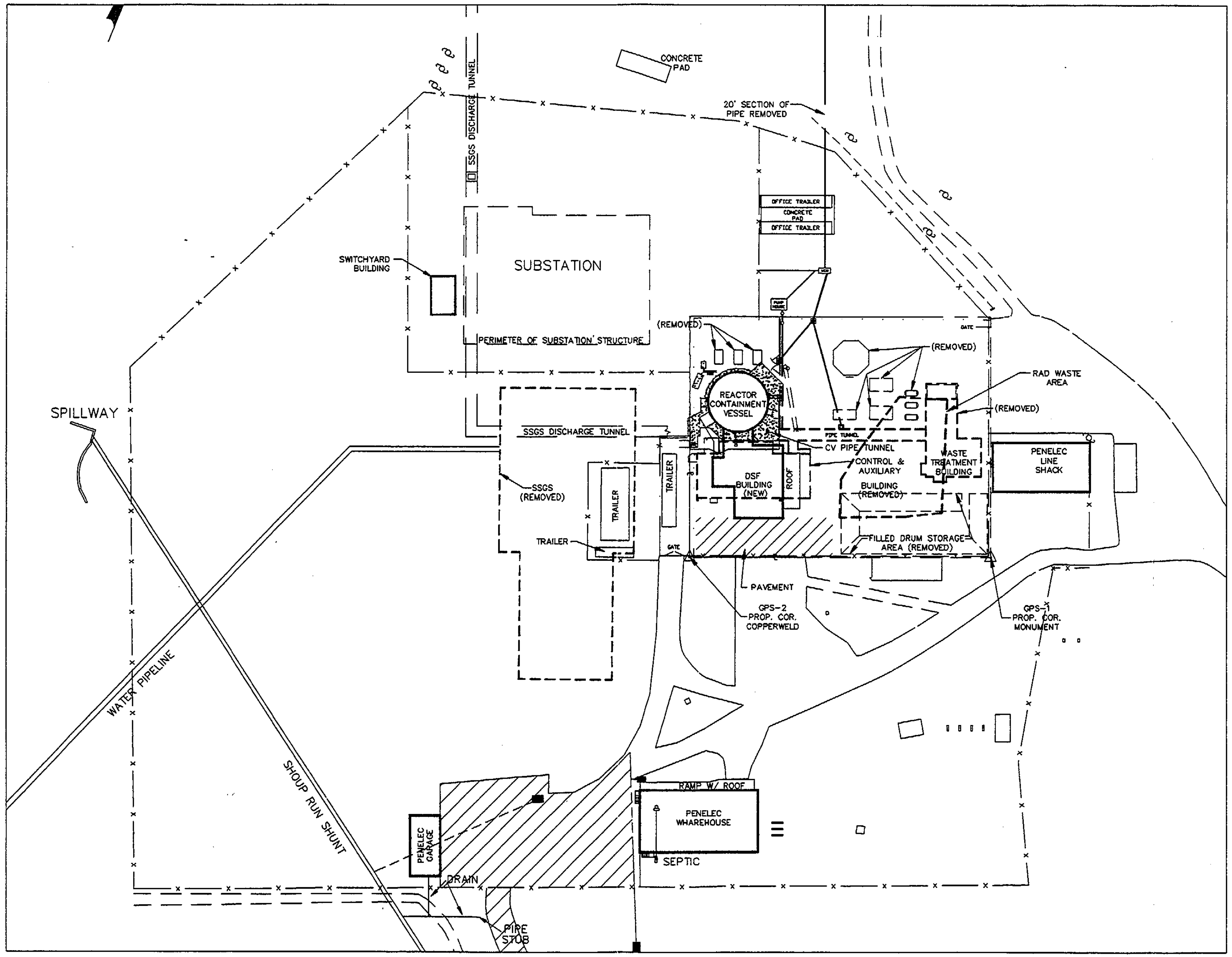

REVISIONS
REV
ZONE
DESCRIPTION
RAYSTOWN BRANCH JUNIATA RIVER
LOCATED RIVER BANK
NORTHEAST DUMP SITE
ABANDONED AIR SAMPLING STATION
SUBSTATION
CURRENT AIR SAMPLING STATION
SPILLWAY
SWAMP AREA
CONCRETE
CONCRETE BOX WITH MANHOLE OPENING
INTAKE TUNNEL
METAL ELECTRICAL TOWER
CONCRETE WALL
NEW ACCESS ROAD
WATER PIPELINE
SHOUP RUN SHUNT
SEPTIC
SPRAY POND
CONCRETE STRUCTURES
POND
WATER
EXPOSED CONCRETE
SHOUP RUN
OLD ACCESS ROAD
POWER PLANT ROAD
PRIVATE DRIVE
CONCRETE HEADWALL
NOTE: THESE GRID CORNERS ARE UNDERWATER
GRAPHIC SCALE
(IN METERS)
1 : 800
LEGEND
IP & ALLOY CAP SET FOR SAMPLING GRID OR AT STRUCTURE CORNERS
P.K. NAIL SET FOR SAMPLING GRID
PROPERTY LINE
FENCE
EXISTING STRUCTURE
EDGE WATER
STORM MANHOLE
TOILET
DEMOLISHED STRUCTURE (FIELD LOCATED WITH IP AT CORNERS)
DEMOLISHED STRUCTURE (NOT FIELD LOCATED)
PAVEMENT
DROP INLET
SIGN
UTILITY POLE
NOTE: BLOCKS A-1 THRU M-7 PINS SURVEYED OCTOBER 1993
Cad File Name : SNECRM-020 SALL R0
THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY
J. MARTIN 01/17/00
SNEC FACILITY
SITE LAYOUT
GRADE ELEV. 812'
DWG. NO.
SNECRM-020
SH. 3
REV. 0
INTERFACING CONCURRENCE
BA NO.
NO.
DWG. NO.
TITLE
REFERENCES

FIGURE 2-11



GRAPHIC SCALE

(IN METERS)

1 : 400

LEGEND

- IP & ALLOY CAP SET FOR SAMPLING GRID OR AT STRUCTURE CORNERS
- P.K. NAIL SET FOR SAMPLING GRID
- PROPERTY LINE
- FENCE
- EXISTING STRUCTURE
- EDGE WATER
- STORM MANHOLE
- TOILET
- DEMOLISHED STRUCTURE (FIELD LOCATED WITH IP AT CORNERS)
- DEMOLISHED STRUCTURE (NOT FIELD LOCATED)
- PAVEMENT
- DROP INLET
- SIGN
- UTILITY POLE

NOTE: BLOCKS A-1 THRU M-7 PINS SURVEYED OCTOBER 1993

Cad File Name : SNECRM-020_SALL_R0

FIGURE 2-12

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SNEC FACILITY
SITE LAYOUT
GRADE ELEV. 812'

DWG. NO. SNECRM-020 SH. 6 REV. 0

INTERFACING CONCURRENCE

BA NO. –

DWG.NO. SNECRM-020 SH. 6

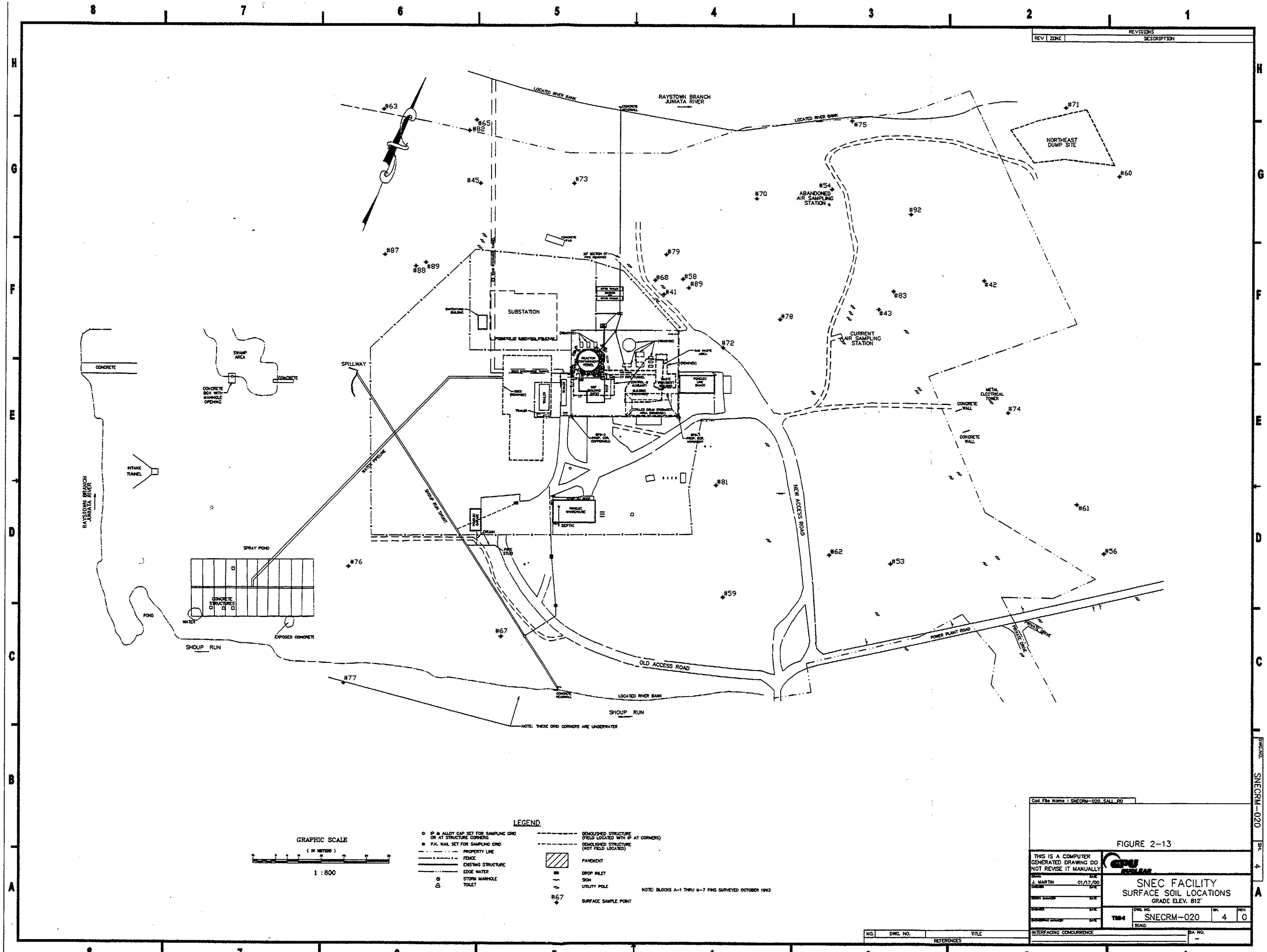
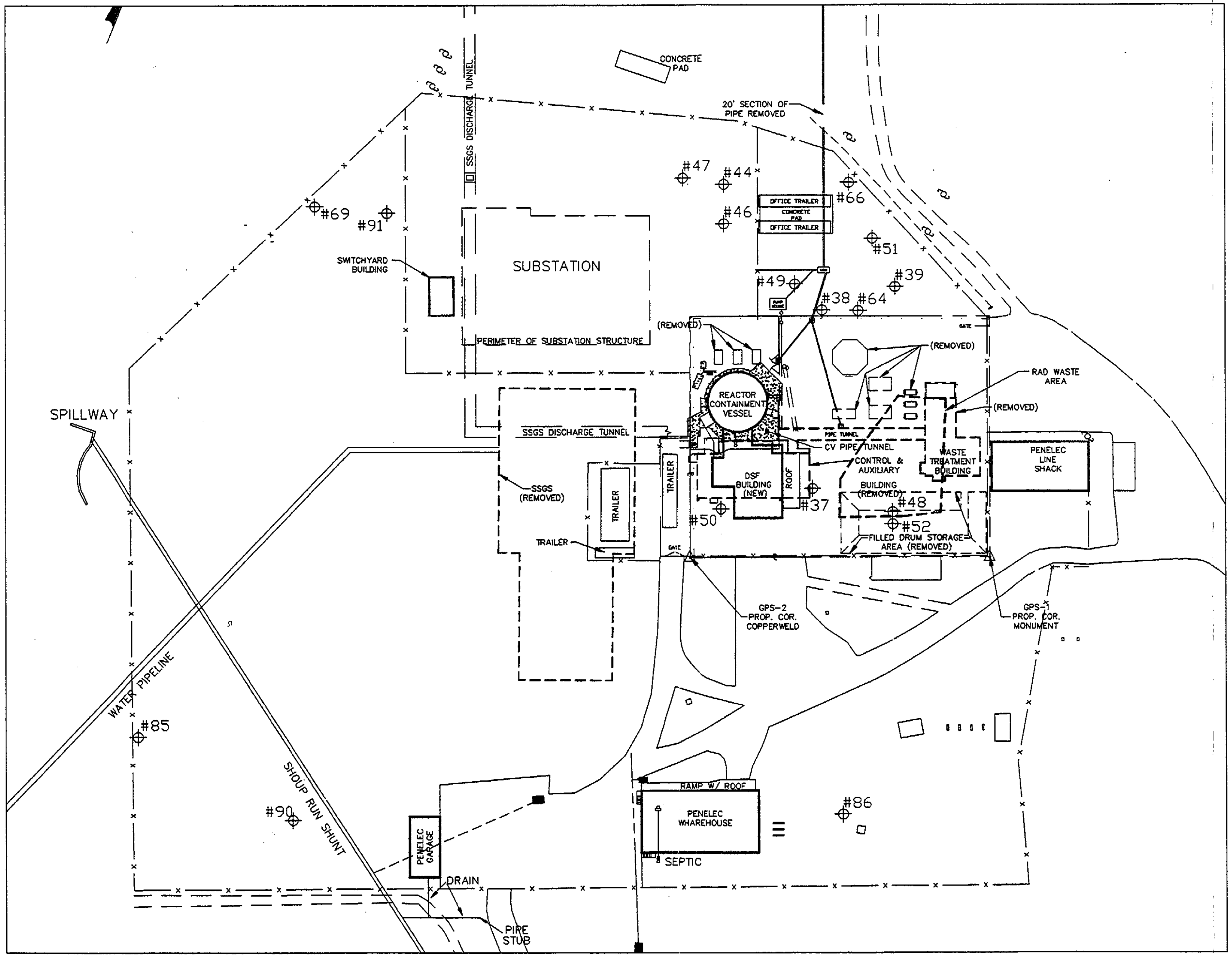

RAYSTOWN BRANCH JUNIATA RIVER
LOCATED RIVER BANK
NORTHEAST DUMP SITE
ABANDONED AIR SAMPLING STATION
CURRENT AIR SAMPLING STATION
SUBSTATION
SPILLWAY
SWAMP AREA
CONCRETE
INTAKE TUNNEL
SPRAY POND
CONCRETE STRUCTURES
POND
WATER
EXPOSED CONCRETE
SHOUP RUN
NEW ACCESS ROAD
OLD ACCESS ROAD
POWER PLANT ROAD
PRIVATE DRIVE
CONCRETE WALL
METAL ELECTRICAL TOWER
SEPTIC
DRAIN
#63 #65 #82 #45 #73 #70 #54 #75 #71 #60 #92 #87 #88 #89 #79 #68 #58 #89 #41 #42 #83 #43 #78 #72 #74 #81 #61 #62 #53 #56 #76 #59 #67 #77
NOTE: THESE GRID CORNERS ARE UNDERWATER
GRAPHIC SCALE
(IN METERS)
1 : 800
LEGEND
PROPERTY LINE
FENCE
EXISTING STRUCTURE
EDGE WATER
STORM MANHOLE
TOILET
PAVEMENT
DROP INLET
SIGN
UTILITY POLE
SURFACE SAMPLE POINT
NOTE: BLOCKS A-1 THRU M-7 PINS SURVEYED OCTOBER 1993
THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY
J. MARTIN 01/17/00
SNEC FACILITY
SURFACE SOIL LOCATIONS
GRADE ELEV. 812'
SNECRM-020
4
0
REVISIONS
REV ZONE DESCRIPTION
REFERENCES
INTERFACING CONCURRENCE

FIGURE 2-13



REVISIONS

REV	ZONE	DESCRIPTION

LEGEND

GRAPHIC SCALE

(IN METERS)

1 : 400

- IP & ALLOY CAP SET FOR SAMPLING GRID OR AT STRUCTURE CORNERS
- P.K. NAIL SET FOR SAMPLING GRID
- PROPERTY LINE
- FENCE
- EXISTING STRUCTURE
- EDGE WATER
- STORM MANHOLE
- TOILET
- DEMOLISHED STRUCTURE (FIELD LOCATED WITH IP AT CORNERS)
- DEMOLISHED STRUCTURE (NOT FIELD LOCATED)
- PAVEMENT
- DROP INLET
- SIGN
- UTILITY POLE
- #67 SURFACE SAMPLE POINT

NOTE: BLOCKS A-1 THRU M-7 PINS SURVEYED OCTOBER 1993

NO.	DWG. NO.	TITLE
	REFERENCES	

Cad File Name : SNECRM-020_SALL_R0

FIGURE 2-14

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GPU NUCLEAR

DRAWN: J. MARTIN DATE: 01/17/00

SNEC FACILITY
SURFACE SOIL LOCATIONS
GRADE ELEV. 812'

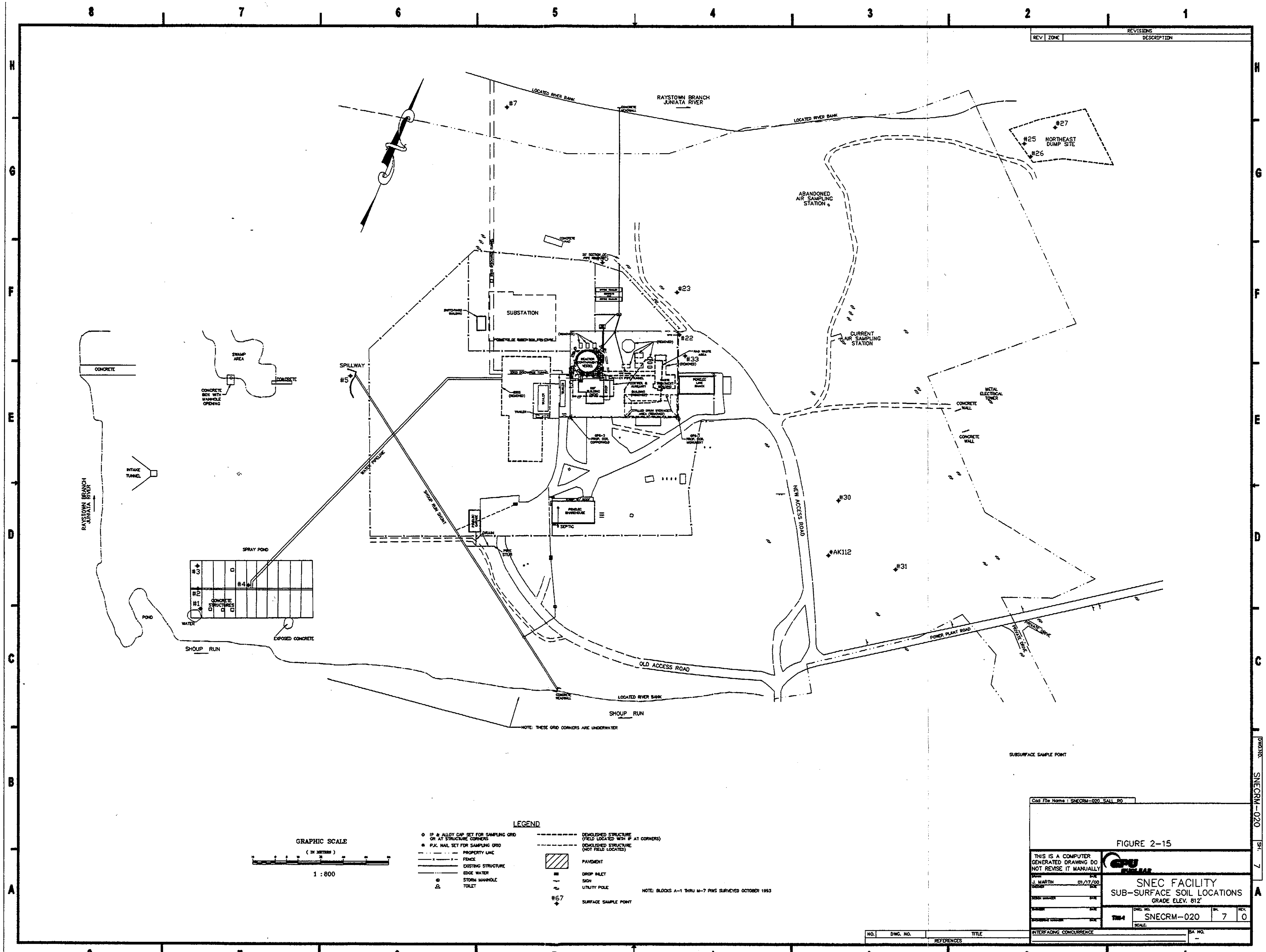
DWG. NO. SNECRM-020 SH. 5 REV. 0

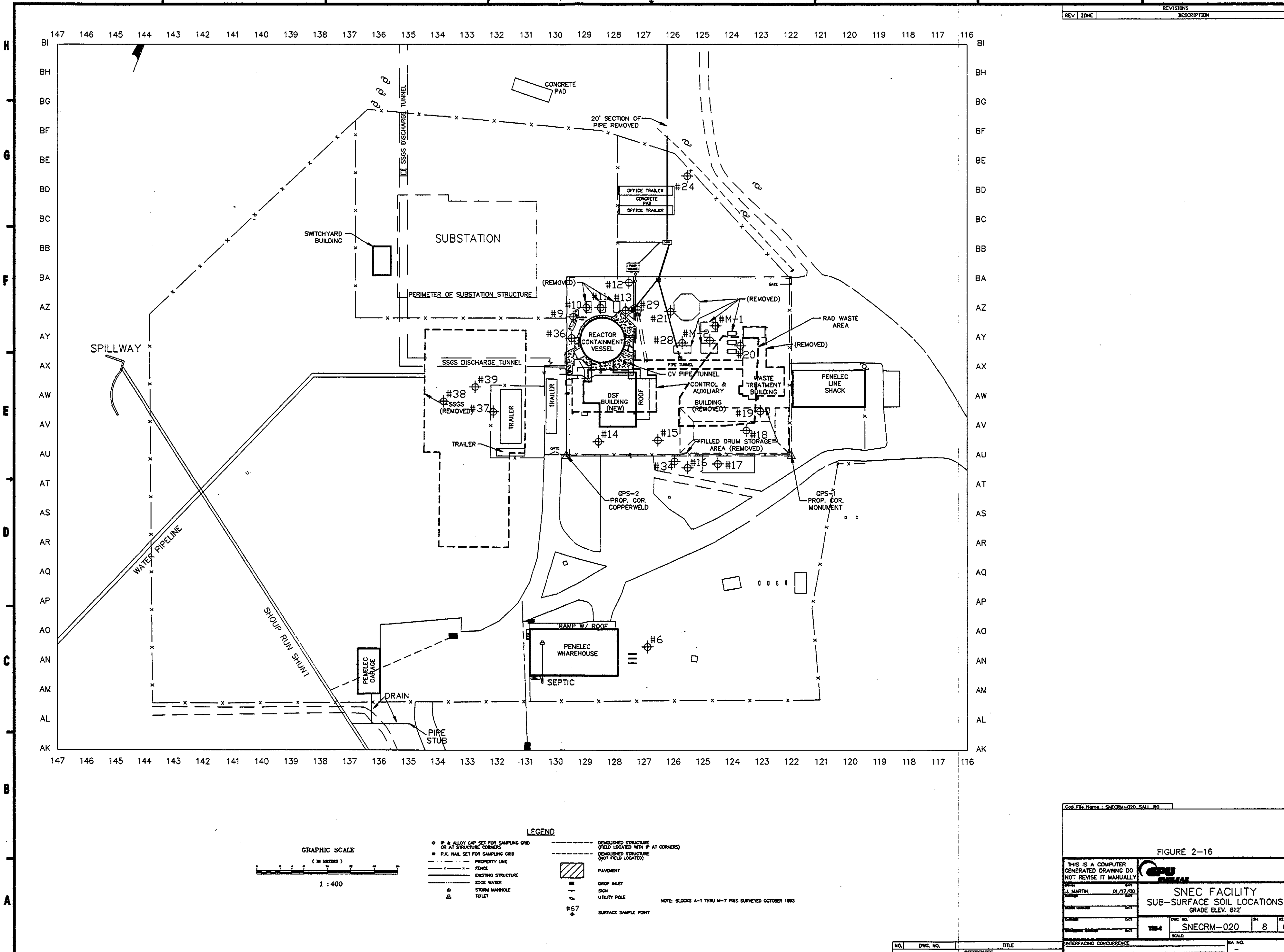
SCALE:

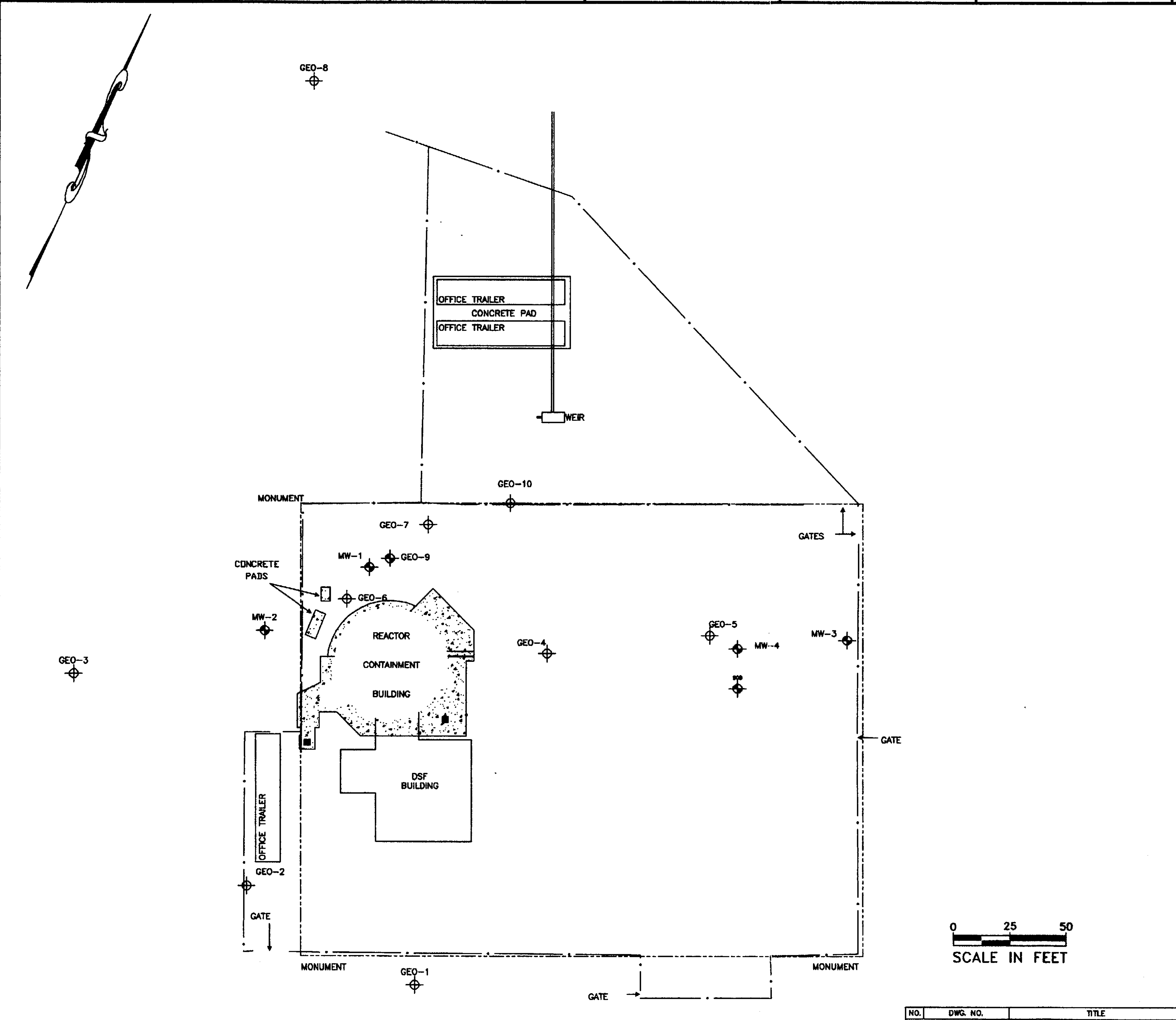
INTERFACING CONCURRENCE

BA NO. –

DWG.NO. SNECRM-020 SH. 5


RAYSTOWN BRANCH JUNIATA RIVER
LOCATED RIVER BANK
#7
#27
#25 NORTHEAST DUMP SITE
#26
ABANDONED AIR SAMPLING STATION
CONCRETE PAD
#23
SUBSTATION
#22
#33
CURRENT AIR SAMPLING STATION
SPILLWAY
#5
CONCRETE
SWAMP AREA
CONCRETE BOX WITH MANHOLE OPENING
METAL ELECTRICAL TOWER
CONCRETE WALL
INTAKE TUNNEL
RAYSTOWN BRANCH JUNIATA RIVER
WATER PIPELINE
SHOUP RUN SIPHON
PENELEC WAREHOUSE
SEPTIC
DRAIN
NEW ACCESS ROAD
#30
#AK112
#31
SPRAY POND
#3
#4
#2
#1
CONCRETE STRUCTURES
POND
WATER
EXPOSED CONCRETE
SHOUP RUN
OLD ACCESS ROAD
POWER PLANT ROAD
PRIVATE DRIVE
LOCATED RIVER BANK
SHOUP RUN
NOTE: THESE GRID CORNERS ARE UNDERWATER
SUBSURFACE SAMPLE POINT
LEGEND
GRAPHIC SCALE
(IN METERS)
1 : 800
PROPERTY LINE
FENCE
EXISTING STRUCTURE
EDGE WATER
STORM MANHOLE
TOILET
PAVEMENT
DROP INLET
SIGN
UTILITY POLE
#67
SURFACE SAMPLE POINT
NOTE: BLOCKS A-1 THRU M-7 PINS SURVEYED OCTOBER 1993
REVISIONS
REV ZONE DESCRIPTION
FIGURE 2-15
THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY
J. MARTIN 01/17/00
SNEC FACILITY
SUB-SURFACE SOIL LOCATIONS
GRADE ELEV. 812'
SNECRM-020
7
0
SNECRM-020
REFERENCES


SPILLWAY
SUBSTATION
SWITCHYARD BUILDING
SSGS DISCHARGE TUNNEL
PERIMETER OF SUBSTATION STRUCTURE
CONCRETE PAD
20' SECTION OF PIPE REMOVED
OFFICE TRAILER
CONCRETE PAD
OFFICE TRAILER
REACTOR CONTAINMENT VESSEL
RAD WASTE AREA
(REMOVED)
CV PIPE TUNNEL
CONTROL & AUXILIARY BUILDING (REMOVED)
WASTE TREATMENT BUILDING
PENELEC LINE SHACK
DSF BUILDING (NEW)
ROOF
TRAILER
SSGS (REMOVED)
FILLED DRUM STORAGE AREA (REMOVED)
GPS-2 PROP. COR. COPPERWELD
GPS-1 PROP. COR. MONUMENT
WATER PIPELINE
SHOUP RUN SHUNT
PENELEC GARAGE
DRAIN
PIPE STUB
RAMP W/ ROOF
PENELEC WHAREHOUSE
SEPTIC
#6 #9 #10 #11 #12 #13 #14 #15 #16 #17 #18 #19 #20 #21 #24 #28 #29 #34 #36 #37 #38 #39 #M-1 #M-2
LEGEND
GRAPHIC SCALE
1 : 400
NOTE: BLOCKS A-1 THRU M-7 PINS SURVEYED OCTOBER 1993
FIGURE 2-16
THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY
GPU NUCLEAR
SNEC FACILITY
SUB-SURFACE SOIL LOCATIONS
GRADE ELEV. 812'
SNECRM-020
8
0



DWG. NO. SNECRM-021 SH. 1

REVISIONS		
REV	ZONE	DESCRIPTION

Cad File Name : SNECRM-021_S1_R0

SAXTON NUCLEAR FACILITY
LIBERTY TOWNSHIP, BEDFORD COUNTY, PENNSYLVANIA

FIGURE 2-17

THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY

GPU NUCLEAR

DRAWN R.A.KOCH DATE 12/28/99

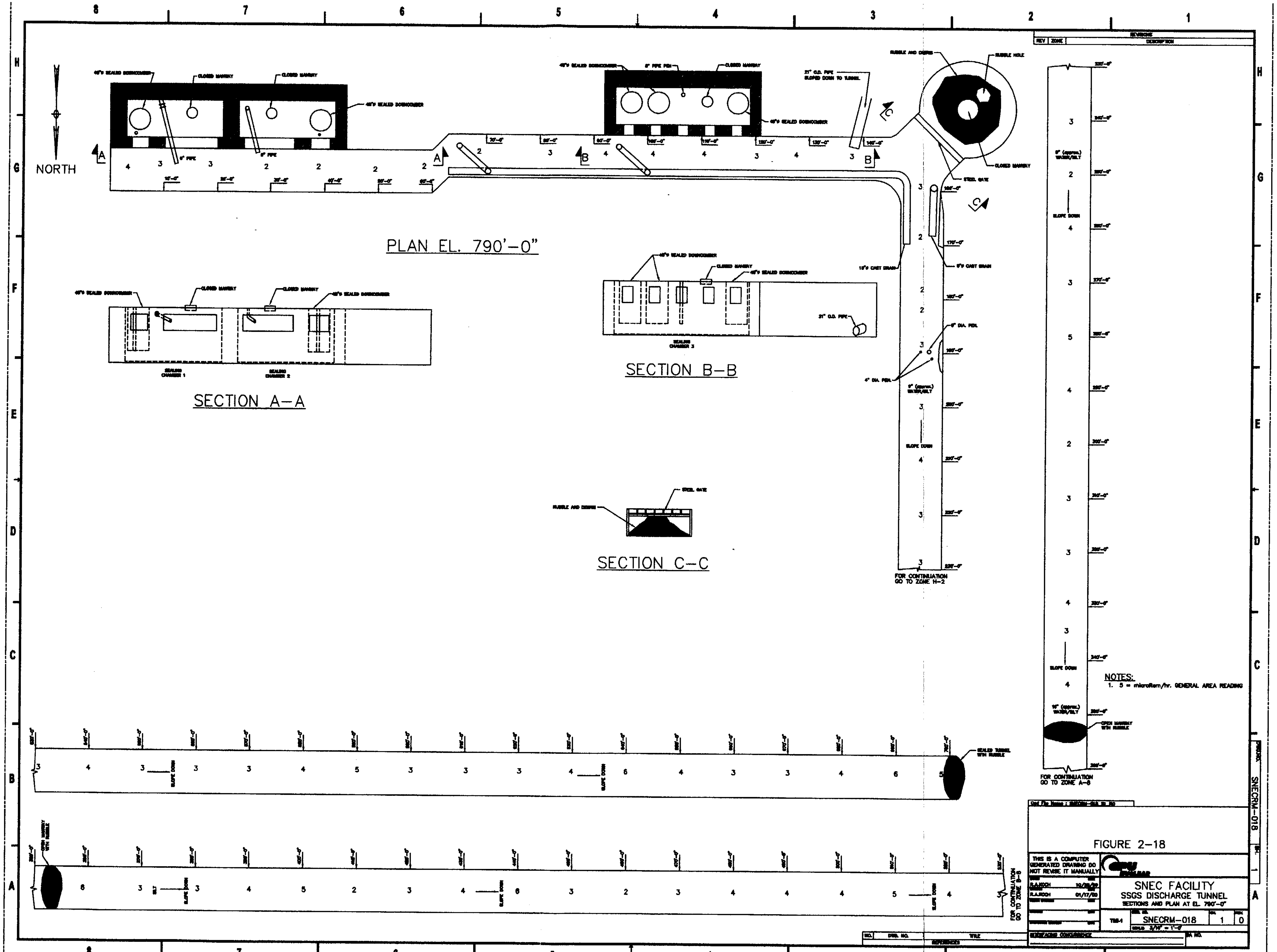
SNEC FACILITY
MONITOR WELL LOCATION PLAN
GRADE EL. 812'-0"

TMI-1 DWG. NO. SNECRM-021 SH. 1 REV. 0
SCALE: NONE

NO.	DWG. NO.	TITLE
REFERENCES		

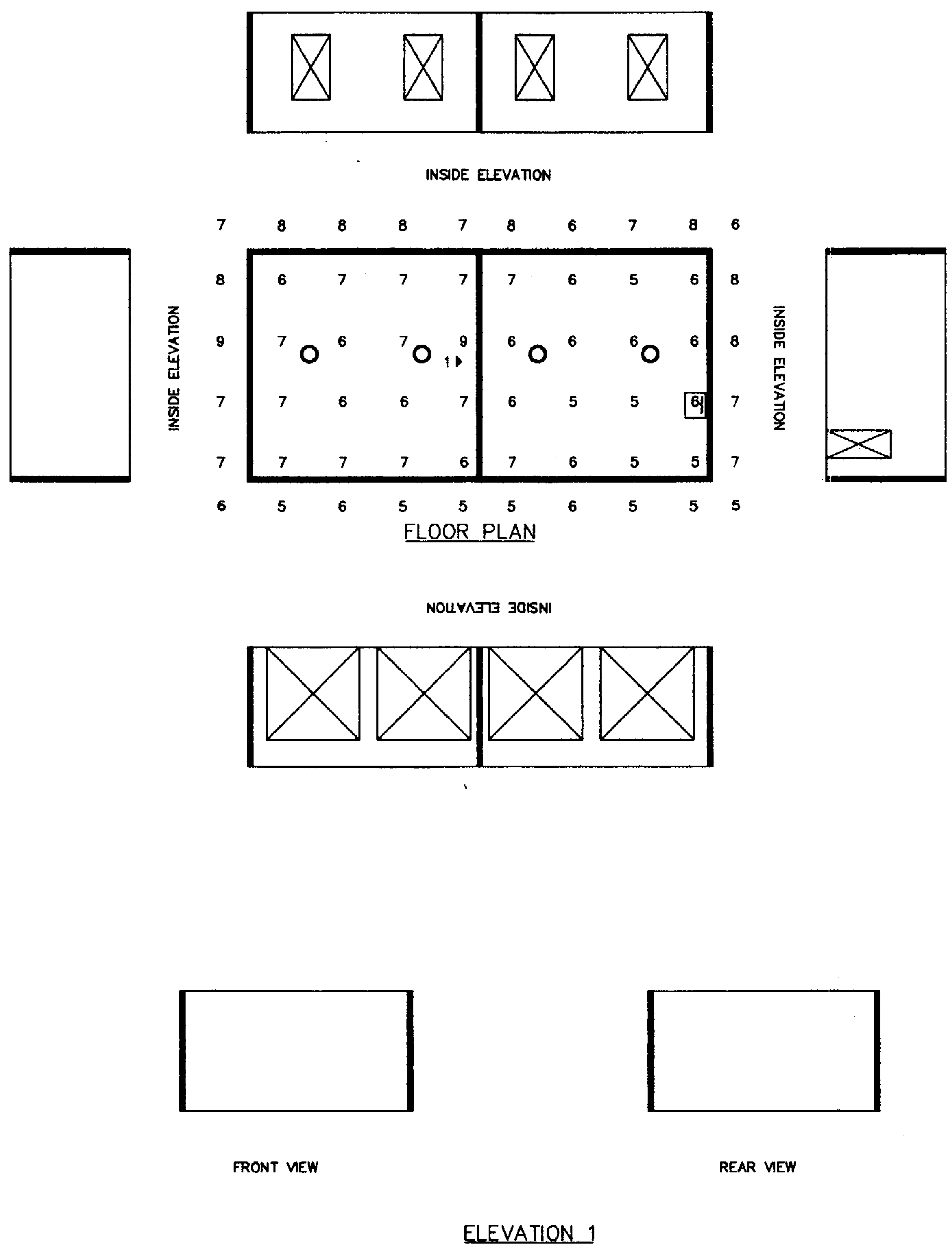
INTERFACING CONCURRENCE

BA NO. -


NORTH
PLAN EL. 790'-0"
SECTION A-A
SECTION B-B
SECTION C-C
NOTES:
FIGURE 2-18
SNEC FACILITY
SSGS DISCHARGE TUNNEL
SECTIONS AND PLAN AT EL. 790'-0"
SNECRM-018

DWG.NO. SNECRM-014 SH. 1

REVISIONS		
REV	ZONE	DESCRIPTION



NOTES:

1. 5 = microRem/hr, GENERAL AREA READING.

NO.	DWG. NO.	TITLE
REFERENCES		

Cad File Name : SNECRM-014_S1_R0

FIGURE 2-19

THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY

GPU NUCLEAR

DRAWN	DATE
R. SCHAIBLE	08/19/99
CHECKED	DATE
R.A.KOCH	01/17/00

SNEC FACILITY

PENELEC GARAGE

GRADE EL. 812'-0"

TMI-1

DWG. NO.	SH.	REV.
SNECRM-014	1	0

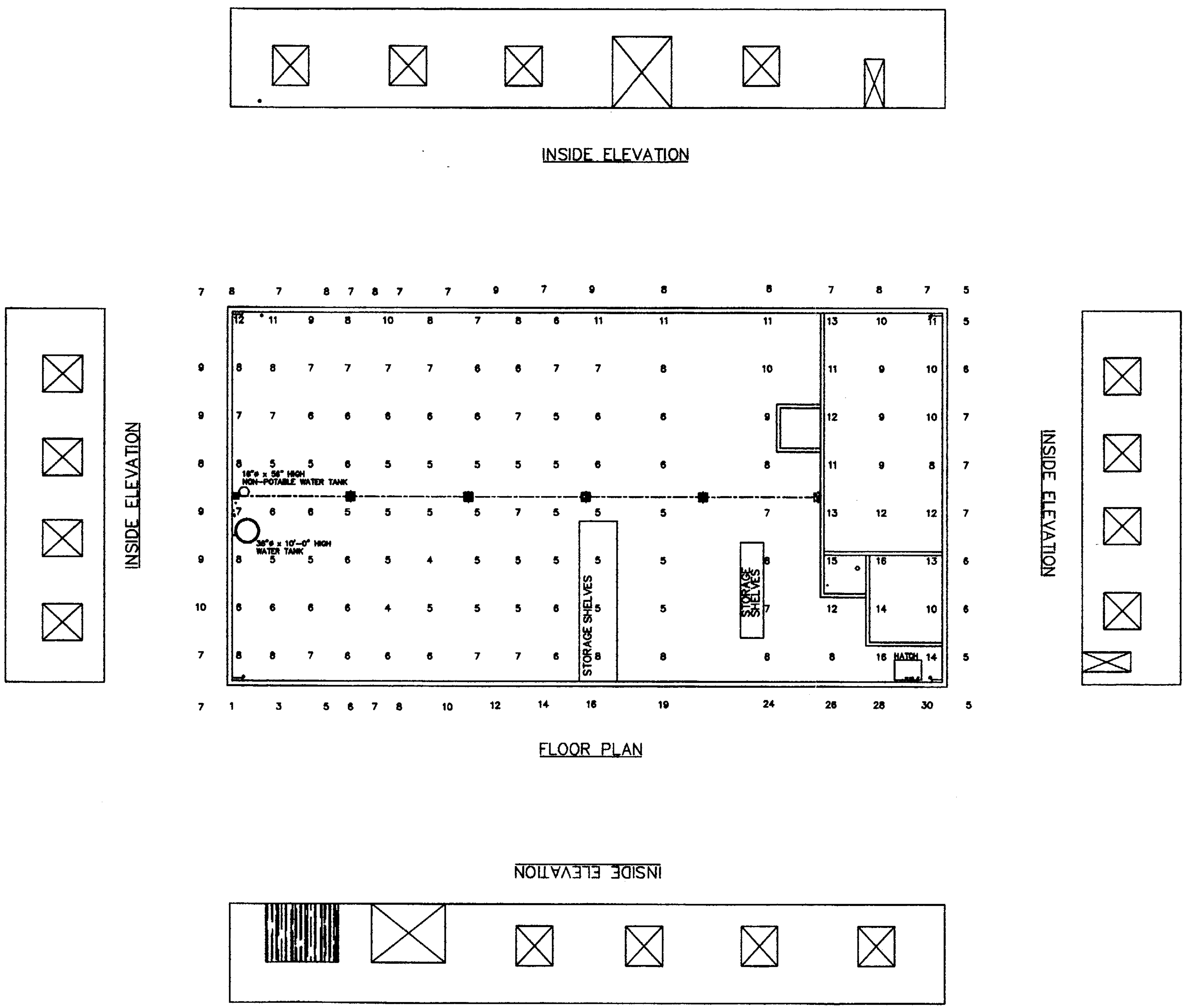
SCALE: 1/8"=1'-0"

INTERFACING CONCURRENCE

BA NO.

DWG.NO. SNECRM-013 SH. 1

REVISIONS		
REV	ZONE	DESCRIPTION



NOTES:
1. 5 = microRem/hr. GENERAL AREA READING.

Cad File Name : SNECRM-013_S1_R0

FIGURE 2-20

THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY

GPU NUCLEAR

R. SCHAIBLE 07/15/99
R.A.KOCH 01/17/00

SNEC FACILITY
PENELEC WAREHOUSE
FLOOR PLAN AND EXTERIOR WALL ELEVATIONS

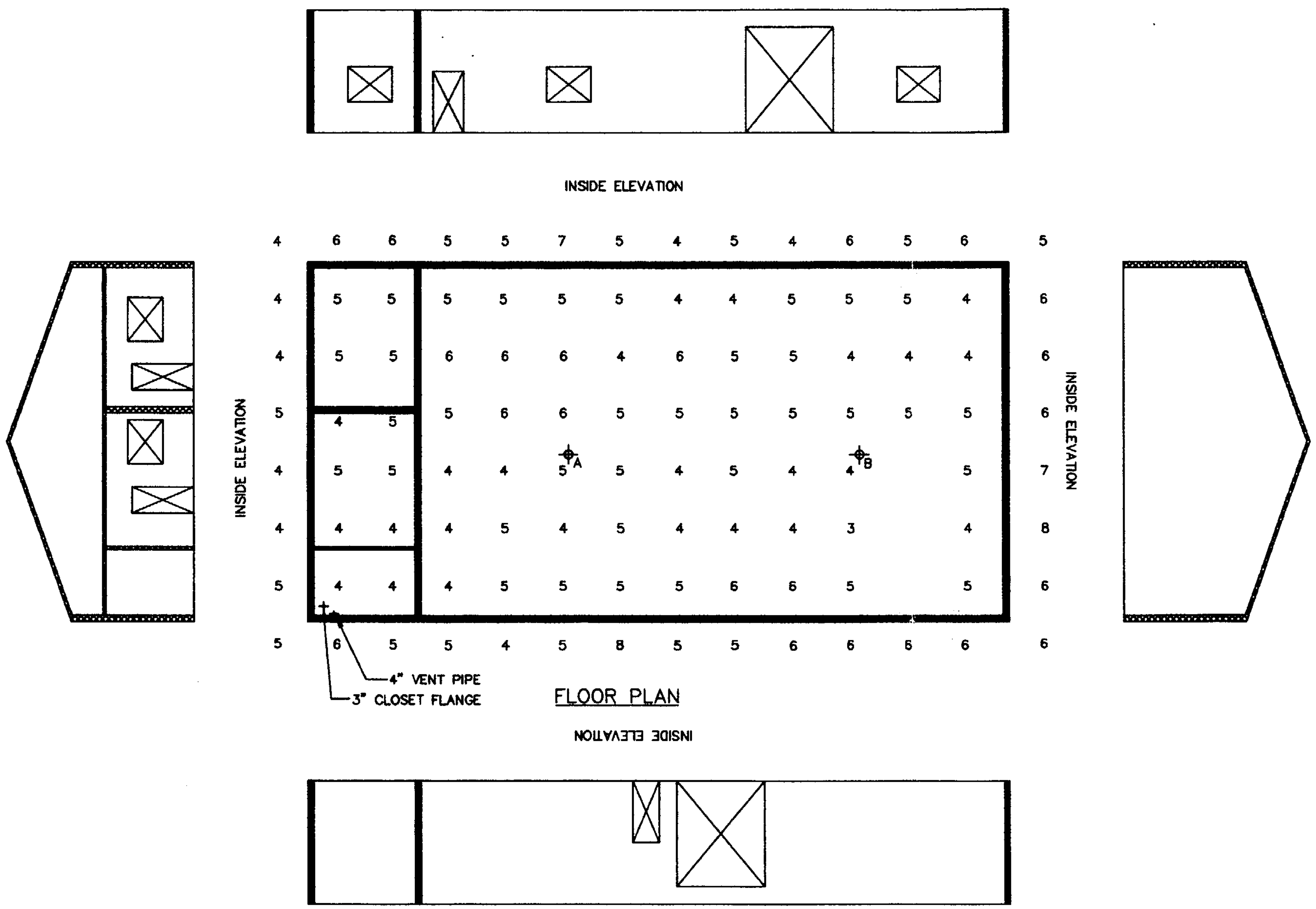
TMI-1 DWG. NO. SNECRM-013 SH. 1 REV. 0
SCALE: 1/8"=1'-0"

INTERFACING CONCURRENCE
BA NO.

NO.	DWG. NO.	TITLE
REFERENCES		

DWG.NO. SNECRM-015 SH. 1

REVISIONS		
REV	ZONE	DESCRIPTION



NOTES:

1. 5 = microRem/hr, GENERAL AREA READING.

Cad File Name : SNECRM-015_S1_R0

FIGURE 2-21

THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY

GPU NUCLEAR

R. SCHAIBLE 08/19/99

R.A.KOCH 01/17/00

SNEC FACILITY

PENELEC LINE SHACK

LINE DEPT. BUILDING FLOOR PLAN AND EXTERIOR WALL ELEVATIONS

SAXTON

DWG. NO. SNECRM-015 SH. 1 REV. 0

SCALE: 1/8"=1'-0"

INTERFACING CONCURRENCE

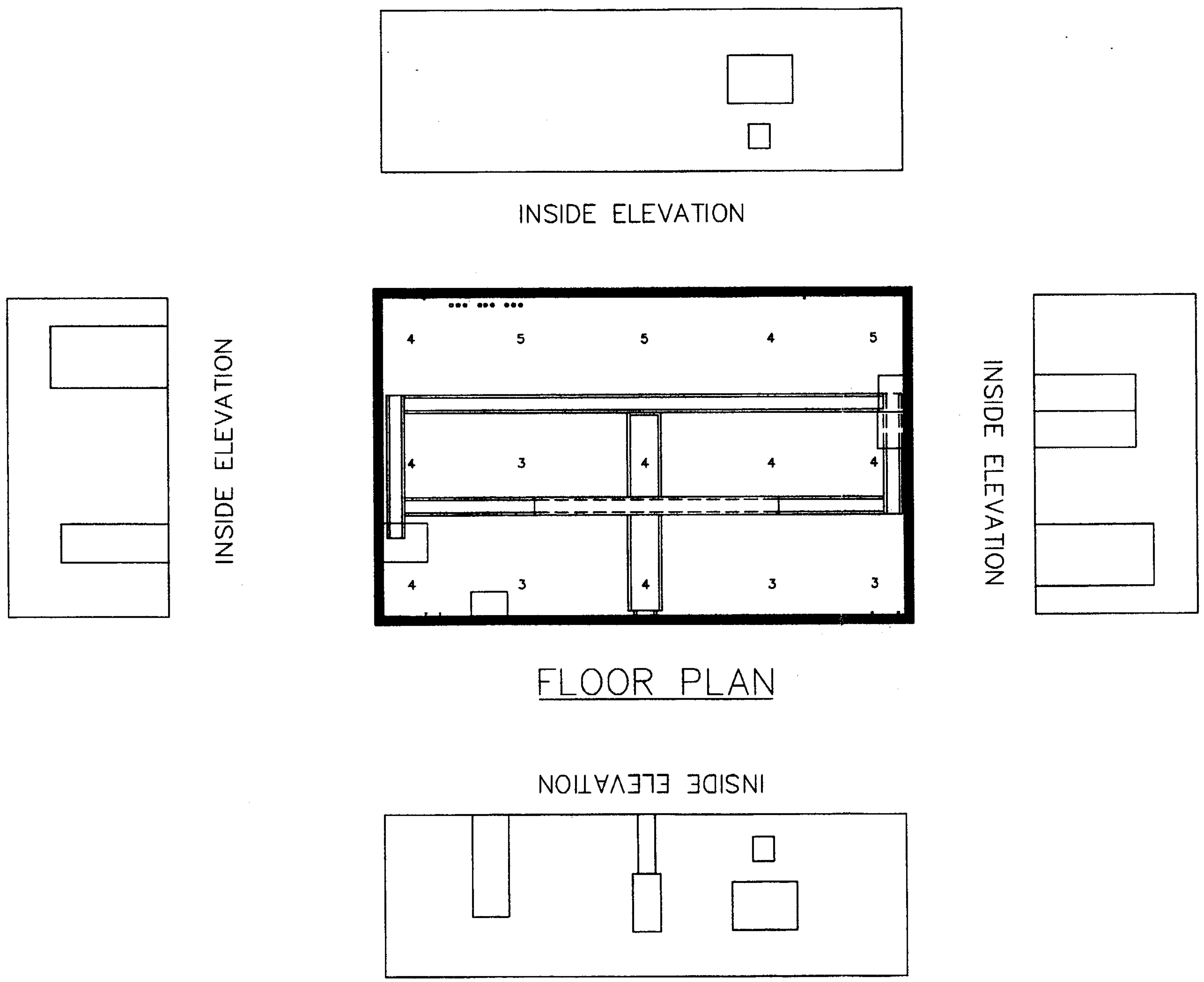
BA NO.

NO.	DWG. NO.	TITLE
REFERENCES		

DWG. NO. SNECRM-017 SH. 1

REVISIONS

REV	ZONE	DESCRIPTION



NOTES:
1. 5 = microRem/hr, GENERAL AREA READING.

Cad File Name : SNECRM-017_S1_R0

FIGURE 2-22

THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY

GPU NUCLEAR

DRAWN R.A.KOCH DATE 01/17/00

CHECKER DATE

DESIGN MANAGER DATE

ENGINEER DATE

ENGINEERING MANAGER DATE

SNEC FACILITY
PENELEC SWITCHYARD BLDG.
FACILITY FLOOR PLAN AND INTERIOR WALL ELEVATIONS

SAXTON | DWG. NO. SNECRM-017 | SH. 1 | REV. 0

SCALE: 1/4"=1'-0"

INTERFACING CONCURRENCE

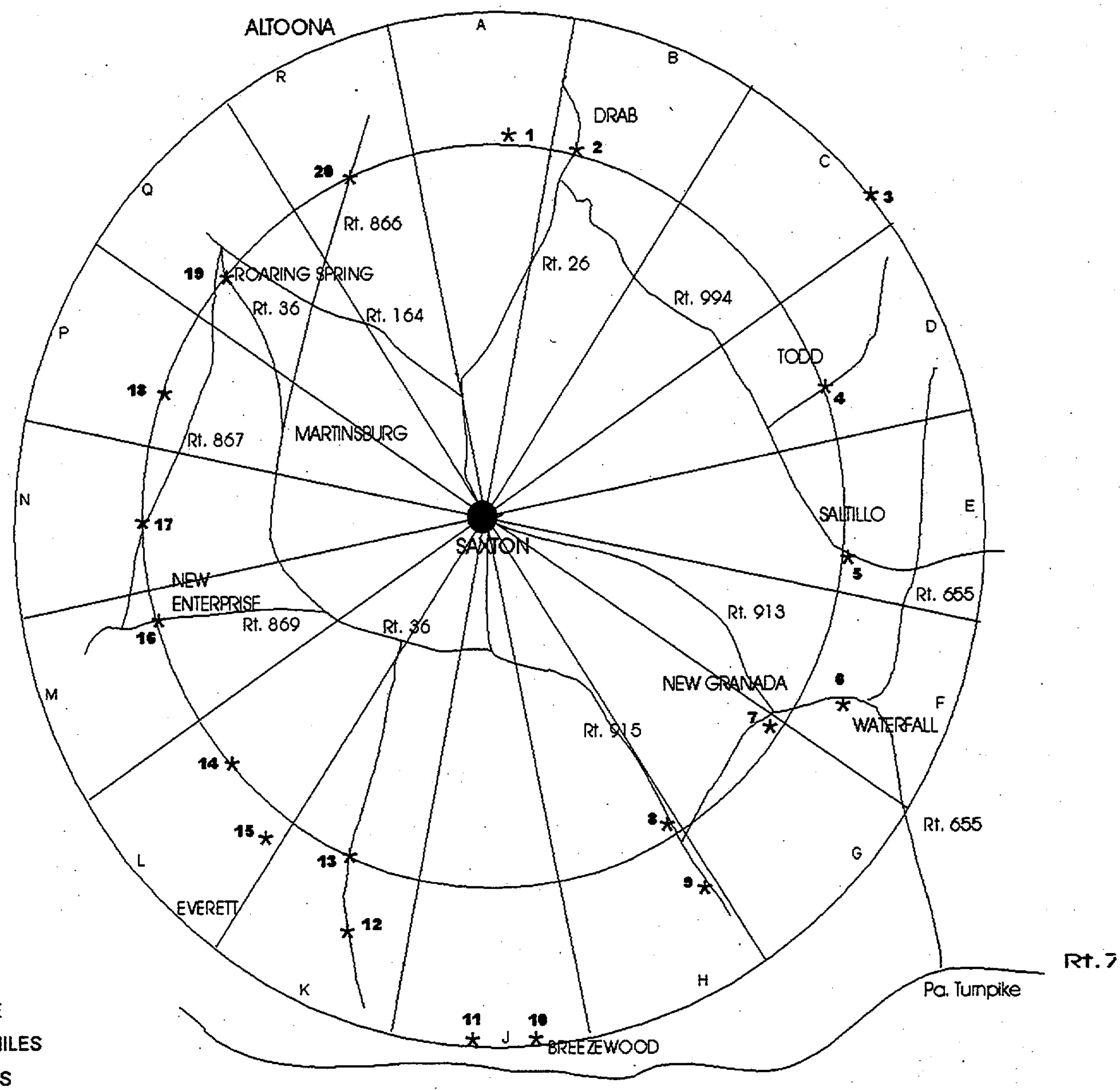
BA NO.

NO.	DWG. NO.	TITLE

REFERENCES

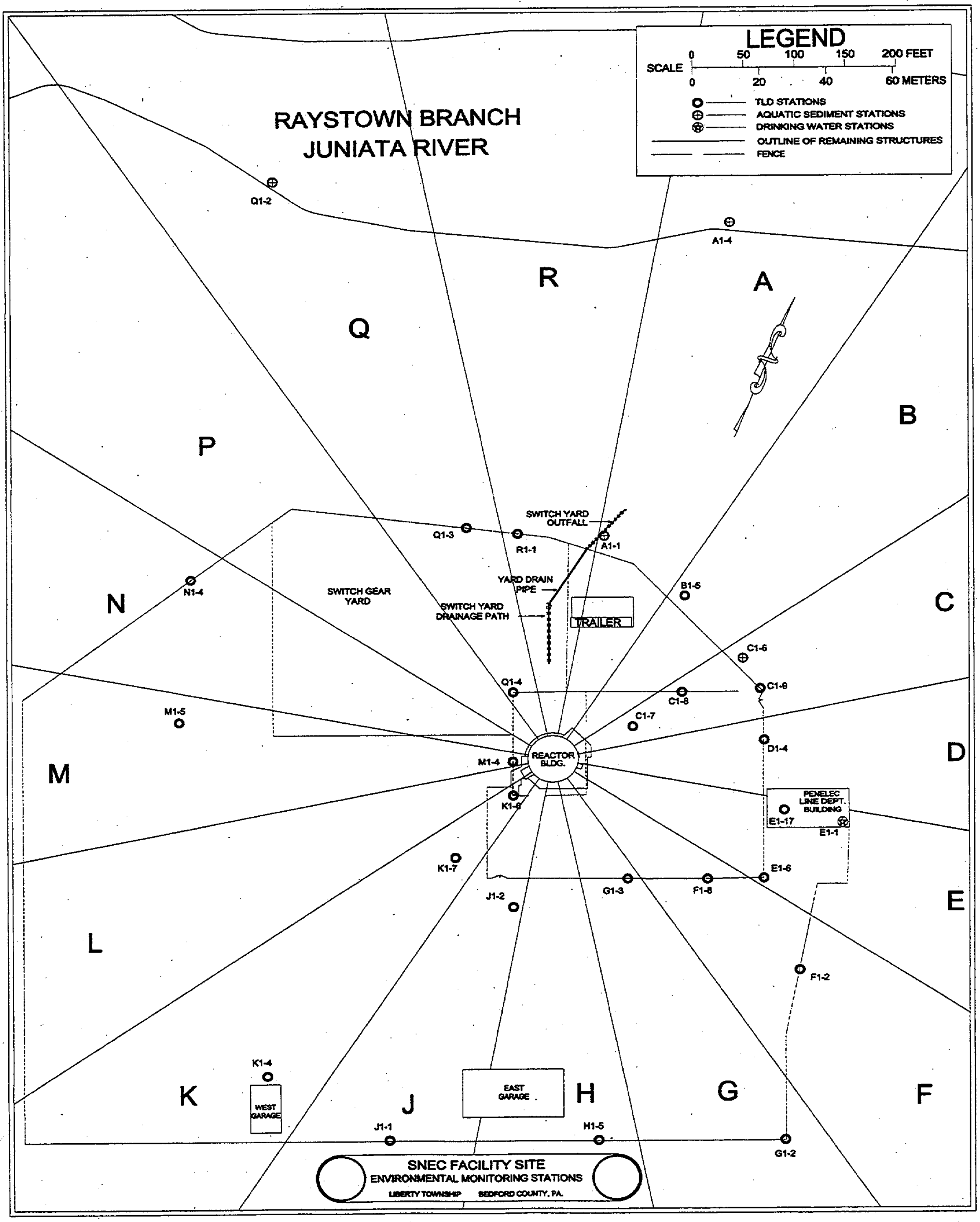
Figure 2-23, Map of the background sampling locations

GPU NUCLEAR



SCALE APPROXIMATE
2.5 INCHES = APPX 10 MILES
◯ = APPX 10 & 15 MILES

Figure 2-24, Map of the REMP Sampling locations



3.0 IDENTIFICATION OF REMAINING DISMANTLEMENT ACTIVITIES

3.1 INTRODUCTION

As discussed previously, this final phase of the SNEC Facility Decommissioning Project commenced in April 1998 following NRC approval of a License Amendment authorizing decommissioning. Since that time, the greater part of 1998 was devoted to removing and shipping the SNEC Facility Large Components (i.e. Reactor Vessel, Pressurizer and Steam Generator). Following removal of the large components, the latter part of 1998 and the beginning of 1999 were devoted to removing the bulk of the remainder of the systems from the SNEC Facility. Following that, concrete decontamination commenced and is continuing.

As described in Section 2.2.2 the site is divided into eight areas in describing radiological conditions. These same area designations will be used in describing remaining site dismantlement activities.

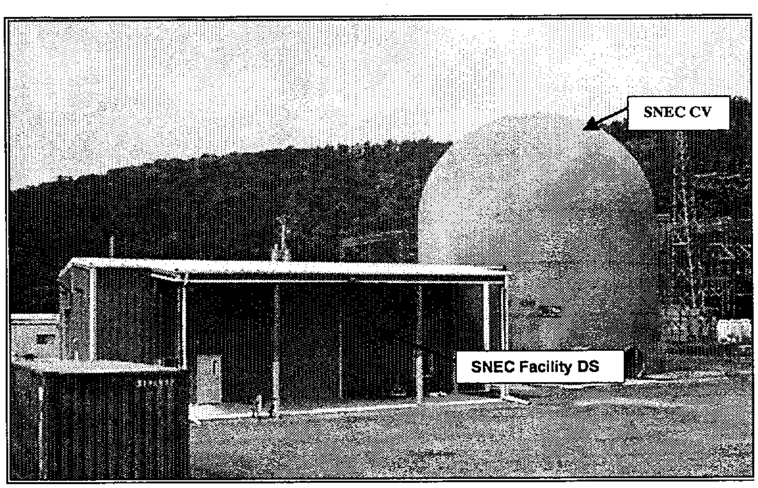


FIGURE 3-1, Photograph of SNEC Facility CV & DSF Buildings

3.2 REMAINING TASKS

3.2.1 Area 1 (CV Basement) Remaining Site Dismantlement Activities

Remaining tasks in Area 1 include removal of two floor drain lines, and removal of miscellaneous steel including the stairway.

3.2.2 Area 2 (Primary Compartment) Remaining Site Dismantlement Tasks

Remaining tasks in Area 2 include decontamination or removal of embedments and pipe penetrations to adjacent areas. This includes many of the penetrations through the five foot thick concrete wall separating Area 2 from Area 6.

3.2.3 Area 3 (Auxiliary Compartment) Remaining Site Dismantlement Activities

Remaining tasks in Area 3 include decontamination or removal of pipe penetrations in the wall between Area 3 and Area 6, between Area 3 and Area 2, and between Area 3 and Area 5, and removal of the structural steel, including the stairway.

3.2.4 Area 4 (Operating Floor) Remaining Site Dismantlement Activities

Remaining tasks in Area 4 include removal of miscellaneous steel, removal of the polar crane and its girders and disconnection of the Containment Ventilation System.

The polar crane is the last large component to be removed from the SNEC Facility. Plans for Polar Crane removal have not been finalized. It can be removed using conventional cutting and rigging techniques and will most likely be dispositioned as radioactive waste.

The Containment Vessel Ventilation System is a special case in that the SNEC Facility License requires the ventilation system to be operating during activities that have the potential to cause a measurable release. Thus, prior to removal of the ventilation system, all dismantlement activities inside the CV that have the potential to cause a measurable release will be completed and the CV placed in a condition to commence Final Status Surveys.

3.2.5 Area 5 (Pipe Tunnel) Remaining Site Dismantlement Activities

As described in Section 3.2, Area 5 consists of a concrete tunnel which extends 235 degrees around the CV. This tunnel is flooded with ground water the elevation of which varies with ground water level. Because this water is slightly contaminated ($3.4E^{-7}$ uCi/ml for Cs-137 and $1.2E^{-7}$ uCi/ml Co-60 {Reference 3-1}), it needs to be removed and treated in accordance with the SNEC Facility Off-site Dose Calculation Manual (ODCM) (Reference 3-2). Once the tunnel is drained and any sediment removed, it will be removed except for the portion under the Material Handling Bay (MHB) section of the Decommissioning Support Facility.

Following removal of the tunnel, soil samples will be taken to determine if further remediation work is required in this area. The portion of the tunnel under the MHB will be surveyed and remediated as appropriate to meet site release levels.

3.2.6 Area 6 (Reactor Compartment and Storage Well) Remaining Site Dismantlement Activities

Remaining tasks in Area 6 include removal of pipe penetrations in the walls between Area 6 and Areas 2, 3, and 5.

3.2.7 Area 7 (Outside of Containment Vessel Dome) Remaining Site Dismantlement Activities

Remaining tasks in Area 7 consist of removing sufficient paint from the CV Dome to support release of the CV Dome during Final Status Survey. Remediation, if needed, will be performed as appropriate.

3.2.8 Area 8 (SNEC Facility Yard Areas) Remaining Site Dismantlement Activities

Remaining tasks in Area 8, with the exception of the Saxton Steam Generating Station (SSGS) Discharge Tunnel will consist of some soil removal and removal of utilities located outside the CV.

The SSGS Discharge Tunnel was used by the SNEC Facility to provide dilution flow for radioactive liquid discharges. Recent surveys in this area indicate there is some residual contamination that will need to be removed. This will include water and sediment removal, and disposal and removal of remnant piping segments.

3.3 ACCESS CONTROL MEASURES

Since all decommissioning activities may not be completed prior to the start of final status survey work, measures as described in Section 5.3 will be implemented to protect survey areas from recontamination during and after the final status survey. In all cases, decommissioning activities creating a potential for the spread of contamination will be completed within each survey area prior to starting a final status survey in the area. Additionally, decommissioning activities that create a potential for the spread of contamination to adjacent survey areas will be evaluated and controlled using barriers, covers, or restricting or rescheduling activities.

3.4 10 CFR 50.59 REVIEW

10 CFR 50.59 "Changes, Tests and Experiments" permits licensees to make changes to the facility as described in the Safety Analysis Report, make changes in procedures as described in the Safety Analysis Report, and conduct tests or experiments not described in the Safety Analysis Report without prior NRC approval unless the change involves a change in the Technical Specifications or an unreviewed safety question.

The remaining tasks described in Section 3.3 are bounded by the Definition for Decommissioning Activities in the SNEC Facility Technical Specifications (Reference 3-3) and are thus permitted by the Technical Specifications. Additionally these tasks are bounded by the SNEC Facility USAR (Reference 3-4).

Thus although some changes will be made to the facility as described in the SNEC Facility USAR, e.g. Removal of the Polar Crane, these activities were anticipated to be performed. Further, greater than 99% of the curies present at the SNEC Facility at the commencement of decommissioning in 1998 have been safely removed from the site, and shipped for proper disposition. Finally, each activity requiring a procedure as defined by the SNEC Facility Technical Specifications are reviewed to ensure they satisfy the criteria of 10 CFR 50.59. Thus, it is anticipated that none of the remaining tasks identified in Section 3.3 requires prior NRC approval.

3.5 DECOMMISSIONING TASKS THAT REQUIRE COORDINATION WITH ANY OTHER FEDERAL OR STATE REGULATORY AGENCY

Prior to License Termination, the only remaining task requiring coordination with any other Federal or State Regulatory Agency is disposal of the water in Area 5 and the Saxton Steam Generating Station Discharge Tunnel portion of Area 8. Discharge of this water will be controlled radiologically in accordance with the requirements of the ODCM (Reference 3-2). The non-radioactive sampling and analysis will be in accordance with a program accepted by the Commonwealth of Pennsylvania.

3.6 SUMMARY

The tasks remaining for site dismantlement are permitted by the SNEC Facility License Technical Specifications and USAR. Based on current estimates, these tasks will be completed in the third quarter of 2000 for an estimate exposure of 37 person-rem (Table 3.1) of this total approximately 35 person-rem have been expended to date. Estimated remaining low level radioactive waste generation is provided in Table 3.2.

3.7 REFERENCES

3-1 SNEC Facility Site Characterization Report, May 1996

3-2 SNEC Procedure E900-PLN-4542.08 "Off-Site Dose Calculation Manual"

3-3 SNEC Facility Technical Specifications

3-4 Updated Safety Analysis Report for Decommissioning the SNEC Facility

Table 3.1 SNEC Facility Decommissioning Person-Rem Estimate

TASK	PERSON-REM
Asbestos Remediation (Actual)	2.97
System Dismantlement (Actual)	12.83
Large Component Removal (Actual)	7.38
Structure D&D	2.75
Miscellaneous Support Activities	2.75
Tours and Inspections	.23
Scaffolds and Shielding	5.75
Characterization	.75
Totals	36.93

Table 3.2 SNEC Facility Low Level Radioactive Waste Projection

TYPE	QUANTITY
Metal	125,000 lbs.
Soil	2,000 ft^3
Water	500 gal
Sediment	1,500 ft^3
Concrete	40,000 lbs.
Dry Active Waste (DAW)	1,500 ft^3

4.0 REMEDIATION PLANS

4.1 INTRODUCTION

The ultimate goal of the decommissioning project at the SNEC facility is to release the site in accordance with NRC regulations (10 CFR Part 20.1402, Radiological Criteria for Unrestricted Use). Release of the site requires assurance that any future use of the site will not result in exposing individuals to unacceptable levels of radiation. The site release criteria requires the Total Effective Dose Equivalent (TEDE) to an average member of the critical population group from residual contamination to be less than 25 mrem/year. In addition, plant-related contamination in groundwater and surface water with the potential to be used as a source of drinking water will be evaluated against the 4 mrem/year dose criteria in the National Primary Drinking Water Standards contained in 40 CFR 141. Remediation of some areas of the site will be necessary in order to meet these release criteria. Section 5.4.4 of the LTP describes the data investigation process used to evaluate the effectiveness of remediation to determine whether further investigation or remediation is required to ensure that an area meets the site release criteria. Section 4.3 and 4.4 identify the remediation methods that may be used and describe the areas on site that may be subject to remediation.

4.2 RADIOLOGICAL CONTROL PROGRAM CHANGES

The Radiological Controls Program will continue to be fully integrated into all aspects of operations at the SNEC Facility throughout the license termination process. The program will ensure that operations at the SNEC Facility are performed in accordance with the ALARA philosophy to protect plant personnel and the general public.

The SNEC Radiation Protection Plan establishes basic policies, philosophies, and objectives to maintain doses to workers and members of the public as low as reasonably achievable (ALARA). Specific details as to how the plan is implemented are incorporated into Radiological Controls procedures. These procedures are established and will be maintained in accordance with the SNEC Facility Technical Specifications. SNEC management does not anticipate significant changes to Radiological Controls procedures during the license termination process. However, any changes will be performed in accordance with the SNEC Facility Technical Specifications and 10 CFR 50.59 process.

4.3 REMEDIATION METHODS

In conjunction with the near completion of Site Dismantlement Activities as described in Chapter 3, remediation will be performed in accordance with the general decontamination and dismantlement considerations of Section 5.0 of the SNEC Updated Safety Analysis Report (Reference 4-1). Any area of the site that does not meet the release criteria will be remediated as appropriate. In keeping with the principles of ALARA, additional residual levels of radioactivity may be reduced commensurate with the minimization of total risk. As an example, because of the effectiveness of some remediation methods, some areas may be remediated to residual dose levels well below 25 mrem/year at little or no additional cost.

4.3.1 Building and Structure Surfaces

Many decontamination methods exist to decontaminate surfaces of buildings and structures. Several factors determine the choice of decontamination method for a given application, including the extent of the contaminated area, surface material, depth of contamination, and access considerations. The plan describes the decontamination methods that may be used during dismantlement operations. In addition, several additional decontamination technologies may be used typical technologies are listed below. All methods will be utilized with proper regard to the potential for airborne contamination and industrial safety, and may be used in conjunction with containment enclosures or HEPA filtration units in order to minimize airborne radioactivity (as appropriate).

- Abrasive Vacuum Blasting with Recyclable Blast Media - This method is highly effective for surface contamination up to a depth of 6 mm. Unlike conventional abrasive blasting, this method uses a recyclable blast media such as steel shot to minimize the volume of waste that is generated.

- Concrete Sectioning - This method can be used to remove large pieces of contaminated concrete where other methods would be too slow. Cutting may be performed with an abrasive blade or a diamond wire saw.

- Needle Gunning - This method is used for removing surface contamination in areas that are too small or inaccessible for other methods.

- Manual Removal of Building/Structural Materials - Contaminated building materials such as steel and loose concrete can be cut and manually removed and disposed of at an appropriate low level radioactive waste burial or treatment facility.

- Concrete Scabbling – Contaminated concrete structures are routinely scabbled to remove surface activity deposits. Scabbling involves mechanical pounding of the surface to remove surface deposits and some subsurface contamination.

4.3.2 Surface Soils, Gravel and Asphalt

Soil remediation will involve the removal of soil, gravel or asphalt as necessary to meet the site release criteria. Asphalt and gravel will be treated in the same way as soil. Soil, gravel and asphalt will be removed with excavation equipment, and due care will be taken to prevent the spread of contamination during excavation and handling including controls to minimize the creation of fugitive dust materials. All contaminated soil, gravel and asphalt will be disposed of at low-level waste disposal facilities.

4.3.3 Sediment

As discussed in Chapter 3, sediment in the Pipe Tunnel and the SSGS Discharge Tunnel will be removed as part of site dismantlement activities. No additional sediment contamination has been found that exceeds the release criteria, including sediment impacted by licensed discharges monitored as part of the SNEC Radiological Environmental Monitoring Program (REMP). Any additional sediment found to be contaminated from plant operations will be removed if the levels of contamination exceed the release criteria. Contaminated sediment may be removed by dredging or by other manual excavation techniques.

4.3.4 Sub-floor Soil

Where radionuclide concentrations that exceed the action level for remediation are found in sub-floor soil beneath structures, the concrete floors will be cut or broken up and the underlying soil excavated and removed along with any contaminated concrete. Because of the difficulty in excavating beneath an existing structure, remediation of sub-floor soil may take place after the structure has been demolished. Remediation may also be performed with the structure intact. Several factors influence the approach that is used, including structural stability issues, the extent and depth of the contamination, the accessibility of the work area to excavation equipment, and the need to protect the work area from the elements. If it is necessary to demolish a structure, the part that is above grade and the accessible parts below grade (interior floors, walls, ceilings) will be decontaminated first (if deemed appropriate). A final status survey will then be performed on these areas to verify that the release criteria have been met. NRC approval of the results will release the surveyed parts of the structure for conventional demolition and disposal without the need for additional surveys. After the debris is removed, radiological controls will be re-established and the radiologically contaminated sub-floor soil will be excavated.

4.4 AREAS TO BE REMEDIATED

Site characterization to determine remaining areas that need remediation is ongoing and will continue throughout decommissioning. The site release criteria and the principles of ALARA will be applied on a case by case basis to identify the extent of the remediation necessary. The following areas have either already been remediated, identified for remediation, or may undergo further analysis as deemed appropriate:

- All Outdoor Radioactive Material Storage Areas - These areas may change as site land use needs change. All Potentially Contaminated Areas (PCA) will be remediated or be shown to meet site release criteria prior to site release. In addition, any previous underground radioactive liquid storage areas will be sampled and analyzed as appropriate.

- Soil and/or Gravel Under or Near Existing Site Facilities – Some contaminated materials have already been removed from beneath site structures during the soil remediation project. Additional soil and/or gravel removal will be remediated as necessary if future site characterization finds contamination in excess of the site release criteria. In addition, soil deposits around or under existing structures such as the old steam tunnel and concrete slabs exterior to the CV, will be sampled, analyzed and remediated as necessary, during dismantlement operations.

- Structural Decontamination - Buildings and structures which have been identified for remediation include the Containment Vessel, Steam Tunnel, Saxton Steam Generating Station Discharge Tunnel, and surrounding concrete slabs. If additional structures are found to be contaminated in excess of the site release criteria, they will be decontaminated when they are no longer required to support site decommissioning operations.

- Storm Drain Out-fall – Section 2.0 in the SNEC Facility Site Characterization Report describes various contamination events that have occurred over the course of the plant's life that may have resulted in discharges of low levels of radioactivity. However, no event is listed that describes above permissible release of liquid to the storm drain and weir system. In addition, samples from sediment from the weir and 10" drain line emptying to the river have not indicated that a release above limits occurred.

4.5 REFERENCES

4-1 Updated Safety Analysis Report for Decommissioning the SNEC Facility – Revision 2, February 1998.

5.0 THE SNEC FACILITY FINAL RADIATION SURVEY PLAN

The SNEC Facility Final Radiation Survey Plan has been prepared using the guidance provided in applicable regulatory guidance documents described in Section 5.1.1 below. Ultimately, this plan will be used to develop lower tier procedures and work instructions as necessary to accomplish the Final Status Survey for the SNEC Facility.

5.1 INTRODUCTION

5.1.1 Purpose

The SNEC Facility Final Status Survey Plan (FSSP) describes the final survey process that will be used to demonstrate that the SNEC Facility and all additional near site impacted areas meet radiological criteria for license termination. 10 CFR 50.82(a)(9)(ii)(D) (Reference 5-1), and Regulatory Guide 1.179 (Reference 5-2) have been used as guides in the preparation of this plan. This plan incorporates the site release criteria provided in 10 CFR 20.1402 (Reference 5-3) and the methodology used to demonstrate compliance provided in Draft Regulatory Guide DG-4006 (Reference 5-4), NUREG-1575 (Reference 5-5) and NUREG-1505 (Reference 5-6). Other documents, such as Draft NUREG-1549 (Reference 5-9), were also reviewed in the process of preparing this plan.

5.1.2 Scope

The final survey encompasses structures, land areas, and any remaining facility systems which, because of licensed activities, are considered contaminated or potentially contaminated. At the time of the final status survey, most building structures will be largely intact. Areas currently exhibiting the highest activity are located within the SNEC Containment Vessel (CV), as illustrated in Chapter 2 of this License Termination Plan (LTP). As of the date of the SNEC Facility LTP submittal, the majority of all contaminated systems, components, and soils will have been removed from the site. Remediation in selected areas will ensure they satisfy unrestricted release levels before the Final Status Survey (FSS) process begins.

5.1.3 Summary

The SNEC Facility FSSP describes the final survey process and the methodology used to develop guideline values against which residual radioactivity levels remaining at the SNEC Facility at the time of the FSS will be compared. The final survey process is described as a series of steps – survey preparation, survey design, data collection, data assessment, and final survey report preparation. However, in practice, this is an iterative process in that once the results from one step are known they may prompt repeating one or more previous steps. In addition, the process is designed to be flexible in that modifications may be made as necessary as more information is collected during the survey process.

FSS activities begin when dismantlement and decontamination activities are believed to be complete. Each survey area is divided into survey units that are classified according to their potential for retaining residual radioactivity, or in accordance with known contamination levels. Survey data from each survey unit are assembled according to data collection requirements and frequencies established for each classification. When residual radioactivity is measured above pre-set levels, an investigation is performed. Based on the results of the investigation, the survey unit may be remediated, reclassified, resurveyed or determined to meet the release criteria.

There are three principal types of survey results collected during the FSS effort. They are 1) scan measurement data, 2) fixed-point measurement data, and 3) sampling of volumetric materials for laboratory analysis. *In-situ* gamma-ray spectrometry may also be included in the release survey process as well as the results of any special measurements or analysis. All collected data is first verified to be of adequate quantity and quality, capable of supporting underlying assumptions necessary for statistical testing. Where necessary, previous survey steps are re-evaluated and additional data is collected before applying statistical testing. Each survey unit will then be tested and compared to the release criteria. To meet the release criteria, the survey data must pass the statistical tests applied. When the data set fails statistical testing criteria, the survey unit is not suitable for unrestricted release without further actions. Failed data sets are first analyzed and then additional data may be collected or the survey unit may be reclassified, remediated and/or resurveyed.

Upon completion of FSS activities, a final survey report will be prepared which summarizes the data. The report will document the conclusion that the SNEC Facility site and near site areas meet the 10 CFR 20.1402 release criteria and may be released for unrestricted use.

5.2 SURVEY OVERVIEW

This section describes the scope and methodology of the final survey process. It includes quality assurance measures and access control procedures. It also describes how implementation of this plan will demonstrate that the remaining structures and site areas meet the 10 CFR 20.1402 criteria for unrestricted release. Also described herein, are the methods used to develop guideline values against which residual radioactivity levels will be compared.

5.2.1 Identity of Radiological Contaminants

The radionuclide inventory at the SNEC Facility was estimated during the site characterization process, which was conducted in 1995 through 1996. The data are complied in the SNEC Facility Site Characterization Report (Reference 5-7) and summarized in Chapter 2 of this plan. Additional data continues to be gathered on radionuclide concentrations from routine operational and decommissioning survey work supporting dismantlement activities, and from supplemental site characterization work performed since 1996. The predominant radionuclide present on structural surfaces and in facility systems is Cesium-137. Cobalt-60 is also present, but at much lower concentrations than Cesium-137. Additionally, there is some low level transuranic radionuclides, such as Americium-241 and Plutonium-238 and 239, present in the SNEC Facility CV and in the former effluent pathway piping leading to the Saxton Steam Generating Station Discharge Tunnel. However, Cs-137 is the dominant isotope present in soils and sediments remaining at the site outside of site structures.

5.2.2 Site Release Criteria

5.2.2.1 Radiological Criteria for Unrestricted Use

These site release criteria correspond to the radiological criteria for unrestricted use given in 10 CFR 20.1402, which are:

- **DOSE STANDARD**

  Residual radioactivity, distinguishable from background radiation and resulting in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group will not exceed

25 mrem/y, including that from groundwater sources of drinking water. However, the intent of the SNEC Facility is to achieve a goal of less than or equal to 4 mrem/y from drinking water, and

- **ALARA STANDARD**

  Residual radioactivity will be reduced to levels that are As Low As Reasonably Achievable (ALARA), as addressed in Section 6.4.

5.2.2.2 Conditions Satisfying the Site Release Criteria

Levels of residual radioactivity that correspond to the allowable radiation dose and ALARA levels cited in Section 5.2.2.1, are calculated (derived) by analysis of various scenarios and pathways (e.g., direct radiation, inhalation, ingestion, etc.). These derived levels are referred to as "derived concentration guideline levels" (DCGLs), and form the basis for the following conditions which when met, satisfy the site release criteria (DCGL concepts are defined in Section 5.8):

- All measurements of residual radioactivity above background from all survey units are equal to or below the $DCGL_W$*. No further testing is required, or
- Individual measurements from small areas within a selected survey unit that exceed the $DCGL_W$, do not exceed the $DCGL_{EMC}$*. In addition, the sum of the fractions for both $DCGL_W$ and $DCGL_{EMC}$ in applicable sections of a survey unit are less than unity for all site survey units, and
- All survey data pass applicable statistical testing criteria.
- In all cases, remediation is performed (as applicable) to reduce the levels of residual radioactivity concentrations to ALARA values.

*The $DCGL_W$ is the permitted average concentration in the survey unit. The $DCGL_{EMC}$ is the elevated measurement comparison DCGL.

5.2.3 <u>Development of Derived Concentration Guideline Levels</u>

5.2.3.1 Dose Modeling

Dose models based on NUREG/CR-5512, Volume 1 (Reference 5-8) and RESRAD (Reference 5-10) were used to calculate the DCGLs. The dose model translates residual radioactivity levels into potential radiation doses to the public and is defined by three factors: 1) the scenario, 2) the exposure pathways, and 3) the critical group. The scenarios described in NUREG/CR-5512 address the major exposure pathways of direct exposure to penetrating radiation and inhalation and ingestion of radioactive materials. These scenarios also identify the critical group. The critical group is the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity within the assumptions of the particular scenario. These scenarios and their modeling are designed to generally overestimate rather than underestimate potential dose.

Two representative scenarios were selected for the SNEC Facility. They are 1) building occupancy, and 2) residential farming. These scenarios, described below, represent reasonable and plausible human activities and future uses of the SNEC Facility site. These scenarios are based on the aforementioned dose modeling software. The building renovation scenario was considered but deemed inappropriate.

5.2.3.1.1 Building Occupancy Scenario

Because surface decontamination operations may not completely remove surface radioactivity, a scenario describing surface contamination is considered. This scenario accounts for exposure to both fixed and removable thin-layer radioactivity for a structure. This scenario also assumes that individuals occupy the building in a passive manner without deliberately disturbing the residual radioactivity on building surfaces. Occupancy of the building is assumed to begin immediately after license termination. The exposure duration is assumed for a full work year (2000 hours) continuing for seventy (70) years. The critical group consists of the building occupants, who are the people who work in the building following license termination.

The pathways that apply to the building occupancy scenario include:

1. External exposure to penetrating radiation from surface sources,
2. Inhalation of re-suspended surface contamination, and
3. Inadvertent ingestion of surface contamination.

5.2.3.1.2 Residential Farming Scenario

Soil at the site is contaminated from licensed operations, accidental spills, and long-term accumulation of material in the soil from effluent releases. It is also contaminated from intentional disposal or burial of concrete or other structural debris such as pavement, masonry or structural steel. The residual radioactivity is assumed to be distributed in a surface soil layer covering the site on property that is used for residential and light farming activities. The scenario assumes continuous exposure via multiple exposure pathways to the critical group. The critical group is the resident farming family who lives on the site following site remediation, grows some portion of their diet on the site and drinks water from a source at the site.

The pathways that apply to the residential farming scenario includes:

1. External exposure to penetrating radiation from volume soil sources while indoors and outdoors,
2. Inhalation exposure to re-suspended soil while indoors and outdoors,
3. Direct ingestion of soil,
4. Ingestion of drinking water from a groundwater source,
5. Ingestion of plant products grown in contaminated soil,
6. Ingestion of plant products grown with contaminated groundwater,
7. Ingestion of animal products grown on-site, and
8. Ingestion of fish from a contaminated surface water source.

5.2.3.2 Derived Concentration Guideline Level (DCGL)

The surface contamination and radionuclide concentration levels of structures, land areas, and facility systems remaining at the time of the FSS are compared to DCGLs calculated using the dose models. A DCGL is defined as "that concentration of residual radioactivity distinguishable from background radiation which if distributed uniformly throughout a survey unit, would result in a Total Effective Dose Equivalent (TEDE) of 25 mrem/y to an average member of the critical group." The average member of the critical group is the individual who is assumed to represent the most likely exposure situation based on the assumptions and parameter values used in the dose model calculation. The DCGLs are calculated based on the peak annual TEDE dose to the average member of the critical group expected within the first 10,000 years after license termination. DCGLs are presented in terms of surface or volumetric radioactivity concentrations and are expressed in units of dpm/100 cm^2 or pCi/g.

5.2.3.2.1 NRC Screening DCGLs

The NRC screening DCGLs are intended to be used as the principal means of releasing structures at the SNEC Facility. However, since the site is radiologically complex (i.e., multiple radionuclides are found in various distributions throughout the site) screening DCGLs are seldom, if ever applied directly to determine compliance with the site release dose criteria. Rather, they are used to develop surrogate ratio, gross activity, or elevated measurement comparison DCGLs ($DCGL_{EMC}$), or are applied using the unity rule. The gross activity or surrogate ratio DCGLs are termed "effective" DCGLs in the sections that follow. Where the broad conservatism inherent in the screening DCGLs prove unrealistically restrictive, a set of site specific DCGLs may be developed and used in their place (with regulatory approval).

NRC screening DCGLs for surface contamination, are presented in Table 5-1, and were calculated by entering standard default conditions into the NRC's dose modeling computer software "DandD". Open land area DCGLs were calculated using RESRAD version 5.82. Additionally, SNEC Facility site specific alpha emitting radionuclides were added to Table 5-1 by SNEC Facility staff using the same default parameters provided in the DandD computer software (for surface activities only). The NRC is currently working on screening parameters for alpha emitting radionuclides to add to their previously provided screening values. When these values are available, SNEC Facility staff may choose to evaluate their use at the SNEC Facility site.

Table 5-1

SNEC Facility DCGL Values

Radionuclide	Surface Area (dpm/100 cm^2)	Open Land Areas (pCi/g)
Am-241	2.7E+01	1.5E+00*
C-14	3.7E+06	3.7E+00
Cm-243	3.9E+01	2.2E+01
Cm-244	4.9E+01	3.8E+01
Co-60	7.0E+03	2.5E+00
Cs-134	1.3E+04	3.6E+00
Cs-137	2.8E+04	8.5E+00
Eu-152	1.3E+04	6.3E+00
Eu-154	1.1E+04	5.7E+00
Eu-155	1.6E+05	2.3E+02
Fe-55	4.5E+06	4.2E+04
H-3	1.2E+08	2.6E+02
Nb-94	8.3E+03	4.5E+00
Ni-59	4.2E+06	4.6E+03
Ni-63	1.8E+06	1.7E+03
Pu-238	3.0E+01	2.4E+01
Pu-239	2.8E+01	2.2E+01
Pu-240	2.8E+01	2.2E+01
Pu-241	8.8E+02	4.5E+01*
Pu-242	2.9E+01	2.3E+01
Sb-125	4.4E+04	1.8E+01
Sr-90	8.7E+03	1.6E+00
Tc-99	1.3E+06	1.1E+01
U-234	9.0E+01	1.8E+01*
U-235	9.1E+01	1.2E+00*
U-238	1.0E+02	3.0E+01*

* DCGL based on 4-mrem/year drinking water dose.

5.2.3.2.2 Site-Specific DCGLs

Where DandD cannot be easily modified to incorporate the use of site-specific data, other computer dose modeling software, such as the US Department of Energy's RESRAD (Reference 5-10) and RESRAD-BUILD (Reference 5-11) software, may be used to generate site-specific DCGL values. The best approximation of real site conditions was obtained by replacing some default-input parameters in the computer code "RESRAD", with site-specific parameters. Site-specific parameters, representing actual site conditions, were obtained from contracted geological services. Site-specific data may justify the use of site-specific parameters to reduce the conservatism and produce a more realistic estimate of site-specific conditions. Site-specific parameter values used in developing site-specific DCGLs are documented, along with the justification for their use. A treatment of uncertainty is included as part of this justification.

5.2.3.2.3 Surrogate Ratio DCGLs

Surrogate ratio DCGL values may be established for areas where ratios between radionuclide concentrations are reasonably consistent. Establishing ratios between radionuclide concentrations allows other radionuclide concentrations to be predicted and therefore assumed present in the mix at a fixed fraction of another radionuclide. Likewise, a surrogate ratio DCGL allows the DCGLs specific to "hard-to detect" (HTD) radionuclides in a mix to be expressed in terms of a single radionuclide which is more easily measured. The measured radionuclide is called the surrogate radionuclide.

To obtain the best approximation of the actual ratio between radionuclides present in any area, a sufficient number of measurements or samples, spatially separated throughout the area must be collected. The number of measurements or samples needed to determine the ratio is based on the chemical, physical, and radiological characteristics of the radionuclides expected to be present in the area. The surrogate ratio may also be determined using the most conservative ratio present in the data set (i.e., the ratio that will produce a measurable value that causes the highest calculated dose). One may also consider the variability in the surrogate ratio by selecting the 95% upper bound of the surrogate ratio (to yield a conservative value for the non-measured radionuclide). Selecting a conservative surrogate ratio ensures that potential exposures from individual radionuclides are not underestimated. The surrogate method will be used only when similar physical and geological characteristics are present in a survey unit.

The general equation used for a simple surrogate situation involving two isotopes such as Cs-137 and Sr-90 (as an example), is shown below:

$$DCGL_{Cs,\ Modified} = DCGL_{Cs} \times DCGL_{Sr} /(((C_{Sr} / C_{Cs}) \times DCGL_{Cs}) + DCGL_{Sr})$$

Where: C_{Sr}/C_{Cs} is the surrogate ratio of Sr-90 to Cs-137 (NUREG-1575, Reference 5-5, Equation 4-1).

When a surrogate ratio is established using data collected prior to remediation, additional post-remediation sampling will be performed to ensure that the data used to establish the ratio is appropriate and representative of existing site conditions. Additional post-remediation measurements and/or sampling and analysis efforts will be used to validate currently existing radionuclide concentrations before performing the FSS.

5.2.3.2.4 Gross Activity DCGLs

Where multiple radionuclides are present, a gross activity DCGL may be developed. The gross activity DCGL enables field measurements of gross activity rather than the determination of individual radionuclide activity, for comparison to the radionuclide-specific DCGL. The gross activity DCGL, or $DCGL_{GA}$, for surfaces or volumes with multiple radionuclides is calculated using the following equation (NUREG-1575, Reference 5-5, Equation 4-4):

$$Gross\ Activity\ DCGL = 1/((f_1/DCGL_1) + (f_2/DCGL_2) + \ldots(f_n/DCGL_n))$$

Where: f_1 is the relative fraction of the total activity contributed by radionuclide 1, and
f_2 is the relative fraction of the total activity contributed by radionuclide 2, and
f_n is the relative fraction of the total activity contributed by the nth radionuclide in the mix.

In situations where an area has unknown or a highly variable concentration of radionuclides throughout, it is acceptable to select the most conservative mix of radionuclides present when developing a gross DCGL. Remediation efforts at the SNEC Facility will seek to remove contamination from concrete surfaces by removing significant near surface volumes of concrete. On other structural surfaces (e.g., support steel), abrasive decontamination techniques may be used to remove surface deposited contamination. This effort will greatly limit isotopic variability on structural surfaces by removing the majority of less soluble surface deposited radionuclides. Additionally, by aggressively chasing cracks and other structural anomalies, little (if any) surface deposited radionuclides should remain. Those that do remain will be at a significantly reduced fraction of their previous level. Post-remediation sampling will be used to adjust gross DCGL values as necessary before performing the FSS. Gross activity measurements will be performed in both reference areas (background areas) and areas to be surveyed.

For soil, contamination specific radionuclides, rather than gross activity values, will be measured in soil samples. Sample results in the area surveyed will be compared to reference area background sample results as applicable. In addition, exposure rate measurements will be performed over open land area survey units. Exposure rate measurements will be compared to measurements made over reference areas. When necessary, spectra of the components of a radiation field may be used to differentiate between site related radioactive materials and natural occurring radioactivity.

5.2.3.2.5 Elevated Measurement Comparison (EMC) DCGLs

Elevated Measurement Comparison (EMC) DCGLs are DCGL values that have been modified by reducing the dose model area size in the dose modeling computer code. The effect is to allow higher levels of contamination to exist in smaller well-defined on-site areas. Assuming the residual radioactivity is concentrated in a much smaller area rather than uniformly over the entire survey unit is the basis for developing the $DCGL_{EMC}$. The methodology used to calculate the $DCGL_{EMC}$ is given in Appendix 5-1. Area factors for individual radionuclides have been calculated and are presented in Table 5-15.

5.2.3.2.6 Unity Rule

Typically, each radionuclide specific DCGL corresponds to the release criteria (e.g., regulatory limit in terms of dose or risk). However, in the presence of multiple radionuclides, the total of the DCGLs for all radionuclides would exceed the release criteria. In this case, the individual DCGLs need to be adjusted to account for the presence of multiple radionuclides contributing to the total dose. One method for adjusting the DCGLs is to modify the assumptions made during exposure pathway modeling to account for multiple radionuclides. The surrogate measurement method discussed previously, describes one method for adjusting the DCGL to account for multiple radionuclides. Additionally, another method includes the use of the unity rule.

The unity rule, represented in the expression below, is satisfied when radionuclide mixtures yield a combined fractional concentration limit that is less than or equal to one (1) (NUREG-1575, Equation 4-3):

$$(C_1/DCGL_1)+(C_2/DCGL_2)+...(C_n/DCGL_n)\leq 1$$

Where: C = concentration of radionuclide (1, 2, ...,n)
DCGL = guideline value for each individual radionuclide (1, 2, ...,n)

A higher sensitivity will be needed in these measurement methods, as the values of C become smaller. In addition, this may influence statistical testing considerations by increasing the number of data points necessary for application of a specific statistical test.

5.2.4 Facility and Site Classification

Not all areas of the site have the same potential for residual radioactivity and, accordingly, do not need the same level of survey effort to demonstrate compliance with the site release criteria. Using the criteria given below, different sections of the site are grouped into impacted and non-impacted areas based on the potential for residual radioactivity to be present. Classification of site areas is based on professional judgment, operational history (Historical Site Assessment (HSA) information, Reference 5-20), site characterization data, operational surveys performed in support of decommissioning, and routine surveillance. See the site facility diagrams Chapter 2, and the SNEC site map (Figure 5-1), which is located at the end of this chapter.

5.2.4.1 Non-Impacted Areas

Non-impacted areas have no reasonable potential for the presence of residual radioactivity from licensed activities. These areas do not need any level of survey coverage since there was no radiological impact from site operations. No surveys are performed in these areas other than those used to determine a reference area (background).

5.2.4.2 Impacted Area

Impacted areas are areas that have a reasonable potential for the presence of residual radioactivity from licensed activities. Impacted areas are subdivided into three classes described below.

5.2.4.2.1 Class 1 Areas

Class 1 areas are areas that have or have had (prior to remediation), a potential for radioactive contamination (based on site operating history), or known contamination above the $DCGL_W$ (based on previous radiological surveys).

Examples of Class 1 areas are:

- Areas previously subjected to remedial actions,
- Locations where leaks or spills are known to have occurred,
- Former burial or disposal sites,
- Waste storage sites,
- Areas with contaminants in discrete solid pieces of material at high specific activity, and
- Areas containing contamination more than the $DCGL_W$ before remediation.

5.2.4.2.2 Class 2 Areas

Class 2 areas are those that have or have had, a potential for radioactive contamination but are not expected to contain radioactive material greater than the $DCGL_W$. Examples of Class 2 areas are:

- Locations where radioactive materials were present in an unsealed form,
- Potentially contaminated transport routes,
- Areas downwind of stack release points,
- Upper walls and ceilings of some buildings or rooms subject to airborne radioactivity,
- Areas where low concentrations of radioactive materials were handled, and
- Areas on the perimeter of radioactive material control areas.

5.2.4.2.3 Class 3 Areas

Class 3 areas are any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$. This would again be based on site operating history and previous radiological survey information. Examples of Class 3 areas are:

- Buffer zones around Class 1 or Class 2 areas,
- Areas with a very low potential for residual contamination, but where insufficient information exists to justify a non-impacted classification.

5.2.4.3 Initial Classification

The initial classifications of the SNEC Facility are given in Table 5-2. They are based on site characterization data, the results of the Historical Site Assessment, and recommendations and concerns of SNEC Facility personnel knowledgeable of site conditions. Site characterization data and radiological history information on Table 5-2 survey areas are summarized in Chapter 2. When there was an uncertainty regarding the preliminary classification of a SNEC Facility impacted area, the area was initially assumed a Class 1 area until determined otherwise.

Table 5-2
INITIAL CLASSIFICATIONS OF SITE AREAS

Survey Unit Designations of the SNEC Facility and Surrounding Impacted Areas								
Description	Classification			Survey Unit Area (m^2)*				No. of Survey Units*
	1	2	3	Floor	Walls	Ceiling	Other	
MISCELLANEOUS SNEC FACILITY AREAS & ITEMS								
Off-site Airborne Monitoring Stations		X					<10	1
Intake Tunnel Opening			X				600	1
SSGS Discharge Tunnel Outfall							600	See Note
Weir Outfall	X						400	1
Weir Outfall Buffer		X					1200	1
Northeast Dump Site			X				7000	1
Remaining Weir Line to River	X						122	1
Spillway (Shunt Line Outfall)			X				400	1
Embedded Piping in CV	X						TBD	1
Northwest Open Land Area			X				4100	1
Northwest Open Land Area		X					10	1
Other Embedments in CV	X						TBD	1
CONTAINMENT VESSEL (CV) AREA 1, BASEMENT 765' TO 779'-8"								
Ceiling	X					50		1
Main Floor	X			40				1
Haunch Wall	X			24	14			1
Sloped Wall South	X				84			1
South Wall 777-8" to 779'-8"	X				7			1
North Wall (Excluding M/U Filter Cubicle)	X				42			1
Sump	X			2	6			1
M/U Filter Cubicle Exterior Walls	X				30			1
M/U Filter Cubicle Mezzanine	X			9				1
M/U Filter Cubicle	X			4	28	4		1
CONTAINMENT VESSEL (CV) AREA 1, ROD ROOM								
Main Floor	X			9				1
Haunch Wall	X			8	4			1
North Wall (Sloped)	X				17			1
South Wall	X				15			1
East Wall	X				14			1
Ceiling	X					23		1
Reactor Vessel Port	X					9		1
CONTAINMENT VESSEL (CV) AREA 2, PRIMARY COMPARTMENT 779'-8" TO 818'								
North Wall 779'-8" to 795'	X				33			1
North Wall 795' to Ceiling	X				40			1
West/South Curved Wall 779'-8" to Ceiling	X				122			2
East Wall 779'-8" to 795'	X				35			1
East Wall 795' to Ceiling	X				42			1
Floor	X			42				1
Ceiling	X					33		1

TBD = To Be Determined. These items may be removed before the FSS begins.
*Estimated with best available information
NOTE: These areas are impacted. Characterization is ongoing, in order to properly classify them.

Table 5-2 (continued)
INITIAL CLASSIFICATIONS OF SITE AREAS

Survey Unit Designations of the SNEC Facility and Surrounding Impacted Areas								
	Classification			Survey Unit Area (m^2)*				No. of Survey Units*
Description	1	2	3	Floor	Walls	Ceiling	Other	
CONTAINMENT VESSEL (CV) AREA 3, AUXILIARY COMPARTMENT 779'-8" TO 812'								
North Wall 779'-8" to 795'	X				32			1
North Wall 795' to Ceiling	X				31			1
West Wall 779'-8" to 795'	X				35			1
West Wall 795' to Ceiling	X				34			1
South & East Curved Wall 779'-8" to 795'	X				53			1
South & East Curved Wall 795' to Ceiling	X				52			1
Ceiling	X					30		1
CONTAINMENT VESSEL (CV) AREA 4, OPERATING COMPARTMENT 812' TO 818'								
812' Floor Above Storage Well	X			38				1
812' Floor Above Aux. Compartment	X			37				1
812' to 818' Center Wall	X				31			1
812' Stairway Hatch	X				14			1
812' Aux. Compartment Equipment Hatch	X				15			1
818' Primary Compartment Equipment Hatch	X				13			1
818' Floor	X			57				1
CONTAINMENT VESSEL (CV) AREA 6, STORAGE WELL 765' TO 812'								
Deep End South Wall 765' to 779'-8"	X				25			1
Deep End South Wall 779'-8" to 795'	X				30			1
Deep End South Wall 795' to Ceiling	X				23			1
Shallow End South Wall 779'-8" to 795'	X				40			1
Shallow End South Wall 795' to Ceiling	X				29			1
Deep End West Wall 765' to 779'-8"	X				22			1
Shallow End 779'-8" Floor	X			29				1
Deep End 765' Floor	X			9				1
Deep End 765' El., Haunch Wall	X			8	4			1
768'-3" El. Top of Haunch Wall to 779'-8"	X				30			1
Deep End 795' to Ceiling Curved Wall	X				31			1
Deep End 779'-8" to 795' Curved Wall	X				40			1
Shallow End 779'-8" to 795' N-NW Curved Wall	X				47			1
Shallow End 795' to Ceiling Curved Wall	X				37			1
Storage Well Shield Block Walls	X				37			1
Ceiling	X					23		1
CONTAINMENT VESSEL (CV), INTERIOR & EXTERIOR DOME								
Interior Walls of CV Dome	X				466			10
Interior Top of CV Dome	X					336		10
Exterior Walls From Grade Down ~2.4 Meters	X				117			2
Exterior Walls From Grade to 2 Meters	X				72			1
Exterior Walls > 2 Meters to Dome Top		X			420			4
Exterior Top of CV Dome		X				336		3

TBD = To Be Determined. These items may be removed before the FSS begins.

*Estimated with best available information

Table 5-2 (continued)
INITIAL CLASSIFICATIONS OF SITE AREAS

Survey Unit Designations of the SNEC Facility and Surrounding Impacted Areas								
Description	Classification			Survey Unit Area (m^2)*				No. of Survey Units*
	1	2	3	Floor	Walls	Ceiling	Other	
MATERIAL HANDLING BAY (MHB) – SNEC AREA								
Floors & Walls Up to 2 Meters (Interior)	X			22	20			1
Upper Walls & Ceiling (Interior)		X			63	22		1
Roof			X			24		1
Exterior Walls			X		56			1
PERSONNEL ACCESS FACILITY (PAF) – SNEC AREA								
Floors & Walls Up to 2 Meters (Interior)	X			36	49			1
Upper Walls & Ceiling (Interior)		X			116	36		1
Roof			X			40		1
Exterior Walls			X		133			1
DECOMMISSIONING SUPPORT BUILDING (DSB) – SNEC AREA								
Floors & Walls Up to 2 Meters (Interior)	X			212	121			5
Upper Walls & Ceiling (Interior)		X			290	212		1
DSB Carport			X	62		62		1
Roof			X			225		1
Exterior Walls			X		325			1
WAREHOUSE (LARGE GARAGE-South) – PENELEC AREA								
Floors & Walls Up to 2 Meters (Interior)		X		450	290			2
Upper Walls & Ceiling (Interior)			X		292	450		1
Exterior Walls			X		374			1
Roof		X				418		1
Drains, Septic System & Misc. Piping		X					<10	1
GARAGE (SMALL GARAGE-Southwest) – PENELEC AREA								
Floors & Walls Up to 2 Meters (Interior)	X			109	122			4
Upper Walls & Ceiling (Interior)			X		297	109		2
Exterior Walls			X		180			1
Roof		X			116			1
Drains & Misc. Piping	X						<10	1
LINE SHACK - PENELEC AREA								
Floors & Walls Up to 2 Meters (Interior)	X			290	177			5
Upper Walls & Ceiling (Interior)	X				191	412		7
Exterior Walls	X				343			4
Roof	X					324		4
Roof Drainage System	X						<10	1
Old Septic System	X						<10	1
Floor Drains & Associated Piping	X						<10	1
PENELEC SWITCHYARD BUILDING								
Interior			X	55	89	55		1
Exterior Walls and Roof			X		151	68		1

TBD = To Be Determined. These items may be removed before the FSS begins.
*Estimated with best available information

Table 5-2 (continued)
INITIAL CLASSIFICATIONS OF SITE AREAS

Survey Unit Designations of the SNEC Facility and Surrounding Impacted Areas								
Description	Classification			Survey Unit Area (m^2)*				No. of Survey Units*
	1	2	3	Floor	Walls	Ceiling	Other	
SAXTON STEAM GENERATING STATION (SSGS)								
Interior of Discharge Tunnel							25059	See Note
Footprint of SSGS - Open Land Area							3200	See Note
Impacted Section of SSGS Intake Tunnel							1930	See Note
SAXTON STEAM GENERATING STATION (SSGS) SPRAY POND AREA								
Open Land Area		X					12300	2
SNEC FACILITY SITE OPEN LAND AREA								
SNEC Facility Site & Near Site Area	X						10800	11
GPU ENERGY (PENELEC) SITE OPEN LAND AREA								
Westinghouse and Adjacent Areas**	X						5700	6
Warehouse Burn Area	X						20	1
Buffer Zones		X					8300	4
REMAINING IMPACTED OPEN LAND AREA								
Site Road Access Areas		X					20900	9
Stack Release Area (NNE)		X					14000	3
Stack Release Area (SSW)		X					8600	2
Buffer Zones			X				33800	4

TBD = To Be Determined. These items may be removed before the FSS begins.
NOTE: These areas are impacted. Characterization is ongoing, in order to properly classify them.
*Estimated with best available information.
**Includes substation yard drainage area.

5.2.4.4 Changes in Classification

Changes in classification are based on survey data and other available information that indicates another classification is more appropriate. All changes of area classifications (after LTP approval) where a higher classification is lowered (e.g., Class 1 to Class 2), will be performed in accordance with 10 CFR 50.59 (Reference 5-3). However, lower classifications may be raised as deemed appropriate to SNEC management, any time new information warrants such a change. To justify changing an area classification from Class 1 to Class 2, the existing information (from the HSA, scoping surveys, or characterization surveys) should provide a high degree of confidence that no individual measurement would exceed the $DCGL_W$. The justification for lowering a Class 2 to a Class 3-survey classification will require a high degree of confidence that no individual measurement would be above a small fraction of the $DCGL_W$ (i.e., 10%). Other justifications for changing an area classification may be appropriate based on finding additional information or identifying specific SNEC Management concerns.

5.2.5 <u>Final Survey Process</u>

Final survey activities do not commence until decontamination activities are complete in the area to be surveyed, and all radioactive waste materials are removed. The FSS process begins with survey preparation activities such as gridding of survey areas and review of final remediation support survey information, as well as survey area walk-downs. Survey design calculations and the issuance of survey requests to field survey teams follow this phase. Field survey teams then collect the data and assemble the survey results in an understandable format in accordance with site procedures. Data assessment and documentation concludes this process.

5.2.5.1 Survey Design

Survey design, described in Section 5.4, identifies relevant components of the FSS process and establishes the assumptions, methods, and performance criteria to be used. Areas ready for FSS are classified as Class 1, Class 2 or Class 3 and divided into survey units. Systematic scan and static measurements are prescribed according to a pattern and frequency established for each classification. Investigation levels are established which, if exceeded, initiate an investigation of the survey data. A measurement from the survey unit that exceeds an investigation level may indicate a localized area of elevated residual radioactivity. Such locations are marked and investigated to determine the area and the level of the residual radioactivity present. Depending on the results of the investigation, the survey unit may require remediation, and/or re-survey or re-classification.

Quality Control (QC) measurements are prescribed to identify and control measurement error and uncertainty attributable to measurement methods or analytical procedures used in the data collection process. QC measurements provide qualitative and quantitative information to demonstrate that measurement results are sufficiently free of error and accurately represent the radiological condition of the SNEC Facility.

5.2.5.2 Survey Data Collection

As deemed appropriate, a final post-remediation survey is performed using similar instrumentation, quality control and survey techniques to be used in the FSS process. A review of the final post-remediation survey data is then carried out to verify that residual radioactivity levels are acceptable and that no additional remediation will be needed in the survey unit. If an area of elevated residual radioactivity is identified, and remediation is determined to be ALARA, the area is remediated and re-surveyed to ensure meeting FSS requirements. The data collected during the final post-remediation survey (when performed), provides a sound basis for interpreting radiological conditions that may be encountered during the FSS process.

Following the collection of acceptable post-remediation survey results (as applicable), the FSS is performed. It ensures that any remaining residual radioactivity meets the 25-mrem/y TEDE site release dose criteria. Measurement results stored as FSS data constitute the FSS of record and are included in the data set used to determine compliance with the site release criteria.

5.2.5.3 Survey Data Assessment

Survey data assessment, described in Section 5.6, is performed to verify that the final survey data are of adequate quantity and quality. Graphical representations and statistical comparisons of the data are made, which provide both qualitative and quantitative information about the data. Assessments are performed to verify that the data support the underlying assumptions necessary for the statistical tests. If the quality, quantity, or one or more of the assumptions are called into question, previous survey steps are re-evaluated and additional data are collected as necessary before further statistical analyses are applied. Statistical tests are then applied and conclusions are drawn from the data as to whether the survey unit meets the site release criteria.

5.2.5.4 Survey Results

Survey results are documented in history files, survey unit release records, and in the FSS report. A FSS report is prepared that summarizes the data and states the conclusions of the survey process.

5.2.6 Project Management

The planning and implementation of the FSS process is performed by SNEC Facility personnel supplemented by the Decontamination and Decommissioning Engineering group of GPU Nuclear. Aspects of the final survey project are outlined below.

5.2.6.1 Final Survey Organization

The Program Director, SNEC Facility - serves as the primary decision-maker (often called the Project Coordinator/Manager (PC/M)) and is responsible for the overall implementation of the FSS process.

The Project Engineer - is an individual appointed by the PC/M to coordinate the activities of the FSS team.

The SNEC Facility Radiation Safety Officer (RSO) - is the lead radiological controls individual on the FSS team. He is responsible for managing all field survey team supervisors and technicians during the FSS process, and will act as a technical consultant to the PC/M.

The SNEC Site Supervisor - leads the Dismantlement Organization at the SNEC site. In addition, he provides craft support to the FSS team e.g., scaffold erection, to permit surveys of difficult to access areas.

The Manager Decontamination and Decommissioning Engineering - provides engineering support to both the FSS team and the Dismantlement Organization.

Oversight of the process to assure compliance with the Quality Assurance/Quality Control (QA/QC) Program is provided under contract with the AmerGen Nuclear Safety Assessment group located at Three Mile Island, Middletown, Pennsylvania.

5.2.7 Quality Assurance and Quality Control (QA/QC)

QA/QC is an integral part of all FSS activities. The objective of QA/QC, as applied to the FSS program, is to ensure the survey data collected, are of the type, and quality needed to demonstrate that the site is suitable for unrestricted release. Proper application of QA/QC activities will ensure that:

1. The elements of this plan are correctly implemented as prescribed,
2. The quality ad quantity of the data collected is adequate, and
3. Identify deficiencies so that corrective actions, when needed, are implemented in a timely manner and confirmed to be effective.

The basis of the SNEC Facility FSS QA/QC program has been derived from the applicable sections of Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment" (Reference 5-12).

The SNEC Facility Decommissioning Quality Assurance Plan (DQAP) (Reference 5-13) is discussed in Section 3.0 of the SNEC Technical Specifications, and is applicable to all final status survey activities. Examples of the QA program application are described in the subsections that follow.

5.2.7.1 Training

Training is conducted to achieve initial proficiency and to maintain that proficiency throughout the final survey process. Personnel performing surveys receive training to qualify in the procedures being performed. Training includes:

1. Overview and objectives of the FSS process
2. Procedures governing the conduct of the final survey
3. Operation of the appropriate field and laboratory instrumentation
4. Collection of final survey measurements and samples
5. Survey data evaluation and documentation

The extent of training and qualifications is commensurate with the education, experience, and proficiency of the individual and the scope, complexity, and nature of the activity. Records of training are maintained in accordance with approved facility procedures (see Table 5-3).

5.2.7.2 Written Procedures

All FSS tasks, that are essential to survey data quality, shall be implemented and controlled by approved procedures or work instructions. Final Status Surveys will be performed in a controlled, deliberate manner, providing assurance of accurate results. Applicable provisions of the SNEC Facility Decommissioning Quality Assurance Plan (1000-PLN-3000.05, Reference 5-13), and the SNEC Radiation Protection Plan (6575-PLN-4542.01, Reference 5-14), apply to all FSS activities. Other implementing procedures have been or are under development to support FSS activities. The following matrix (Table 5-3) provides procedure titles relating to SNEC decommissioning and FSS issues.

Table 5-3, SNEC Procedure Matrix Listing

Area Of Applicability	Procedure Title	Number
Quality Assurance Plan	Saxton Nuclear Experimental Corporation Facility Decommissioning Quality Assurance Plan	1000-PLN-3000.05
Radiological Instrumentation	Quality Assurance Program for Radiological Instruments	6575-QAP-4220.01
Calculations	Saxton Technical Evaluations Procedure	6575-ADM-4500.44
Records	Records Retention	6575-ADM-4500.04
Environmental Measurements	Environmental Monitoring	6575-ADM-4500.22
Air Sampling	Environmental Air Sampling	E900-ADM-4500.30
Chain of Custody	Chain of Custody of Samples	E900-ADM-4500.39
ALARA	SNEC ALARA Program	E900-ADM-4500.47
Characterization	SNEC Site Characterization Plan	6575-PLN-4520.06
Radiation Protection	SNEC Radiation Protection Plan	6575-PLN-4542.01
Process Control	SNEC Facility Process Control Program	6575-PLN-4542.09
Emergency	Emergency Response Procedure and Emergency Plan	E900-ADM-4500.06
Procedures & Work Instructions	SNEC Facility Procedures and Work Instructions	E900-ADM-4500.07
Radiological Surveys	Radiological Surveys: Requirements & Documentation	E900-ADM-4500.12
Training	Training Requirements for SNEC Facility Workers	E900-ADM-4500.42
Decommissioning Safety	SNEC Facility Safety Review Process	E900-ADM-4500.52
Off-Site Dose	SNEC Facility Off-site Dose Calculation Manual	E900-PLN-4542.08
Soil Erosion	SNEC Soil Erosion and Sedimentation Control Plan	6575-PLN-4542.02
Source Accountability	SNEC Radioactive Source Accountability and Control Program	E900-ADM-4500.53
Isolation of Areas	Post Remediation Isolation	E900-ADM-4500.54
FSS Sampling	Final Status Survey Sampling Methodology	E900-IMP-4520.01
Sample Preparation	SNEC Facility Sample Preparation	E900-IMP-4520.02
Gridding Areas	Establishing a Reference Coordinate Grid System	E900-IMP-4520.03
Gamma Scans of Samples	Acquisition & Data Analysis of High Resolution Gamma Spectra using the Inspector Portable Gamma Spectroscopy System	E900-OPS-4524.33
FSS Surveys	Final Status Survey Methodology	Under Development
Gamma-ray Spectroscopy	Portable Gamma-ray Spectroscopy	Under Development

NOTE: This procedure listing is subject to change.

5.2.7.3 Instrumentation Selection, Calibration and Operation

Proper selection and use of instrumentation will ensure that sensitivities are sufficient to detect radionuclides at the minimum detection requirements specified by the survey design documents, which will assure the validity of the survey data. Instrument calibrations will be performed in accordance with approved GPU Nuclear and/or SNEC Facility procedures, using calibration sources traceable to the National Institute of Standards and Technology (NIST), or by qualified contractors providing results traceable to NIST. Operation of all survey instrumentation will be established by approved procedures.

5.2.7.4 Sample Chain-Of-Custody

One of the most important aspects of sample management is to ensure that the integrity of the sample is maintained; that is, that there is an accurate record of sample collection, transport, analysis, and disposal. This ensures that samples are neither lost nor tampered with and that the sample analyzed in the laboratory is actually and verifiably the sample taken from a specific location in the field. SNEC has developed procedures for sample chain-of-custody using NUREG-1575 guidelines (Reference 5-5).

5.2.7.5 Quality Control Surveys

Quality control surveys will be made for all structures, facilities and open land areas. These measurements will be performed in accordance with Section 5.4.5.1. Quality control surface contamination and exposure rate measurements will be compared to the original FSS measurements. If the same conclusions are reached without any exceptions, the original FSS results for these survey units will be accepted as satisfactory. All discrepancies between FSS survey results and those obtained from quality control re-survey efforts shall be resolved with documented resolutions. If quality control measurements fall outside of their acceptance criteria, a documented investigation will be performed which may result in re-survey, re-sampling or other management actions.

5.2.7.6 SNEC Facility Sample Analysis

High-resolution gamma spectroscopy is used to identify gamma-emitting isotopes, in addition to other appropriate measurement methods used to determine the total radionuclide composition of sample materials. Sample data results will be reviewed in accordance with existing requirements to ensure a reasonable interpretation of results.

Samples from the SNEC Facility may be expected to contain one or more of the following radionuclides. Minimum Detectable Concentrations (MDC) determined during analysis will be performed using count times and instrumentation sensitive enough to detect typical environmental levels for these radionuclides (as appropriate).

Table 5-4, Radionuclides Present at the SNEC Facility

Am-241	C-14	Cm-243	Cm-244	Co-60	Cs-134
Cs-137	Eu-152	Eu-154	Eu-155	Fe-55	H-3
Nb-94	Ni-59	Ni-63	Pu-238	Pu-239	Pu-240
Pu-241	Pu-242	Sb-125	Sr-90	Tc-99	U-234
U-235	U-238				

SNEC Facility samples will be analyzed in accordance with the following requirements:

- Representative samples will be retaken and/or reanalyzed on site (see Section 5.4.5.1),
- 5-10% of selected sample groups will be analyzed for Transuranic and Hard-To-Detect (HTD) radionuclides at an off-site laboratory,
- An independent off-site laboratory will be used to perform repeat measurements of selected samples.

5.2.7.7 Access Control of Surveyed Areas and Systems

Administrative and physical controls for access to surveyed areas will be established to preclude the possibility of re-contamination subsequent to completion of the final status survey in that area.

5.2.7.8 Control of Vendor Supplied Services

Quality-related services, such as instrument calibration and laboratory analysis, are procured from qualified vendors whose internal QA program is subject to approval in accordance with the SNEC Facility DQAP. Vendors or contractors that are not listed on an approved vendor listing shall perform all necessary work in accordance with SNEC procedures and work instructions. If vendor services include survey or sampling data to be used as FSS results, these services will be reviewed and approved in accordance with the Saxton Technical Evaluations Procedure (6575-ADM-4500.44, Reference 5-15).

5.2.7.9 Audits and Independent Reviews

Periodic audits are performed to verify that survey activities comply with established procedures and other aspects of the SNEC Facility DQAP and to evaluate the overall effectiveness of the program. The audits are conducted in accordance with approved procedures and performed by individuals who are independent of the activities being audited. Audit results are reported to responsible management in writing, and actions to resolve identified deficiencies are tracked and appropriately documented. Qualified personnel will perform an independent review of the Final Status Survey Report. This review will ensure that FSS results are performed and documented in accordance with appropriate methodology, and that all conclusions reported are accurate and correctly presented.

5.2.8 <u>Survey Records and Documentation</u>

Generation, handling, and storage of FSS design information and survey data are controlled by approved procedures. Survey records and documentation are maintained as quality records and decommissioning records in accordance with approved facility procedures. Where possible, they are also maintained as electronic media.

At a minimum, each final status survey record will include:

1. Date and time survey was performed
2. Instrumentation used and calibration due date(s)
3. Survey location (grid location or other reference markings)
4. Type of measurement performed (scan survey, fixed-point measurements etc.)
5. Survey team member(s) involved
6. Name of field supervisor(s) responsible for reviewing survey data
7. Survey and sample request numbers

Generation, handling and storage of the original final status survey design and data packages shall be in accordance with the SNEC Records Retention procedure (6575-ADM-4500.04, Reference 5-16) and Radiological Surveys: Requirements & Documentation procedure (E900-ADM-4500.12, Reference 5-17).

5.2.9 Technical Evaluations

Technical Evaluation documents are prepared in accordance with approved facility procedures. Technical Evaluation documents show what methods were used, how the methods are derived, underlying assumptions, the basis for deviations from this plan, and other information as necessary. They may include position papers, calculations, computer code verification results, file memoranda or correspondence. All personnel who prepare or review FSS related Technical Evaluation documents will be trained in FSS methodology.

DCGL documentation includes reports generated by the D and D or RESRAD computer software. Site-specific data supporting any changes made to default input parameters will also be included in this documentation. If other computer models are used, sufficient information will be documented to permit review of the model, scenarios, and parameters as necessary. All DCGL documentation will be performed in accordance with the SNEC Technical Evaluations Procedure.

5.2.10 Schedule

Final status surveys are planned, scheduled, and tracked as a part of the overall decommissioning planning process. The schedule is dependent upon the progress and completion of several decommissioning activities and review and approval of the License Termination Plan. Presently, survey data collection is expected to begin in mid-to late 2000. Final survey activities are planned and will be discussed with the NRC in advance to allow scheduling of the required public meeting on the License Termination Plan.

5.2.11 Stakeholders

The stakeholders for the SNEC decommissioning project include those organizations and concerned individuals listed below:

- The Citizens Task Force (CTF),
- The Concerned Citizens for Saxton Safety (CCSS),
- Liberty Township,
- Huntington and Bedford Counties,
- The Commonwealth of Pennsylvania,
- GPU companies,
- Applicable contractors, and
- The US Army Corps of Engineers.

5.3 FINAL POST REMEDIATION SURVEYS

The professional judgment of the SNEC Facility staff will be used to implement a systematic approach for final post remediation surveys in areas where former contamination levels required extensive remediation or in other areas as deemed necessary. Properly designed, post remediation surveys can facilitate the transfer and control of areas, and minimize the impact of planned or ongoing dismantlement activities in adjacent areas.

5.3.1 Walkdown

A walk-down of the survey unit is performed prior to isolation. The principle objective of the walk-down is to assess the physical state of the survey unit and the scope of work necessary to prepare it for final survey. During the walk-down, requirements are identified for accessing, isolating, and controlling the survey unit. Support activities necessary to conduct the final survey, such as scaffolding, interference removal, and electrical tag-outs, are identified. Safety concerns such as confined space entry, high walls, and ceilings are identified. For systems, the walk-down includes a review of system flow diagrams and piping drawings. The walk-down is performed when the final configuration is known, usually near or after the completion of dismantlement activities.

5.3.2 Isolation Criteria

The following criteria will be satisfied prior to acceptance of a survey unit by the FSS team. The physical aspects of these criteria are verified during the walk-down.

1. Planned dismantlement activities within the post remediation survey unit are completed.
2. Planned dismantlement activities affecting or adjacent to the post remediation survey unit are completed, or are evaluated and determined to not have a reasonable potential to introduce radioactive material into the post remediation survey unit.
3. An operational radiation protection survey of the post remediation survey unit is completed and all outstanding items are addressed.
4. Planned physical work in, on, or around a post remediation survey unit, other than routine surveillance or maintenance, is complete.
5. Tools, non-permanent equipment, and material not needed for survey data collection are removed.
6. Housekeeping, clean up, and remediation of the survey unit are completed.
7. Scaffolding, temporary electrical and ventilation equipment and components, and other material or equipment needed for survey data collection is radiologically clean and left in place.
8. Transit paths to/through the post remediation survey unit are eliminated or re-routed.
9. Appropriate measures are instituted to prevent the re-introduction of radioactive material into isolated area from ventilation systems, drain lines, system vents, and other potential airborne and liquid contamination pathways.
10. Measures are instituted to control access and egress and otherwise restrict radioactive material from entering the survey unit.

5.3.3 Transfer of Control

Once a walk-down has been performed and the isolation criteria are met, control of activities within the post remediation survey unit is transferred from the Dismantlement organization to the FSS team. The need for localized remediation within the isolated area may be identified after transfer of control. Localized remediation may be performed under the control of the FSS organization. However, if large areas require remediation, the isolated area may be transferred back to the Dismantlement organization for further decontamination.

5.3.4 Isolation and Control Measures

Prior to performing the FSS, the post remediation survey unit is isolated and controlled. Routine access, equipment removal, material storage, and worker and material transit through the area are no longer allowed. One or more of the following administrative and physical controls will be established to minimize the possibility of introducing radioactive material from ongoing decommissioning activities in adjacent or nearby areas.

1. Personnel training
2. Installation of barriers to control access to area
3. Installation of postings with access/egress requirements
4. Locking or otherwise securing entrances to the area
5. Installation of tamper-evident seals or labels

Isolation and control measures are implemented through approved facility procedures and remain in place through the FSS data collection process until license termination.

5.4 SURVEY DESIGN

The survey design identifies relevant components of the FSS process, and establishes the assumptions, methods, and performance criteria to be used. The survey design is summarized in Table 5-5.

The application of survey design criteria to structures and land areas will vary based on the type of survey media and the relative potential for elevated residual radioactivity. For facility systems, many of the survey design criteria applicable to structures and land areas do not apply or are dictated by the physical system layout and the accessibility to the system piping and components. To accommodate these factors, the survey design integrates both non-systematic (random) and judgmental (biased) methods to data collection to achieve the overall objective of the final survey process.

Table 5-5
Survey Design Summary

Specification	Class 1		Class 2		Class 3		Plant Systems
	Structures	Land Areas	Structures	Land Areas	Structures	Land Areas	
SURVEY UNITS							
Size Range=>	10 to 100 m^2	100 to 2000 m^2	10 to 1,000 m^2	100 to 10,000 m^2	No Limit	No Limit	N/A
Reference Coordinate Grid[a]=>	1 to 2 m	10 to 20 m	1 to 2 m	10 to 20 m	5 to 10 m	20 to 50 m	N/A
SCAN MEASUREMENTS							
Scan Coverage=>	100%		10 to 100%[b]		0 to 10%		Variable[c]
Scan Area Selection=>	Accessible surface areas		Judgmental; systematic along transects or of randomly selected grids		Judgmental; random		Judgmental; accessible[d] surface area
STATIC MEASUREMENTS							
Number of Measurement	Calculated using the methodology of Appendix 5-2 (Default Value is 30[e])						30[f]
Location Selection=>	Random starting point, systematic spacing[g]				Random		Accessible Points
Spacing (L)=>	L = $(A/n)^{1/2}$ for square grid (see Section 5.4.3.2), A = total survey unit area; n = # of measurements				N/A		N/A
Type of Survey[h]=>	SC	SO[i]	SC	SO[i]	SC	SO[i]	SC[j]

1. A square grid system pattern is used and multiple grid patterns are employed as necessary unless survey needs dictate otherwise.
2. Where scanning coverage greater than 50% is judged appropriate, the survey unit may be reclassified as a Class 1 survey unit.
3. Performed according to the scan coverage for the class of survey unit (where possible). The amount of accessible surface area dictates the percentage of surface area scanned
4. Includes health and safety considerations.
5. This number is sufficient for survey units less than 10 square meters in area, and may be used for embedments such as brackets, unistrut or sections of piping.
6. As allowed by plant system size and accessibility to system interior surfaces.
7. Except when statistical tests are not applied (i.e., post remediation survey data for a survey unit are all less than DCGL).
8. SC represents surface contamination measurements; SO, represents soil measurements.
9. Subsurface samples will be obtained from randomly selected locations as well as biased locations.
10. Scale and sediment samples will be collected from embedments (e.g., piping, unistrut) as appropriate.

5.4.1 Survey Units

As reflected in Table 5-5, impacted areas are divided into survey units to facilitate survey design. A survey unit is a physical area of specified size and shape with similar characteristics and potential for residual radioactivity for which data analysis and statistical analysis are performed. A separate decision is made for each survey unit as to its acceptability for release.

5.4.1.1 Survey Unit Size

Professional judgment is used to divide facilities and areas into appropriately sized survey units. Survey unit sizing is sufficient to assure that the total number of data points, based on the measurement frequency, will allow statistical evaluation of the data. Considerations for establishing survey units are physical characteristics, concentration levels, and previous remediation efforts, as well as spatial and logistical considerations.

Survey units are sized to ensure data points are relatively uniformly distributed among areas of similar potential for residual contamination. Small survey units are developed to ensure a conservatively established coverage of an area, location or residual system piping or embedment.

Survey units conform to site physical characteristics to the extent practical. Survey units have relatively compact shapes unless an unusual shape is appropriate because of site operational history or site topography. Where possible, existing facility or site characteristics such as horizontal and vertical structural supports (beams, concrete pour seams, or piping runs) are used to define the boundaries of the study. Survey unit sizes are given in Table 5-5. Survey unit sizes may be adjusted as necessary as long as assumptions used to develop area dose models remain valid.

5.4.1.2 Reference Coordinate System

A reference coordinate system is used to facilitate selection of measurement locations, and provide a method for locating the same points in the future. A reference coordinate system is a set of intersecting lines referenced to a fixed site location or benchmark. Typically, grid lines are arranged in a perpendicular pattern, dividing the survey unit into squares of equal area. However, other types of grid patterns may be used. Examples of a reference coordinate system are shown in Figures 5-4 and 5-5, located at the end of this chapter.

Scale drawings, maps, or photographs of each survey unit are prepared, along with an overlay of the reference coordinate system. While some of the maps presented with this plan have a grid overlay, the actual or final layout may be somewhat different than that provided herein. The reference coordinate system provided on attached drawings are intended primarily for reference purposes and do not necessarily dictate final grid layouts.

Physical gridding is used only where it is useful and cost effective. Where Class 1 and Class 2 survey units are gridded, the basic grid patterns are at 1 to 2 meter intervals on structural surfaces, and at 10 to 20 meter intervals over land areas. For practical purposes, Class 3 areas may typically be gridded at larger intervals, for example, 5 to 10 meters for large surfaces and 20 to 50 meters for land areas.

The physical grid layout on a structural surface is marked by chalk line or other appropriate means along the entire reference line or only at line intersections. For land areas, the reference coordinate system is marked by wooden stakes or metal pins driven into the surface at line intersections, or by other appropriate surface markers. The selection of an appropriate marker depends on the characteristics and routine use of the survey area.

5.4.1.3 Background Reference Areas

The residual radioactivity of a survey unit may be compared directly to the DCGL. However, the residual radioactivity may contain radionuclides, which occur in background. To identify and evaluate those contributions attributable to licensed activities, representative background radionuclide concentrations are established using background reference areas. Background reference areas have similar physical, chemical, radiological, and biological characteristics as the areas to be surveyed. They are usually selected from non-impacted areas, but are not limited to natural areas undisturbed by human activities. Surveys will be conducted of one or more background reference areas (where appropriate), to determine background levels for comparison with specific survey units. However, environmental background levels will not be subtracted from nuclide specific measurement results (e.g., gamma-ray spectroscopy measurements of sample materials etc.) for any open land area. Appendix 5-3 provides additional discussions in selecting and applying background reference areas.

Background reference areas are not necessary where:

1. The residual radioactivity does not contain radionuclides occurring in background and the detection method is radionuclide-specific.
2. The background levels are known to be an acceptably small fraction of the $DCGL_W$.

5.4.2 Scan Measurements

Scan measurements are performed to locate elevated areas of residual radioactivity that will require further investigation. They are performed according to a preset pattern established for each classification. The level of scanning effort is proportional to the potential for finding elevated measurement results.

Scan measurements of Class 1 survey units are performed over 100 percent of the accessible surface area. However, personnel health and safety issues are taken into consideration when determining whether an area is accessible. Scan surveys are designed to detect small areas of elevated radioactivity that would not be detected by static measurements, using a systematic measurement pattern. If the sensitivity of the scanning method is not sufficient to detect levels of residual radioactivity below the DCGL, the number of static measurements may be adjusted appropriately. Appendix 5-2 describes how this is accomplished.

Scan measurements of Class 2 survey units are typically performed over 10 to 100 percent of the surface area. Class 2 survey units have a lower probability of elevated residual radioactivity than Class 1 survey units. Those areas with the highest potential for elevated residual radioactivity (e.g., corners, ditches, and drains) are included in the survey based on professional judgment. If the entire survey unit has an equal probability of having areas of elevated residual radioactivity, systematic scans are performed along grid intersections of randomly selected grid blocks. A 10 percent scanning coverage is appropriate if it is unlikely that any area would exceed the DCGL. Coverage of 25 to 50 percent is appropriate when there might be locations above the DCGL. Where scanning coverage of greater than 50 percent is judged appropriate, the survey unit may be reclassified as a Class 1 survey unit.

Scan measurements of Class 3 survey units are performed typically over approximately 10 percent of the surface area. Class 3 survey units have the lowest probability of containing elevated residual radioactivity. Those areas with the highest potential for elevated residual radioactivity, based on professional judgment, are selected for scanning in a Class 3 area.

Scan measurements of facility systems are performed according to required scan coverage for the classification of the survey unit. The amount of accessible surface area dictates the percentage of the surface area scanned. However, the majority of all SNEC Facility systems and components have been removed from the site. When scanning is not possible, such as in water-covered areas, outfalls etc., a sufficient number of randomly selected samples will be collected as appropriate.

5.4.3 Static Measurements

Static measurements provide a quantitative measure of the radioactivity present at the location measured. Static measurements are performed at a frequency and location throughout each survey unit, such that a statistically sound conclusion can be developed. Static measurements may be performed at locations of elevated residual radioactivity identified by scan measurements. These types of static measurements may include direct surface contamination measurements, and soil and bulk material measurements.

When instrumentation and techniques used for scan measurements are capable of providing data of sufficient quality as static measurements, they may be used in place of static measurements. The same logic may be applied for *in-situ* gamma spectrometry instead of sampling and analysis for soil and bulk materials.

5.4.3.1 Number of Measurements

As described in Appendix 5-2, the MARSSIM process incorporates design constraints that ensure that an adequate number of sample measurements are taken per survey unit. However, a minimum number of 30 measurement points per survey unit may be collected in areas or locations where there is difficulty in applying MARSSIM fixed point requirements, because of survey unit size, access problems or obstructions. Survey units of this type will be investigated thoroughly prior to planning the FSS.

5.4.3.2 Measurement Locations

Measurements in Class 3 survey units and background reference areas are taken in random locations. Random means that each measurement location in the survey unit has an equal probability of being selected. The random selection process uses random numbers that correspond to a survey units reference coordinate system to establish the measurement locations within the survey unit. The random numbers are generated using a random number generator or other acceptable random selection process.

Remaining sections of facility system piping, and embedments of all types with limited accessibility, may not allow the full number of measurement points. When this is the case, an assessment of the embedment is performed to determine if the embedment can easily be removed or can be prepared for the FSS survey. The history of the area where the embedment resides is first reviewed along with the expected radionuclide concentration present on the embedment. In these cases, the same MARSSIM approach encompassing historical assessment, characterization, remediation, and post remediation survey data is used as a basis for biased scanning and sampling to the extent practicable to ensure that the release criteria are met.

For Class 1 and Class 2 survey units, a random-start systematic pattern is used in place of a random pattern. This is done to meet survey design objectives and to locate small areas of elevated residual radioactivity that may exist within the survey unit. A random selection process determines the starting point. For a survey point placement using a square grid, the physical spacing of the measurement locations, L, is determined as follows (NUREG-1575, Equation 5-6):

$$L = \sqrt{A / n_{EA}}$$

Where A is the area of the survey unit, and n_{EA} is the number of measurement points.

The calculated value of L is rounded down to the nearest distance easily measured in the field. Using the reference coordinates, the measurement locations are identified around the starting point in a perpendicular manner at intervals of L. This process is repeated to identify the pattern of measurement locations throughout the survey unit. Where other than a square grid system is used, the physical spacing of the measurement locations is determined such that they are distributed around the starting point in a systematic, equidistant manner across the survey unit area.

Equation 5-5 of NUREG-1575 is used when a triangular grid sampling point layout is used.

$$L = \sqrt{A / 0.866 n_{EA}}$$

Measurement locations selected using a random selection process or a systematic pattern that do not fall within the survey unit area, or that cannot be surveyed due to site conditions, including health and safety considerations, are replaced. Replacements are made using other measurement locations determined by the random selection process. Supplemental measurement locations are also determined using the random selection process.

Measurement locations selected based on professional judgment violates the assumption of unbiased measurements used to develop the statistical tests and are not used in the statistical evaluation. However, special considerations are necessary for survey units with surface areas less than 10 m^2, land areas less than 100 m^2, and remaining site system piping and other embedments. The data generated from these smaller survey units may be obtained using professional judgment, rather than systematic or random sampling design. Once again, the number of 30 measurement points for each of these smaller survey units (< 10 m^2) may be used whenever practicable.

5.4.3.3 Location Identification

Measurement locations within the survey unit are clearly identified and documented to ensure that they can be found again as necessary. Actual measurement locations are marked with tags, self-adhesive labels, bar codes, permanent markings, stakes, notations on survey maps, or equivalent methods. A unique identification code or number identifies each measurement location. The number convention allows survey data to be referenced back to a specific measurement point that is identified in photographs, drawings, diagrams or maps of the survey unit.

5.4.4 Data Investigation

The data collection, investigation and evaluation process checklist is presented in Figure 5-2. Use of this checklist or a similar organizer provides a high degree of confidence that all data requirements have been met.

Figure 5-2
EXAMPLE OF A DATA INTERPRETATION CHECKLIST

1. Collect Data
   - Structural
   - Open land areas
   - Embedments

2. Convert Data to Standard Units
   - Structural activity in dpm/100 cm^2
   - Solid media (soil, etc.) activity in pCi/g

3. Evaluate Elevated Measurements
   - Identify elevated data/mark location
   - Compare data with derived elevated area criteria
   - Determine need to remediate and/or reinvestigate elevated condition
   - Compare data with survey unit classification criteria
   - Determine need to investigate and/or reclassify

4. Assess Survey Data
   - Review survey planning and design data
   - Verify that data of adequate quality and quantity were obtained
   - Perform preliminary assessments (graphical methods) for unusual or suspicious trends or results – investigate further if appropriate

5. Perform Statistical Tests
   - Select appropriate tests for category of contaminant
   - Conduct tests
   - Compare test results against hypotheses
   - Confirm power level of tests

6. Compare Results to Guidelines
   - Determine average or median concentrations
   - Confirm that residual activity satisfies guidelines

7. Compare Results with survey design information (ALARA may be included in the survey design)
   - Determine if all planning and design requirements are satisfied
   - Explain/describe deviations from design-basis survey requirements

5.4.4.1 Investigation Levels

Examples of typical investigation levels are shown in Table 5-6, taken from the MARSSIM manual (NUREG-1575, Table 5.8). Investigation levels are radioactivity levels that are based on the site release criteria, which if exceeded, initiate an investigation of the survey data. Investigation levels are typically established for each class of survey unit.

Table 5-6

TYPICAL INVESTIGATION LEVELS (from NUREG-1575)

Survey Unit Classification	Flag Direct Measurements or Sample Result When:	Flag Scan Measurements When:
Class I	$>DCGL_{EMC}$ or $>DCGL_W$ and > a statistical parameter based value	$>DCGL_{EMC}$
Class 2	$>DCGL_W$	$>DCGL_W$ or > MDC
Class 3	>fraction of $DCGL_W$	$>DCGL_W$ or > MDC

The principal purpose of an investigation level is to guard against the possible misclassification of the survey unit. They also serve as a QC check during the final survey process. A survey measurement that exceeds an investigation level may indicate that the survey unit has been improperly classified. It may also indicate a failing survey instrument or a localized area of elevated residual radioactivity where there was a failure in the remediation process. Large variations in background exposure rates may also result in investigative surveys. Investigative surveys of this type may be performed using a variety of measurement tools including *in-situ* gamma-ray spectroscopy instrumentation.

Depending upon the results of the investigation, survey units may require no action, may be remediated, or may be reclassified and/or re-surveyed. Initial administrative action or investigation level guidelines may be found in Table 5-7. For a Class 1 survey unit, while measurements above the DCGL are not necessarily unexpected, any measurement exceeding the DCGL is investigated. The site release criteria allows individual measurements representing small areas of residual radioactivity to exceed the DCGL. However, any measurement that exceeds the DCGL is subject to the elevated measurement comparison (EMC), described in Appendix 5-1. For a Class 2 survey unit, any measurement above the DCGL is unexpected and is investigated. As there is a low expectation for residual radioactivity in a Class 3 survey unit, any above background static measurement, exceeding a small fraction of a DCGL is investigated. If the scanning MDC exceeds the DCGL, any indication of residual radioactivity during the scan is also investigated.

If a background reference area is to be applied to the survey unit, the mean of the background reference area measurements may be added to the appropriate investigation level to which the survey measurements are compared. Where an excessive number of measurements exceed the investigation level, the results are reviewed to ensure that the applied background reference area is appropriate. If any background reference area is determined to be inappropriate, it is adjusted as necessary and documented.

TABLE 5-7

Summary of SNEC Investigation/Action Levels

	SURVEY AREA TYPE		
	CLASS 1 AREA	**CLASS 2 AREA**	**CLASS 3 AREA**
Investigation or Action Level	Flag any discrete measurement > $DCGL_W$ or >mean + 3 sigma. Flag any scan measurement > $DCGL_W$	Flag any discrete measurement >25% of $DCGL_W$. Flag any scan measurement > $DCGL_W$ or >MDC	Flag any discrete measurement >10% of $DCGL_W$. Flag any scan measurement > $DCGL_W$ or >MDC
Reclassification Level	N/A	If scan or discrete measurement values are ≥ the $DCGL_W$, area should be reclassified as Class 1.	If scan or discrete measurement values are ≥ $DCGL_W$, area should be reclassified as Class 1. If scan or discrete measurement values exceed 50% of the $DCGL_W$, but are < the $DCGL_W$. Area should be reclassified as Class 2 area.
Remediation Indicated When:	Consider remediation when residual activity exceeds 3 times the $DCGL_W$ for any scan or discrete measurement averaged over 100 cm^2, or when the mean for any contiguous 1-m^2 area is more than the $DCGL_W$ for discrete measurements. Soil mean is > the $DCGL_W$ for 100 m^2 area or $DCGL_{EMC}$ is greater than 3 times the $DCGL_W$	Not indicated for Class 2 or Class 3 survey areas unless above limits specified for Class 1 survey area. Re-classify and Re-survey as Necessary	Not indicated for Class 2 or Class 3 survey areas unless above limits specified for Class 1 survey area. Re-classify and Re-survey as Necessary

NOTE 1: The above values are initial values that will not be changed without applicable reviews in accordance with proposed License Condition 2.E. (d). All investigation/action levels assume background values have been subtracted (when appropriate).

5.4.4.2 Investigation

Locations identified by scan or static measurements with residual radioactivity, which exceed an investigation level, are marked and investigated. The elevated measurement is then confirmed to exceed the investigation level. The area around the elevated measurement is investigated to determine the extent of the elevated residual radioactivity, and to provide reasonable assurance that other undiscovered areas of elevated radioactivity do not exist. Scan coverage of the area being investigated is increased to 100 percent (if not already at that level). Static measurements are also taken if scan measurements are not capable of providing sufficient data to characterize the elevated area. A posting plot, described in Section 5.6.2.1, is generated to document the area investigated and the levels of residual radioactivity found. Depending on the results of the investigation, the survey unit may require remediation, reclassification, and/or re-survey. Possible outcomes of the data investigation process are shown in Table 5-8 below.

Table 5-8

Possible Actions Resulting From Data Analysis

No.	Data Results	Class 1	Class 2	Class 3
1	One or more data points > $DCGL_{EMC}$ or $DCGL_W$	Perform statistical testing, remediate and re-survey as necessary	Re-classify & re-survey	Re-classify & re-survey
2	All data points ≤ $DCGL_{EMC}$	Survey Unit Passes Applicable Elevated Measurement Comparisons	N/A	N/A
3	All data points ≤ $DCGL_W$	Survey Unit Passes	Determine if re-classification is required as follows	Determine if re-classification is required as follows
4	One or more points > 50% of $DCGL_W$ but ≤ $DCGL_W$	Survey Unit Passes	Increase survey coverage or review & re-classify & re-survey as necessary	Re-classify & re-survey
5	One or more points > 10% of $DCGL_W$ but ≤ 50% of $DCGL_W$	Survey Unit Passes	Survey Unit Passes	Re-classify & re-survey
6	All data points ≤ 10% of DCGL	Survey Unit Passes	Survey Unit Passes	Survey Unit Passes

Static measurements above the investigation level that should have been, but were not identified by scan measurements may indicate that the scanning method is inadequate. In that case, the scanning method is evaluated and appropriate corrective actions are taken. Corrective actions may include re-scanning affected survey units using other survey protocol or survey instrumentation.

5.4.4.3 Remediation

Areas of elevated residual radioactivity above the $DCGL_{EMC}$ are remediated to acceptable levels. Based on the survey data, it may be necessary to remediate all or a portion of a survey unit. Remediation activities are addressed in Chapter 4.0.

5.4.4.4 Reclassification

If survey measurements in a Class 2 or Class 3-survey unit exceed the DCGL, the survey unit is reclassified as a Class 1-survey unit. A Class 2 or Class 3-survey unit that is remediated is reclassified as a Class 1 survey unit. If survey measurements in a Class 3-survey unit exceed 0.10 x the DCGL, the survey unit is reclassified as a Class 2 survey unit. If a Class 2 survey unit exhibits measurements exceeding 0.5 x the DCGL it may be further investigated or re-classified as a Class 1 survey unit.

5.4.4.5 Resurvey

If a survey unit is reclassified or if remediation activities are performed, then a re-survey using the methods and frequency applicable to the new survey unit classification is performed. Where only a small fraction (< 10%) of the area of a Class 1 survey unit is remediated, replacement measurements are collected within the remediated area. Their locations are determined using the random selection process.

5.4.5 Quality Control (QC) Measurements

QC measurements are a component of the survey quality assurance process, and include quality checking and repeat measurements. Quality checking and repeat measurements are performed to identify, assess, and monitor measurement error and uncertainty attributable to measurement methods or analytical procedures used in the data collection process. Quality checking includes direct observations of survey data and sample collections, and sample preparation and analyses. Repeat measurements are multiple measurements at the same location or from the same survey unit. Repeat measurements provide quantitative information to demonstrate that measurement results are sufficiently free of error to accurately represent the radiological condition of the SNEC Facility. Results of QC measurements are documented in accordance with approved site procedures.

5.4.5.1 Type, Number, And Scheduling

QC checks will typically be performed by randomly re-sampling and/or re-surveying 5% of all sampling and/or survey points. For a low number of points (less than 10), the number of re-survey or re-sample locations will not be less than one (1). Alternatively, the type, number, and scheduling of QC measurements may be determined by a performance-based method as described in Section 4.9.2 of NUREG-1575. This method is based on the potential sources of error and uncertainty, the likelihood of occurrence, and the consequences in the context of final survey data accuracy. The primary factors considered here are 1) the number of persons or organizations involved in the data collection, 2) the number of measurement types or analytical methods used, and 3) the time interval over which the data are collected. Other factors include:

1. Number of survey measurements collected,
2. Experience of personnel involved,

3. Types of measurement methods or sampling and analytical procedures used,

4. Variability of survey instruments used,

5. Level of radioactivity in the survey unit, and

6. How close the measurement level is to the detection limit.

The collection of QC measurements is initiated early in the data collection process to identify problems and establish estimates of accuracy. QC measurements continue to be collected for the duration of the survey to verify that sources of error and uncertainty are minimized and controlled.

5.4.5.1.1 Scan Measurements

Quality checking of surface scanning surveys is performed to evaluate the effectiveness of scanning methods for identifying areas of elevated residual radioactivity. The frequency of quality checking for scan surveys is dependent on:

1. The number of surveyors,
2. The number of scanning methods employed,
3. The time interval over which scanning data are collected,
4. The scan MDC, and
5. Professional judgment.

The ability of surveyors to identify areas of elevated residual radioactivity by scanning will be periodically tested and documented in accordance with approved SNEC Facility procedure E900-ADM-4500.42, "Training Requirements for SNEC Facility Workers".

5.4.5.1.2 Static Surface Contamination Measurements

Repeat measurements of static surface contamination are performed to assess error and uncertainty associated with field measurement methods. Measurement locations are selected based on measurement results and representative of the entire dynamic range of residual radioactivity found. The usable range of radioactivity includes the highest measurement result and the lowest measurement result with an acceptable measurement uncertainty compared to the desired level of accuracy. Repeat measurements with results at or near the detection limit are not used because the measurement uncertainty is usually greater than the desired level of accuracy.

5.4.5.1.3 Soil And Bulk Material Measurements

QC measurements for soil and bulk materials are performed on split samples to assess error and uncertainty associated with sample methodology and analytical procedures. A split sample is a collected sample that has been homogenized and divided into two or more aliquots for subsequent analysis. Both samples are then analyzed using the same method, but by different laboratories. An alternative is to submit both samples to the same laboratory for analysis. This method is used where applicable.

5.4.5.2 Measurement Accuracy

Measurement accuracy may be estimated using the results of QC repeat measurements and comparing the results to the original measurements. For laboratory analysis, the results of the split samples are compared to one another. The accuracy estimates based on two or more surveyors (or laboratories) refer to the agreement expected when different surveyors or laboratories perform the same measurement using the same method.

Acceptance criteria for measurement accuracy are established during the survey design process. Where the acceptance criteria are not met an investigation of the data collection and/or sample analysis process is initiated to assess and identify the extent of error or uncertainty. The results of the investigation and the error introduced by laboratory instrumentation and the laboratory analyst is assumed controlled by the laboratory internal QC program. Corrective actions taken are documented.

5.5 SURVEY DATA COLLECTION

Survey data are collected after the survey unit has been isolated and controlled to ensure that radioactive contamination has not been introduced from ongoing decommissioning activities in adjacent or nearby areas.

5.5.1 Survey Performance

Survey data are collected from the post remediation survey, the final survey, and any investigation surveys performed. The final survey uses both random and biased data collection methods and is performed using the methodology, techniques, and quality control requirements prescribed in this plan. The post remediation and investigation surveys are biased surveys performed using similar methodology, techniques, and quality control requirements as the final survey. A post remediation survey, when performed, precedes the final survey. Investigation surveys may be performed at any time.

5.5.1.1 Post Remediation Survey

A special post remediation survey is performed where extensive dismantlement activities have occurred. These surveys are based on the professional judgment of the staff, and are performed when operational radiation surveys do not provide sufficient confidence that the survey unit is ready for the FSS. These special post remediation surveys are designed to verify that residual radioactivity levels are acceptable and that no additional remediation is necessary. It is conducted using similar methodology, techniques, and quality control procedures, as those required for the final survey. Professional judgment is used to: 1) identify measurement locations most likely to have elevated levels of residual radioactivity, and 2) establish the scanning coverage and the number of static measurements to be taken.

5.5.1.2 Final Survey

The objective of the final survey is to collect data of sufficient type, quantity, and quality, supporting conclusions regarding the radiological condition of the site. The final survey uses both random and biased data collection methods. Scan measurements are taken from both biased and prescribed measurement locations. Static measurement results used in the statistical tests are obtained from randomly derived measurement locations. The FSS of each survey unit is performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use.

5.5.1.3 Investigation Survey

An investigation survey is performed when one or more survey measurements exceed an investigation level as described in Section 5.4.4. The purpose of the investigation survey is to define the area and level of the elevated residual radioactivity. The data collected during investigation surveys are used to characterize the area being investigated and to provide the basis for any further actions.

5.5.2 Instrumentation

Commercially available portable and laboratory instruments and detectors are used to perform three types of measurements: 1) surface scanning, 2) direct surface contamination measurements, and 3) laboratory analysis of soil and bulk materials. Other instrumentation is also used to perform other types of measurements as dictated by data collection requirements. The issuance, control, and operation of survey instrumentation is controlled by approved procedures.

5.5.2.1 Instrument Selection

Radiation detection and measurement instrumentation is selected based on reliable operation, detection sensitivity, operating characteristics, and expected performance in the field. As a rule, instruments used for static measurements are capable of detecting the radiation of concern to an MDC less than 50 percent of the $DCGL_W$.

Generally, instruments used for scan measurements are capable of detecting the radiation of concern to a MDC less than the $DCGL_W$. Typical instrumentation that may be used is identified in Table 5-9. The detectors used for direct surface contamination measurements are typically operated with data logging survey meters.

Table 5-9

Typical Survey Instrumentation Characteristics

Measurement Type	Detector Type	Effective Detector Area and Window Density	Instrument and Model	Detector Model
Alpha Scan	Gas-flow Proportional	126 cm^2 0.8 mg/cm2 Aluminized Mylar	Ludlum 2350-1	Ludlum 43-68
Beta-Gamma Scan	Gas-flow Proportional	126 cm^2 0.8 mg/cm2 Aluminized Mylar	Ludlum 2350-1	Ludlum 43-68
Gamma Scan	NaI Scintillator	1" D x 1" L, also 2" D x 2" L	Ludlum 2350-1	Ludlum 44-2, or 44-10 (or eq.)
Gamma Scan	Plastic Scintillator	1" D x 1" Length	Bicron Micro-Rem Meter	N/A
Static Surface Contamination	Gas-flow proportional	126 cm^2 0.8 mg/cm^2 Aluminized Mylar	Ludlum 2350-1	Ludlum 43-68
Soil and Bulk Material	High-purity Germanium	1.60" x 1.94", 2.16" x 2.32"	Ortec/Canberra	N/A

5.5.2.2 Calibration And Maintenance

Instruments and detectors are calibrated for the radiation types and energies of interest at the site. Instrument calibration and maintenance are performed in accordance with approved procedures. If vendor services are used, these services are conducted in accordance with approved procedures and a vendor QA program that is subject to approval in accordance with the SNEC Decommissioning Quality Assurance Plan (DQAP). Radioactive sources used for calibration purposes are traceable to the National Institute of Standards and Technology (NIST) or equivalent standards.

5.5.2.3 Response Checks

Instrument response checks are conducted to assure consistency in instrument response, to verify the detector is operating properly, and to demonstrate that measurement results are not the result of detector contamination or other disturbances. At a minimum, instrument response is checked before instrument use each day. Portable instruments are also checked after instrument use each day. A check source is used that emits the same type of radiation (i.e., alpha, beta, and/or gamma) as the radiation being measured and that gives a similar instrument response. However, the check source does not necessarily use the same radionuclide as the radionuclide being measured. The response check is performed using a specified source-detector alignment that can be easily repeated. If the instrument fails its response check, it is not used until the problem is resolved. Measurements made between the last acceptable response check and the failed check are evaluated and either retained or discarded, as appropriate.

5.5.2.4 Minimum Detectable Concentration (MDC)

The MDC is determined for the instruments and techniques that are used for survey data collection. The MDC is the concentration that a specific instrument and technique can be expected to detect 95 percent of the time under actual field conditions.

5.5.2.4.1 Beta-Gamma Scan MDC For Structural Surfaces

Scanning methodology implemented at the SNEC Facility will follow an approved training process. A check source assembly will be used to train personnel in detecting areas exhibiting two to three times the background count rate. The source is adjusted to a height below the source assembly surface such that two to three times the background count rate is presented to the detector while siting directly over the source. Personnel will then be asked to move the detector across the source exposure area at a fixed rate of speed, while listening for elevated counting rates. Scan speeds are adjusted according to the ability of the surveyor to discern a specified counting rate above the existing survey area background level. The check source assembly is also used to train personnel in proper scan survey techniques.

The scan MDC, or MDC_{scan}, for scanning structural surfaces for beta and gamma emitters is determined from NUREG-1575, Equation 6-10:

$$MDC_{SCAN} = MDCR/(\sqrt{p}\varepsilon_i\varepsilon_s(A/100cm^2))$$

Where:

MDC_{SCAN} = minimum detectable concentration for scanning surfaces (dpm/100 cm^2)
MDCR = minimum detectable count rate (Table 6.6 of NUREG-1575)
ρ = surveyor efficiency, (0.5, from draft Regulatory Guide DG-4006, Reference 5-4)
ε_i = instrument efficiency for emitted radiation (cpm/dpm)

ε_s = source efficiency for emissions/disintegration
A = area of detector (cm^2)

The value of ρ represents a mean value for normal field conditions and is discussed in Section 6 of NUREG-1507, "Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions" (Reference 5-18).

5.5.2.4.2 Alpha Scan MDC For Structural Surfaces

For most conditions found at the SNEC Facility, the presence of alpha emitting radionuclides may be predicted by use of a surrogate beta-gamma emitting radionuclide such as Cs-137. Scanning for the surrogate radionuclide is significantly easier than scanning for alpha activity. During the scanning operation, when levels of the surrogate radionuclide are found to exceed a predetermined level, both a static alpha and beta-gamma measurement may be employed, to verify the elevated scan reading. Any surrogate radionuclide used will be based on the ability to detect the surrogate radionuclide and the relative ratio of the alpha activity to the surrogate radionuclide in the survey area. Relative ratios of radionuclides will be verified using sample and analysis techniques. This method of indirectly surveying for alpha surface activity provides additional assurance that these radionuclides are at acceptable levels on structural surfaces, and is superior to scanning only for the alpha radionuclide by itself.

When only alpha scans are employed, scanning for alpha emitters will differ significantly from scanning for beta and gamma emitters, in that the expected background response of most alpha detectors is close to zero. Since the time the probe is in the area of elevated residual radioactivity varies and the background count rate may be less than 1 cpm, it is not practical to determine a fixed MDC for scanning. Instead, another approach described in Section 6.7.2.2 of NUREG-1575 (Reference 5-5) is used. Given the $DCGL_W$ and a known scan rate, the probability of detecting an area of elevated residual radioactivity is calculated. The probability of detecting given levels of alpha surface contamination can be calculated by using Poisson summation statistics (see Section 6.7.2.2 of NUREG-1575 (Reference 5-5) for a more complete description of this method).

For alpha survey instrumentation with backgrounds $\leq$ 3 cpm, a single count provides a surveyor sufficient, cause to stop and investigate further. When one or more counts are registered, the surveyor pauses scanning operations and waits for a predetermined time to determine if the counts are from elevated residual radioactivity. The time interval of the pause corresponds to a 90 percent probability of detecting counts associated with elevated residual radioactivity. This time interval may be calculated in accordance with Equation 6-13 of NUREG-1575 (Reference 5-5).

5.5.2.4.3 Gamma Scan MDC For Land Areas

For scanning land areas with a sodium iodide gamma detector, the MDC_{SCAN} values given in Table 6.7 of NUREG-1575 (Reference 5-5) are used (as appropriate).

5.5.2.4.4 Static MDC For Structural Surfaces

For static measurements of surfaces, the MDC_{STATIC} may be calculated using draft Regulatory Guide DG-4006, Equation 3, (Reference 5-4):

$$MDC_{static} = ((3 + (4.65)\sqrt{B}) / (K)(t)$$

Where:

MDC_{static} = minimum detectable concentration in for static counting (dpm/l00 cm^2)
B = background counts during measurement time interval t (counts)
t = measurement counting time interval (minutes)
K = calibration constant (counts/minute per dpm/100 cm^2)

The value of K may include correction factors for the detection efficiency and detector geometry.

5.5.2.5 Detection Sensitivity

The detection sensitivity of typical detectors for surface contamination measurements is estimated and the results summarized in Table 5-10. The results are shown for the principal instruments that are expected to be used for alpha and beta-gamma direct surface contamination measurements.

Count times are selected to ensure that the measurements are sufficiently sensitive with respect to the $DCGL_W$. For example, the count times associated with measurements for surface contamination and gamma spectral analysis (soil and bulk materials) are normally set to ensure an MDC_{static} is equal to or less than 50 percent of the $DCGL_W$. The scan rate associated with surface scans is normally set to ensure an MDC_{SCAN} of no more than 75 percent of the $DCGL_W$. If the MDC_{SCAN} exceeds the $DCGL_W$, additional static measurements may be required, as discussed in Appendix 5-1.

Table 5-10

Typical Detection Sensitivities

Instrument and Detector	Radiation	BKGND Count Time (min)	BKGND (cpm)	Instrument Efficiency[a] (cpm/dpm)	Count Time (min)	MDC (dpm/100 cm^2)	Scan[b] MDC dpm/100 cm^2
Ludlum Model 2350-1	Alpha	5	2	0.155	1	49	500[c]
Model 43-68	Beta-Gamma	5	243	0.275	1	220	511
2"x2" NaI	Gamma	1	~10,000	900 cpm/uR/h (weighted)	1 sec (scan)	N/A	6.4 pCi/g (Cs-137)

[a] Actual calibration sources may be Cs-137, Tc-99, Am-241 or Pu-239. The efficiency is determined by counting the source with the detector in a fixed position from the source (reproducible geometry).
[b] MDC_{scan} is calculated by assuming a scan rate of 5 cm/sec (unless otherwise marked), which is equivalent to a count time of 0.03 min, assuming an 8.9 cm detector width.
[c] The alpha scan MDC is determined by the approach described in Section 6.7.2.2 of NUREG-1575 (Reference 5-5). It assumes ≥ 1 cpm is necessary for the surveyor to pause.

5.5.3 Survey Methods

Survey measurements are performed in accordance with specific instructions contained in approved site procedures. Measurements include surface scans, static surface contamination measurements, and laboratory analysis of soil and bulk materials. Other measurements, such as removable surface contamination and exposure rate measurements may be obtained as required.

5.5.3.1 Scan Measurements

Scanning is performed to locate small areas of residual radioactivity above the investigation level. If an area of elevated residual radioactivity is identified during the scan of a survey unit, the area is marked for investigation.

Structure and site system surfaces are scanned for beta-gamma emitting radionuclides. Beta scintillation or thin window gas-flow proportional detectors are typically used. In general, the detector is held less than 2 cm from the surface and moved at about 1 detector width per second. The scan rate is adjusted such that residual radioactivity can be detected at or below the investigation level.

Scanning for alpha emitters and low-energy beta emitters (<100 keV) are limited to structural surfaces. Where scanning is performed, alpha scintillation or thin window gas-flow proportional detectors are typically used. The detector is kept close to the surface, usually less than 1 cm, and moved at a rate such that there is a high probability of detecting elevated residual radioactivity.

Land areas are scanned for gamma-emitting radionuclides. Sodium iodide scintillation detectors are normally used because of their high detection efficiency. The detector is held close to the ground surface (usually less than 6 cm), and moved in a serpentine (S-shaped) pattern. This is done while walking at a speed that allows the surveyor to detect the residual radioactivity at or below the investigation level. A scan rate of approximately 0.5 meters/second is typically used to start. This rate is adjusted depending on the required detector response time.

5.5.3.2 Static Surface Contamination Measurements

Static measurements are taken to detect surface contamination. Static measurements are generally performed by placing the detector on, or near the surface measured. Measurements are made over a discrete measurement time interval. Results are recorded. A one minute integrated count is a practical time interval for most field survey instrumentation and provides detection sensitivities that are usually below the $DCGL_W$. Other time intervals may be used as warranted.

Static measurements are taken with 100 cm^2 detectors or are corrected to reflect a 100 cm^2 area. In the event that contamination is more than what would be acceptable for an area of 100 cm^2, an evaluation is performed to ascertain compliance with the $DCGL_W$.

Static measurements are typically restricted to relatively smooth impermeable surfaces where the radioactivity is present as surface contamination. Because the detector is used in close proximity to the potentially contaminated surface, contamination of the detector or damage to the detector caused by irregular surfaces is considered before performing direct measurements.

5.5.3.3 Soil And Bulk Material Samples

Soil and bulk material samples are routinely collected and analyzed. Soil samples are generally collected down to a depth of 15 cm at static measurement locations. Sampling at greater depths is done in areas where site characterization or other information indicates the potential exists for contamination below 15 cm. Sample preparation may include; removing extraneous material, homogenizing, splitting, drying, and compositing sample materials for counting. For

QC repeat measurements, the samples are obtained from the selected measurement locations as indicated in the survey/sample design package.

Samples of paint chips, tank sediment, sewage sludge, roofing material, concrete, pavement, and other bulk materials are collected for laboratory analysis as part of the biased sampling effort. Such samples may be collected in drain receptacles, sumps, and other locations in impacted areas. Selected storm drains are sampled in accessible locations. These samples are quantitatively analyzed by gamma spectroscopy for principal gamma-emitting radionuclides and the results compared to the $DCGL_W$. If residual radioactivity can be measured at $DCGL_W$ levels by *in-situ* gamma-ray spectroscopy techniques, *in-situ* techniques may be used in place of, or to supplement, sampling and analysis methods. For gamma emitting radionuclides, the above data may also be supplemented by dose rate measurements.

5.5.3.4 Special Measurements

The historical site assessment and site characterization surveys are used to indicate if residual radioactivity is present in areas or locations described below. Any of these types of areas will require the application of special measurements techniques.

5.5.3.4.1 Cracks, Crevices, And Small Holes

Surface contamination on non-planar or irregular structure surfaces, such as cracks, crevices, and small holes, may be difficult to measure directly using standard field survey detectors and established techniques. Where no remediation has occurred, and residual radioactivity is not expected above background levels, cracks, crevices, and small holes are assumed to have the same level of residual radioactivity as that found on adjacent surfaces. The accessible surfaces are surveyed the same as other structural surfaces and no special measurement methods are applied.

Where remediation has occurred on surrounding surfaces, or where residual radioactivity above background levels is expected, a representative sample of surface contamination within the crack, crevice, or small hole is obtained. The level of residual radioactivity is measured and detection sensitivities can be adjusted such that reasonable approximations may be made using indirect measurement techniques. For the most part, the areas requiring special attention with respect to this type of survey and remediation work are located in the SNEC CV. Additional discussion on this subject is presented in Draft Regulatory Guide DG-4006, Section 2.10.1 to 2.10.4, (Reference 5-4).

5.5.3.4.2 Paint Covered Surfaces

Surfaces painted to fix loose contamination are remediated before FSS activities begin. For other surfaces painted after site start-up, representative samples in areas where it is suspected that elevated levels of residual radioactivity could have been covered over, are taken and analyzed. Detection sensitivities are adjusted or remediation is performed as dictated by the sample analysis results.

5.5.3.4.3 Facility Systems, Floor Drains, Embedded Piping, Unistrut

Surface contamination on internal surfaces of site systems, floor drains, and embedded piping and embedded unistrut sections may be inaccessible or difficult to measure directly using typical field survey instrumentation. However, no special measurement methods are generally needed where no remediation has occurred in an area. When this is the case, internal surfaces of embedments are assumed to have the same level of residual radioactivity as that found on accessible surfaces. Residual radioactivity is not expected above background levels in these areas.

Contaminated or potentially contaminated embedments may be evaluated in several ways. Where remediation has occurred, or where residual radioactivity above background levels is expected, representative samples of the embedments may be obtained using a random sampling approach. The levels of residual radioactivity are then measured and evaluated on the removed embedment sections, and the results are extrapolated to the remaining population. As an example, several unistrut sections (~1 foot in length) are first removed from the CV, and then analyzed in a low background area to determine the residual activity per unit length. From the counting results, a mean activity per length is estimated as well as a postulated standard deviation and variance for the remaining population. The required number of statistically based samples is then developed for the remaining lengths of unistrut.

For other types of embedments, scale and sediment samples may be obtained (as appropriate), as allowed by system size and accessibility to internal surfaces. Detection sensitivities are then established such that reasonable approximations may be made of any remaining residual activities within these embedments using indirect measurement techniques and technical evaluations.

Additionally, calibrated detectors may be used to measure the internal activity of piping and ductwork. Accessible internal surfaces are surveyed in the same manner as other structural surfaces and the results are extrapolated to the remaining inaccessible surfaces as applicable.

As a final resolution, when no reasonable method exists for evaluating the residual activity remaining in/on the embedment, the embedment is conservatively assumed to be above limits and is removed as radioactive waste. The embedment evaluation, measurement, and assessment program will be performed concurrently with other on-going remediation efforts at the SNEC Facility.

5.5.3.4.4 Volumetrically Contaminated Structural Materials

It is assumed that remediation efforts will be successful in removing all but a small quantity of residual activity from structural surfaces within the SNEC CV. If a need arises to further evaluate volumetrically contaminated materials within this structure, an ALARA analysis of remediation effectiveness will be performed. Remediation effectiveness is evaluated by collecting representative samples of structural materials for analysis. Volumetrically contaminated concrete (including activated concrete) and other structural materials are measured in units of activity per unit mass (pCi/g). Indirect measurement techniques such as evaluating exposure rates, gross gamma count rates and/or *in-situ* gamma-ray spectrometry measurements will be performed. Detection sensitivities will be established such that reasonable approximations of the quantity of remaining volumetric activity can be made. These types of evaluations will precede the development of allowable residual limits for structural materials.

To aid in any future dose modeling requirements for this kind of material, samples of contaminated SNEC CV concrete have been sent to an off-site laboratory, where K_d (distribution coefficient) values are being developed for relevant radionuclides. When K_d values are available, have been reviewed and are accepted by GPU Nuclear, they may be used to further develop bounding limits for residual radioactivity retained in the SNEC CV concrete. Any residual activity allowed to remain in the SNEC CV structural materials will meet the site dose criteria for unrestricted release. The need for developing additional volumetric contamination limits will be addressed if necessary. However, as of the date of this submittal, only the SNEC CV holds the potential for this additional assessment.

5.5.3.4.5 Paved Parking Lots, Roads, Sidewalks, And Other Paved Areas

Paved parking lots, roadways, concrete slabs, and other paved areas are treated as structure surfaces. Scan and static measurements are taken as prescribed by the survey design. Where remediation has occurred or where residual radioactivity above background levels is suspected, direct surface contamination measurements are taken and a representative number of subsurface samples (below 15 cm) will be collected and analyzed. Depending on the size of the paved area and the distribution of the residual radioactivity, the paved area may be a separate survey unit or be included as part of a larger survey unit. Sampling of these areas is also appropriate where there is reason to believe that contamination resides in, on, or below these structures.

5.5.3.4.6 Trailers And Temporary Facilities

Trailers or other temporary facilities used to support dismantlement work prior to the start of FSS activities are not included in this study, but instead will be released in accordance with current SNEC Facility Radiological Controls work practices and procedures. Any temporary facilities remaining at the time of FSS activities shall be classified and surveyed in accordance with the applicable area classification.

5.5.3.4.7 Subsurface Soil Contamination Survey

Selected open land areas described in Chapter 2.0 have been sampled to depths of over two-(2) meters below the surface. Results indicate that (in general), some areas near or in the 1.148 acre SNEC Facility site have shown, or are known to have subsurface contamination levels at or exceeding the $DCGL_W$. These suspect below grade areas include soils surrounding the foundations and remains of previously demolished buildings such as:

1. Areas immediately adjacent to the SNEC CV,
2. The Saxton Steam Generating Station Discharge Tunnel.

Other areas of concern are areas where underground tanks once resided, areas below current and former Rad Waste storage areas, areas below and adjacent to known spill locations and other suspect areas. These areas will be remediated as necessary and FSS subsurface sampling and surveying will be performed. Surface soil $DCGL_W$ values will be applied as subsurface soil contamination limits.

Several methods of sampling and analysis will be employed to properly evaluate the residual subsurface radioactivity. These methods include obtaining samples of subsurface material at the depth and location of concern. Another method will be to drill down to a specified depth and then perform a gamma-logging measurement using a sodium iodide (NaI) detector assembly attached to a multichannel analyzer. The subsurface measurement program will collect data at both biased locations (samples and measurements), and randomly selected measurement points.

It may also be necessary to open, sample and survey several locations within or near the former Saxton Steam Generating Station footprint. If opened, scoping and characterization surveys will be performed as necessary to determine their proper survey classification before planning final status surveys for these areas.

5.5.3.5 Investigation Measurements

Removable activity, dose rate, and *in-situ* gamma spectrometry measurements may be used as diagnostic tools to further characterize the radiological conditions in selected areas, and to evaluate potential response actions. Sodium iodide detectors can also be used, both for hard to reach areas e.g., embedments and duct work, as well as for subsurface gamma-logging efforts. Sodium iodide detectors become especially useful when employed in conjunction with multichannel analyzers that are capable of discerning between natural occurring and site-specific radionuclides.

5.5.3.6 Hard-To-Detect (HTD) Radionuclides

Many radionuclides are comparatively simple to detect in the field at environmental levels using routine gamma-ray spectroscopy analysis techniques. n contrast, the "Hard-To-Detect" (HTD) radionuclides, or the "Difficult-To-Measure" (DTM) radionuclides, (Electric Power Research Institute (EPRI), (Reference No. 5-19), are not easily identified using any routinely applied field measurement practices. The HTD group of radionuclides typically includes H-3, C-14, Tc-99, I-129, Ni-63, and Fe-55. Historically reported values and detection limits for these radionuclides, are periodically orders of magnitude above true concentrations for these nuclides in utility wastes. This type of error routinely leads to inaccurate disposal information, waste misclassification, higher disposal costs and can also lead to elevated and overly conservative dose assessments for decommissioning work.

SNEC Facility personnel will make conservative but reasonable estimates of the concentration of each HTD radionuclide (where applicable) when addressing effective DCGLs. When a real or positive value for a HTD radionuclide exists in any sample result for a selected sample type (e.g., soil, concrete, etc.), in any selected survey unit, the real value will always be used to adjust the effective DCGL for the survey unit. Additionally, a site specific scaled value (to Cs-137) may be developed as appropriate, and be applied for other similar areas, and other similar media types. When an MDA value for a HTD radionuclide is higher than typically reported scaled values for the HTD radionuclide, the MDA value will be reviewed against both site specific scaled values and those scaling functions reported in other applicable reference documents.

Each HTD radionuclide will be reviewed on a case-by-case basis. However, some HTD radionuclides have a very low potential for being present at any concentration. I-129 has not been positively identified in any soil sample materials taken from the SNEC Facility during the characterization and remediation process, and has not been identified in the historical site assessment phase. In-addition, I-129 was not detected at any level in any samples of any media collected at the SNEC Facility. Based on this information, I-129 will not be considered further in effective DCGL determinations. Conversely, Fe-55, H-3, Tc-99 and Ni-63 have been found at low concentrations in facility sample materials. However, most of these nuclides have $DCGL_W$ values that are relatively high for soil and surface activities and produce little additional dose at their current existing levels, or at levels implied by typically reported MDA values. Consequently, these isotopes will be assumed present at MDA concentrations, or will be scaled from their expected ratios to Cs-137 whenever effective DCGL values are to be calculated.

C-14 on the other hand, can produce significant contributions to dose using conservative assumptions. It is therefore important to lower the MDA level for C-14 to a value that is as low as possible. In order to facilitate conservative but reasonable treatment of the HTD radionuclide C-14, samples of soils removed during the 1994 soil remediation program at the SNEC Facility, were reanalyzed for C-14 using special low level analytical techniques. Additionally, CV concrete sample materials, recently taken from scabbled concrete surface areas within the SNEC CV, were also analyzed for C-14. Both of these sample types contained relatively high levels of Cs-137.

The results show that C-14 is present in concrete materials at detectable levels and should be considered present at MDA levels for CV concrete when not positively identified, or be scaled in using SNEC Facility developed scaling factors. C-14 was not identified above MDA levels for soil materials. However, the soil sample MDA value for C-14 was at a level that reduced its impact on site dose determinations for soil materials.

Whenever possible SNEC Facility developed scaling factors will be used to provide HTD radionuclide concentrations. However, Reference 5-19 provides several possible scaling factor sources and results that may also be used in place of MDA values (as appropriate) to estimate HTD radionuclide concentrations, and consequently determine effective DCGLs for the SNEC Facility.

5.5.4 Sample Handling And Analysis

When sample custody is transferred (e.g., when samples are sent off-site to another lab for analysis), a chain-of-custody record accompanies the sample for tracking purposes. The sample chain of custody record documents the custody of samples from the point of measurement or collection until final results are obtained. These tracking records are controlled and maintained in accordance with approved site procedures. On-site laboratory capabilities are used to perform gamma spectroscopy of bulk sample materials and gross beta-gamma and alpha counting of smears. Off-site laboratory services are procured as needed for H-3, Sr-90, TRU and other Hard-To-Detect (HTD) radionuclides. Laboratory analytical methods are generally capable of measuring levels at 10 to 50 percent (or less) of applicable $DCGL_W$ values.

5.5.5 Data Management

Final survey data may be collected from post remediation surveys, final surveys, investigation surveys or special measurement evaluations such as those made to determine embedment or sub-surface activity levels. QC measurements are not recorded as final survey data.

5.5.5.1 Other Scan Measurements

When 100% of any area is scanned at a high detection efficiency, capable of discerning low levels of residual activity (well below established $DCGL_W$ levels), collected results have a greater assurance that survey areas meet the site release criteria. Therefore, the need to measure a finite number of randomly selected survey points are reduced or eliminated. Consequently, some scan survey measurement efforts performed for initial phase and/or investigative purposes, may be accepted as final survey data provided the following conditions are met:

1. The MDA for the scan is a small fraction of the required $DCGL_W$ for the survey area, and there is sufficient sensitivity present in the survey design at an acceptable confidence level.

2. All applicable survey data collection requirements as prescribed in Section 5.5 and 5.6.1 are followed.
3. The area was isolated prior to the survey activity.

5.5.5.2 Other Static Measurements

Other static measurements performed during post remediation and investigation surveys are based on professional judgment. Since they are biased and not random, they may not be used in the statistical tests. However, this does not necessarily preclude their acceptance as final survey data. These measurements may be accepted as final survey data provided:

1. All applicable survey data collection requirements as prescribed in Section 5.5 and 5.6.1 are followed.

2. Thirty or more data points are collected within the survey unit. For piping and other embedments, accessibility to interior surfaces may not allow this number of measurements. In these cases, similar survey methodology encompassing historical assessment, characterization, remediation, and post remediation survey data will be used as a basis for biased measurements and sampling, to ensure that the release criteria are met.

3. None of the data points exceeds the $DCGL_W$.

4. The area was isolated prior to the survey activity.

5.5.5.3 Data Recording

Survey measurements will be recorded in units appropriate for comparison to the $DCGL_W$ by correcting for background, efficiency, geometry, detector area, and measurement size as applicable. The recording units are dpm/100 cm^2 for surface contamination and pCi/g for radionuclide concentration.

Records of survey data are maintained in accordance with approved site procedures. Survey data records include the identification of the surveyor, type of measurement, location, instrumentation used, results, time and date measurement was performed and the instrument calibration information.

5.6 SURVEY DATA ASSESSMENT

The data assessment process checklist is illustrated in Figure 5-2. Final survey data, described in Section 5.5, are reviewed to verify they are of adequate quantity and quality. Graphical representations and statistical comparisons of the data can be made which may provide both quantitative and qualitative information about the data. An assessment is performed to verify the data. If the quantity or quality of the data is called into question, previous survey steps are re-evaluated and additional data are collected as necessary prior to further statistical analysis. The statistical tests are applied and conclusions are drawn from the data as to whether the survey unit meets the site release criteria.

5.6.1 Data Verification And Validation

The final survey data will be reviewed to verify they are authentic, appropriately documented, and technically defensible. The review criteria for data acceptability are:

1. The instruments used to collect the data are capable of detecting the radiation of interest at or below the investigation level. If not, acceptable compensatory measures have been taken.

2. The calibration of the instruments used to collect the data is current and radioactive sources used for calibration are traceable to recognized standards or calibration organizations.

3. Instrument response is checked before and, where required, after instrument use each day data are collected.

4. Survey team personnel are properly trained in the applicable survey techniques.

5. The MDCs and the assumptions used to develop them are appropriate for the instruments and the survey methods used to collect the data.

6. The survey methods used to collect the data are appropriate for the media and types of radiation being measured.

7. Special measurement methods used to collect data are applied as warranted by survey conditions.

8. The custody of samples that are to be sent for off-site laboratory analysis, are tracked from the point of collection until the final results have been obtained, and

9. The final survey data set consists of qualified measurement results representative of current facility status are collected as prescribed by the survey design package.

A discrepancy exists where one or more criteria are not met. The discrepancy will be reviewed and corrective actions taken as appropriate, in accordance with site procedures.

5.6.2 Graphical Data Review

Survey data may be graphed to identify patterns and relationships in the data that might go unnoticed using purely numerical methods. When needed, a posting plot and/or a frequency plot may be used. Other graphical data representation tools can also be used as appropriate.

5.6.2.1 Posting Plot

Posting plots, generated during investigation surveys, may be used to identify spatial patterns in the data. A posting plot is simply a map of the survey unit with the data values entered at the measurement locations. The posting plot can reveal non-homogeneous spatial characteristics in the survey unit such as patches of elevated residual radioactivity or groupings of measurements that exceed the $DCGL_W$. Even in a background reference area, a posting plot may reveal spatial trends in background data that might affect the results of the statistical tests. In some cases, the trends could be due to residual radioactivity, but may also indicate non-homogeneous characteristics in the background reference area.

5.6.2.2 Frequency Plot

A frequency plot is used to examine the general shape of the data distribution. A frequency plot is a bar chart of the number of data points within a certain range of values. The frequency plot may reveal any obvious departures from symmetry, such as skewness or bi-modality (two peaks), in the data distributions for the survey unit or background reference area. When the data distribution is highly skewed, it is often because there are a few elevated areas of residual radioactivity. The presence of two peaks in the data may indicate the existence of isolated areas of residual radioactivity or a mixture of background concentration distributions due to different soil types, construction materials, etc. The greater variability in the data due to the presence of such a mixture will reduce the power of the statistical tests to detect an inadequately remediated survey unit. These situations may indicate the need to more carefully match background reference areas to the survey unit, or to divide the survey unit into survey units with more homogeneous backgrounds.

5.6.3 Basic Statistical Comparisons

Statistical quantities (range, median, mean, and standard deviation) are calculated for the final survey data set where one or more data points exceed the $DCGL_W$. The calculated quantities are compared to the values shown in Table 5-11. The statistical comparison values represent assumptions underlying the statistical test to be used. Where the statistical quantity fails the comparison, the data set and/or survey design assumptions are examined.

Table 5-11

Basic Statistical Comparisons

Statistical Quantity	Acceptable Value	Failure Response
Range (R)	$R \leq 3\ \sigma$	Examine Data for Outliers
Median ($\tilde{u}$)	$\lvert(\tilde{u} - \bar{X})/\sigma\rvert \leq 0.5$	Examine Data for Outliers and Anomalies
Mean ($\bar{X}$)	$\bar{X} \leq DCGL_W$	Apply reference area, remediate or reclassify
Sigma (σ)	$\sigma \leq 0.3 \times DCGL_W$	Review initial survey design parameters

5.6.3.1 Outliers

Where the range is greater than 3 standard deviations, the data are examined for outliers. Outliers are measurements that are extremely large or small relative to the rest of the data set and, therefore, are suspected of misrepresenting the population from which they were collected. Outliers may result from measurement collection and recording errors. Outliers may also represent true extreme values of a distribution, such as areas of elevated residual radioactivity, and indicate more variability in the population than was expected. Not removing true outliers and removing false outliers both lead to a distortion of estimates of population parameters. Tests developed to detect outliers in a data set may be used to identify data points that require further examination. A test alone cannot determine whether statistical outliers should be discarded or corrected. This decision is generally based on professional judgment.

5.6.4 Statistical Testing

The Sign or the Wilcoxon Rank Sum (WRS) statistical test, also known as the Mann-Whitney test, may be applied to the final survey data set where one or more measurements exceed the

$DCGL_W$. The statistical test is based on the hypothesis that the level of residual radioactivity in the survey unit exceeds the $DCGL_W$. There must be sufficient survey data with levels of residual radioactivity at or below the $DCGL_W$ to reject this statistical hypothesis and to conclude the survey unit meets the site release criteria.

5.6.4.1 Application Of Statistical Tests

The statistical test does not need to be performed when the survey data clearly show that the survey unit meets the site release criteria. The survey unit clearly meets the criterion if:

1. Every measurement in the survey unit is less than or equal to the $DCGL_W$, or

2. Where a background reference area is used, and the difference between the maximum survey unit measurement and the minimum background reference area measurement is less than or equal to the DCGL. In these instances, the statistical test is not applied.

The statistical test is applied where one or more measurements exceed the $DCGL_W$. Similarly, for a survey unit where a background reference area is used, the statistical test is applied where the difference between any survey unit measurement and any background reference area measurement is greater than the DCGL. Survey results and the corresponding conclusions for when a background reference area is and is not used, are shown in Tables 5-12 and 5-13, respectively.

Table 5-12

Initial Survey Results and Conclusions When A Background Reference Area Is Not Used

Survey Result (Class 1 Areas)	**Conclusion: Survey unit meets site release dose criteria**	
	Yes	No
All measurements less than or equal to $DCGL_W$	✓	
Mean greater than $DCGL_W$		✓
Any measurement greater than DCGL with mean less than or equal to DCGL which passes Sign test	✓	
Any measurement greater than DCGL with mean less than or equal to DCGL which fails Sign test		✓

Table 5-13

Initial Survey Results and Conclusions When A Background Reference Area Is Used

Survey Result (Class 1 Areas)	Conclusion: Survey unit meets site release dose criteria	
	Yes	No
Difference between maximum survey unit measurement and minimum background reference area measurement less than or equal to $DCGL_W$	✓	
Difference between survey unit mean and background reference area mean greater than $DCGL_W$		✓
Difference between any survey unit measurement and any background reference area measurement greater than $DCGL_W$, and difference between survey unit mean and background reference area mean less than or equal to $DCGL_W$ which passes WRS test	✓	
Difference between any survey unit measurement and any background reference area measurement greater than DCGL and difference between survey unit mean and background reference area mean less than or equal to $DCGL_W$ which fails WRS test		✓

5.6.4.2 Sign Test

The one-sample Sign statistical test is used if the radionuclide of concern is not present in background and radionuclide-specific measurements are made. The Sign test may also be used if one or more radionuclides are present in background at such small fractions of the $DCGL_W$ as to be considered insignificant. In this case, background concentrations of the radionuclides are included with the residual radioactivity (in other words, the entire amount is attributed to facility operations). Thus, the total concentration of the radionuclides is compared to the site release criteria. This option is only used if it is expected that ignoring the background concentration does not affect the outcome of the statistical test. The advantage of ignoring a small background concentration is that no background reference area is necessary.

The Sign test is applied as follows:

1. List the survey unit measurements, X_i, i = 1, 2, 3,. . .,n; where n = the number of measurements.

2. Subtract X_i from the $DCGL_W$ to obtain the difference ($DCGL_W - X_i$, i=1, 2, 3...n).

3. Discard differences where the value is exactly zero and reduce n by the number of zero measurements.

4. Count the number of positive differences. The result is the test statistic S+. Note that a positive difference corresponds to a measurement below the $DCGL_W$ and contributes evidence that the survey unit meets the site release criteria.

Compare the value of S+ to the critical values in Appendix I, Section I.3 of NUREG-1575 (Reference 5-5). The Table columns equate to the false positive decision error rate, α. The value of α is the probability of passing a survey unit which actually fails to meet the site release criteria, which is obtained from the survey design (the initial value is 0.05 – see Appendix 5-2). If S+ is greater than the critical value for the false positive decision error rate given in the Table, the survey unit meets the site release criteria. If S+ is less than the critical value, the survey unit fails to meet the criterion.

5.6.4.3 Wilcoxon Rank Sum (WRS) Test

The two-sample WRS statistical test is used when the radionuclide of concern appears in background, or when a measurement method is used that is not radionuclide-specific. Because gross activity measurements are not radionuclide-specific, they must be performed for both the survey unit being evaluated by the WRS test and for the corresponding background reference area.

The WRS test is applied as follows:

1. Adjust the background reference area measurements by adding the $DCGL_W$ to each background reference area measurement, X_i ($X_i + DCGL_W$).

2. Sum the number of adjusted background reference area measurements, m, and the number of survey unit measurements, n, to obtain N (N = m + n).

3. Pool and rank the measurements in order of increasing size from 1 to N. If several measurements have the same value, they are all assigned the average rank of that group of measurements.

4. Sum the ranks of the adjusted background reference area measurements to obtain Wr.

5. Calculate the critical value using equation I.1, NUREG-1575 (Reference 5-5). This equation is used when there are several measurements that have the same value.

$$Critical\ Value = ((m(n+m+1))/2) + (z\sqrt{nm(n+m+1)/12})$$

Where z is the (1 - α) percentile of a standard normal distribution, and can be found in Table 5-14 below.

Table 5-14, Values For α and z

α	Z
0.001	3.090
0.005	2.575
0.01	2.326
0.025	1.960
0.05	1.645
0.1	1.282

The value of α is obtained from the survey design (the initial value is 0.05 – see Appendix 5-2). Where m and n are less than 20, the critical value is given in Table I.4 of NUREG-1575 (Reference 5-5).

6. Compare the value of Wr with the critical value calculated above. If Wr is greater than the critical value, the survey unit meets the site release criteria. If Wr is less than the critical value, the survey unit fails to meet the criterion.

5.6.5 Data Conclusions

The results of the statistical test allow one of two conclusions to be drawn. The first conclusion is the survey unit meets the site release criteria. The data have provided statistically significant evidence that the level of residual radioactivity in the survey unit does not exceed the site release criteria. The decision that the survey unit is acceptable for unrestricted release can be made with sufficient confidence and without further analysis.

The second conclusion that is that the survey unit fails to meet the site release criteria. The data does not provide sufficient statistically significant evidence that the level of residual radioactivity in the survey unit does not exceed the site release criteria. The data is analyzed further to determine why the statistical test result led to this conclusion.

Possible reasons the survey unit fails to meet the site release criteria are:

1. It is in fact true,
2. It is a random statistical fluctuation, or
3. The test did not have sufficient power to detect that it is not true. The power of the test is primarily based on the actual number of measurements obtained and their standard deviation. A retrospective power analysis for the test may be performed as described in Appendices I.9 and I.10 of NUREG-1575 (Reference 5-5). If the power of the test is insufficient due to the number of measurements, additional data may be collected. If it appears that the failure may be due to statistical fluctuations, the survey unit may be resurveyed and another set of discrete measurements collected for statistical analysis. A larger number of measurements increases the probability of passing if the survey unit actually meets the site release criteria. If it appears that the failure was caused by the presence of residual radioactivity in excess of the site release criteria, the survey unit is remediated and resurveyed.

5.7 SURVEY RESULTS

Survey results are documented in history files, survey unit release records, and are summarized in the final survey report. Other detailed and summary data reports may be generated as requested by the NRC or SNEC Management.

5.7.1 Survey Unit Release Record

The survey unit release record is the complete release record in a standardized format prepared for each survey unit or group of survey units with similar histories. The survey unit release record is a collection of information necessary to demonstrate compliance with the site release criteria. This record includes:

1. A history file checklist

The history file checklist references relevant operational and decommissioning data. The purpose of this checklist is to provide a basis for the survey unit classification. The history file will reference relevant sections of the Historical Site Assessment (Reference 5-20) and other compiled records including:

- History of remediation
- The survey unit operating history affecting radiological status
- Scoping, site characterization and post remediation survey data
- Other relevant information.

2. Description of the survey unit
3. Survey design information for the survey unit
4. Survey unit ALARA analysis, if performed
5. Survey measurement locations and corresponding survey data
6. Survey unit investigations performed with documented results, as applicable
7. Any survey unit data assessment results
8. Results of any special measurements performed for the survey unit

5.7.2 Final Survey Report

A final survey report will be prepared and submitted to the NRC. The report will provide a summary of any ALARA analysis, survey data results, and overall conclusions, which demonstrate that the SNEC Facility and site meet the radiological criteria for unrestricted use. Information such as the number and type of measurements, basic statistical quantities, and statistical test results will be included in the report.

The following outline illustrates a general format that may be used for the final status survey report. The outline below may be adjusted to provide a clearer presentation of the information. The level of detail will be sufficient to clearly describe the final status survey program and certify the results.

1. Final Site Description
2. Final Status Survey Methodology Summary
3. Final Status Survey Results
4. Summary

5.7.3 Other Reports

If requested by the NRC, computer-generated detailed and summary data reports for one or more survey units will be provided in hard copy or electronic form. Survey data include date, instrument, location, type of measurement, and mode of instrument operation. Other data, such as conversion factors, background reference areas, and the MDCs used, are available which will allow independent verification of the results. Measurement results will also be presented graphically. The FSS report will be independently reviewed.

Any independent verification survey performed will be performed by an organization outside the SNEC Facility staff and management organization. Reports generated as a result of any independent verification survey process initiated by the SNEC Facility, will be available upon request.

5.8 DEFINITIONS

1. Accessible Surface Area – An area available to a radiation detector for direct scanning or fixed-point measurements.

2. Area Factor (AEMC) – A factor used to adjust the DCGLW to estimate DCGLEMC and the minimum detectable concentration for scanning surveys in Class 1 survey units (DCGLEMC = DCGLW x AEMC. The area factor (AEMC) is the magnitude by which the residual radioactivity in a small area of elevated activity can exceed the DCGLW, while maintaining compliance with the release criterion. SNEC Facility area factors are listed in Table 5-15 of Appendix 5-1.

3. Background Radiation – Naturally occurring radiation which may include cosmic, terrestrial (radiation from the naturally radioactive elements) and man-made radiation from global fallout.

4. Characterization Survey – A radiological survey and its supporting evaluations performed to establish the SNEC Facility radiological condition for planning decommissioning activities.

5. Confidence Level – The probability associated with a confidence interval which expresses the probability that the confidence interval contains the population parameter value being estimated.

6. Derived Concentration Guideline Levels (DCGL) – Residual radioactivity levels that equate to the site release criteria for that particular pathway or measurement. The two (2) basic DCGLs defined in this plan are 1) the DCGLW and, 2) the DCGLEMC. The DCGLW is the average concentration limit for the standard size survey area. The DCGLEMC is the elevated measurement area DCGL, which is used for small areas of elevated activity (above the DCGLW). When not defined, DCGL refers to the DCGLW. Other DCGLs discussed in this plan (e.g., DCGLGA etc.) are derived from these two basic definitions and are sometimes referred to as an "effective DCGL".

7. Elevated Area – Areas of residual contamination exceeding the guideline value.

8. Final Status Survey (FSS) – Radiological measurements, evaluations and supporting activities undertaken to demonstrate that the SNEC Facility satisfies the criteria for unrestricted use.

9. Hard-to-Detect Nuclide (HTD) – A radionuclide emitting radiation(s) that are difficult to detect with field or laboratory based instrumentation.

10. History File – A compilation of information used to justify the classification and survey design for the survey unit. It should reference sections of the Historical Site Assessment, characterization survey data, remediation surveys and other information used to establish the basis for the design of the final status survey.

11. Independent Verification Survey – An information only radiological survey, performed by an organization independent of the SNEC Facility staff and management, which will provide SNEC Facility management with an additional level of confidence concerning the validity of the Final Survey results.

12. Minimum Detectable Activity (MDA) – The minimum level of radiation or radioactivity that can be measured by a specific instrument and technique. The MDA is usually established on the basis of assuring false positive and false negative rates of less than 5%.

13. Minimum Detectable Concentration (MDC) – The minimum detectable concentration (MDC) is the *a priori* activity level that a specific instrument and technique can be expected to detect 95% of the time. When stating the detection capability of an instrument, this value should be used. The *MDC* is the detection limit, L_D, multiplied by an appropriate conversion factor to give units of activity.

14. Operational Survey – A radiological survey performed in accordance with SNEC procedures in support of routine site operations.

15. Quality Control Survey – A survey that consists of repeat measurements on a specified fraction of the survey areas. The survey areas are usually selected at random to provide an additional check of final status survey measurements.

16. Release Criteria – A term used to identify the radiological requirements for release of the SNEC Facility for unrestricted use.

17. Remediation Survey – Any survey performed that is used to determine the effectiveness of remediation activities. The final post remediation survey is a special remediation effectiveness survey performed with instrumentation similar to the type used for the FSS. The survey methodology is also similar to actual FSS methodology.

18. Scoping Surveys – Surveys such as investigative surveys used to provide a quick look at conditions before or during FSS work. These surveys are not necessarily documented.

19. Scan Survey – A qualitative radiological monitoring technique that is performed by moving a detector over a surface at a specified speed and distance to detect elevated activity areas or locations. Also called a "Surface Scan".

20. Structures – All SNEC Facility site buildings and their surfaces. In addition, platforms, restraints and supports, and external surfaces of piping systems, heating and ventilation systems, tanks, stacks, etc., are also treated as structures in the final status survey if they exist beyond remediation efforts.

21. Surface Contamination – The total of both fixed and removable contamination. For the purposes of this plan, this would also include any remaining neutron-activated material near the surface. Also called total surface contamination.

22. Survey Area – The basic survey entity for the management of the Final Status Survey. It is comprised of one or more survey units, the bounds of which are defined by existing facility physical features, such as a room, intersection of walls, column-and-row layout of a floor elevation, or structural I-beams.

23. Survey Location – In a structural or open land survey area, a survey location is usually represented by a single grid block. In a system survey area, a specified length of piping or a component such as a valve or tank is referred to as a survey location. A survey location can contain one or more survey points. Also referred to as measurement locations.

24. Survey Unit Release Record – A collection of information in a standardized format for controlling and documenting field measurements taken for the Final Status Survey. A survey unit release record is prepared for each survey area. The survey unit release record may include the survey instructions, a control form, grid map(s), survey measurement data sheets and survey maps. It may also be called a survey package.

25. Survey Point – A smaller subdivision within a survey location (grid block, system, component) where local measurements are taken. For structures and systems, a survey point generally refers to an area covered by a detector, or an area of 100 cm2 when a smear is taken. For open land areas, a survey point refers to the area covered by a detector (for paved surfaces), the point at which a dose rate measurement is taken, or the point at which a soil or pavement sample is collected.

26. Survey Unit – A contiguous area (usually) with similar characteristics and contamination potential. Survey units are established to facilitate the survey process and aid in the statistical evaluation of the survey data. Because survey units are generally designed to be contiguous areas with similar characteristics and potential for contamination, the actual size of a survey unit is not deemed to be critical, provided each survey unit contains a sufficient number of measurement locations.

27. Total Effective Dose Equivalent (TEDE) – The sum of the deep dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

28. Unity Rule – Where more than one radionuclide is present, the sum of the ratios of each radionuclide concentration to its respective DCGL should not exceed unity. When this method is used, the effective DCGL is equal to one (1).

5.9 REFERENCES

5-1 Code of Federal Regulations, Title 10, Part 50.82, "Termination of License"

5-2 Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," January 1999.

5-3 Code of Federal Regulations, Title 10, Part 20.1402, "Radiological Criteria for Unrestricted Use", and Title 10, Part 50.59, "Changes, Tests and Experiments".

5-4 Draft Regulatory Guide DG-4006, "Demonstrating Compliance with the Radiological Criteria for License Termination, August 1998

5-5 NUREG-1575/EPA 402-R-97-016, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), " December 1997

5-6 NUREG-1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys".

5-7 SNEC Facility Site Characterization Report, May, 1996

5-8 NUREG/CR-5512, "Residual Radioactive Contamination From Decommissioning, Final Report," Volume 1, October 1992

5-9 Draft NUREG-1549, "Using Decision Methods for Dose Assessment to Comply With Radiological Criteria for License Termination," July 1998

5-10 Yu, C. F. et al., Manual for Implementing Residual Radioactivity Materials Guidelines Using RESRAD, Environmental Assessment Division, Argonne National Laboratory

5-11 Yu, C. F. et al., RESRAD-Build, A Computer Model for Analyzing the Radiological Doses Resulting from the Remediation and Occupancy of Buildings Contaminated with Radioactive Material. Environmental Assessment Division, Argonne National Laboratory

5-12 Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment"

5-13 SNEC Procedure, 1000-PLN-3000.05, "SNEC Facility Decommissioning Quality Assurance Plan"

5-14 SNEC Procedure, 6575-PLN-4542.01, "SNEC Radiation Protection Plan"

5-15 SNEC Procedure, 6575-ADM-4500.44, "Saxton Technical Evaluations Procedure"

5-16 SNEC Procedure, 6575-ADM-4500.04, "SNEC Records Retention Procedure"

5-17 SNEC Procedure, E900-ADM-4500.12, "Radiological Surveys: Requirements & Documentation Procedure"

5-18 NUREG-1507, "Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," June 1998

5-19 Electric Power Research Institute (EPRI) Document TR-109448, "Utility Use of Constant Scaling Factors", April 1999

5-20 SNEC Facility Historical Site Assessment Report, Draft January 2000

APPENDIX 5-1

ELEVATED MEASUREMENT COMPARISON (EMC)

The EMC, sometimes called a "hot spot test," is a simple comparison of measured values against a limit. There are two applications of this comparison in the final survey process. It is used when the sensitivity of the scanning technique is not sufficient to detect levels of residual radioactivity below the DCGL (i.e., where the MDC_{scan} is greater than the DCGL). In this application, the number of static measurements may need to be adjusted. Appendix 5-2 describes how this is done. The second application in this appendix, is when one or more scan or static measurement data points exceed the DCGL. The use of the EMC for measurements above the DCGL provides assurance that unusually large measurements receive the proper attention and that any area having the potential for significant dose contributions is identified. The EMC is intended to flag potential failures in the remediation process.

Locations, identified by scan or static measurements, with levels of residual radioactivity, which exceed the DCGL, are investigated (see Section 5.4.4). The size of the area where the elevated residual radioactivity exceeds the DCGL and the level of the residual radioactivity within the area are determined. The average level of residual radioactivity is then compared to the $DCGL_{EMC}$. If a background reference area is to be applied to the survey unit, the mean of the background reference area measurements may be added to the DCGL or the $DCGL_{EMC}$ to which the average level of residual radioactivity is compared.

The $DCGL_{EMC}$ is calculated using the following equation (NUREG-1575, Equation 8-1):

$$DCGL_{EMC} = Area\ Factor \times DCGL$$

The area factor is the multiple of the DCGL that is permitted in the area of elevated residual radioactivity without requiring remediation. The area factor is related to the size of the area over which the elevated residual radioactivity is distributed. That area, denoted A_{EMC}, is generally bordered by levels of residual radioactivity below the DCGL, and is determined by the investigation. The area factor is the ratio of dose per unit area or volume for the default surface area for the applicable dose modeling scenario to that generated using the area of elevated residual radioactivity, A_{EMC}. It is calculated based on the methodology given in chapter 8 of NUREG-1505 (Reference 5-6).

If the average level of the elevated residual radioactivity is less than the $DCGL_{EMC}$, there is reasonable assurance the site release criteria is still satisfied and the area does not require remediation. Radioactivity at the $DCGL_{EMC}$ distributed over the area A_{EMC} delivers the same calculated dose as does residual radioactivity at the DCGL distributed over the default surface area. If the $DCGL_{EMC}$ is exceeded, the area is remediated and resurveyed. Area factors for open land areas at the SNEC Facility are provided in Table 5-15. Surface area DCGLs supplied by the NRC as their default release criteria will not employ Area factors. Elevated surface contamination areas will be evaluated using a weighted averaging approach.

Table 5-15
AREA FACTORS FOR OPEN LAND AREAS
SNEC Area Factors (AF)

	DCGL	DCGL		DCGL		DCGL		DCGL		DCGL	
Isotope	**10000 m²**	**2500 m²**	**AF**	**400 m²**	**AF**	**100 m²**	**AF**	**25 m²**	**AF**	**1 m²**	**AF**
Am-241	1.5	1.5	1.0	1.5	1.0	3.0	2.0	6.1	4.1	47.0	31
C-14	3.7	8.4	2.3	50.7	13.7	197.0	53.2	398.0	107.6	3.3E+03	900
Cm-243	21.7	22.0	1.0	38.9	1.8	66.5	3.1	98.7	4.5	569.0	26
Cm-244	38.0	38.2	1.0	94.4	2.5	355.0	9.3	1.2E+03	31.3	6.2E+03	162
Co-60	2.5	2.6	1.0	2.9	1.2	3.2	1.3	4.2	1.7	26.0	10
Cs-134	3.6	4.1	1.1	4.8	1.3	5.5	1.5	7.1	2.0	43.0	12
Cs-137	8.5	9.8	1.2	12.4	1.5	15.0	1.8	19.6	2.3	119.0	14
Eu-152	6.3	6.5	1.0	6.9	1.1	7.5	1.2	9.7	1.5	58.7	9
Eu-154	5.7	5.9	1.0	6.3	1.1	6.9	1.2	8.8	1.5	54.4	10
Eu-155	234.0	242.0	1.0	253.0	1.1	274.0	1.2	345.0	1.5	1,875.0	8
Fe-55	4.2E+04	8.5E+04	2.0	2.7E+05	6.3	1.1E+06	25.0	4.2E+06	100.0	9.3E+07	2,182
H-3	258.0	295.0	1.1	7.6E+02	2.9	3.0E+03	11.8	1.2E+04	46.5	2.9E+05	1,120
Nb-94	4.5	4.7	1.1	5.0	1.1	5.5	1.2	7.0	1.6	42.2	9
Ni-59	4.6E+03	6.8E+03	1.5	1.9E+04	4.1	7.6E+04	16.4	3.0E+05	65.4	7.5E+06	1,617
Ni-63	1.7E+03	2.5E+03	1.5	6.9E+03	4.1	2.8E+04	16.4	1.1E+05	65.5	2.7E+06	1,619

NOTE: DCGL is in pCi/g

Table 5-15, AREA FACTORS FOR OPEN LAND AREAS (continued)
SNEC Area Factors (AF)

Isotope	DCGL 10000 m^2	DCGL 2500 m^2	AF	DCGL 400 m^2	AF	DCGL 100 m^2	AF	DCGL 25 m^2	AF	DCGL 1 m^2	AF
Pu-238	23.8	24.1	1.0	59.5	2.5	224.0	9.4	750.0	31.5	3.9E+03	164
Pu-239	21.5	21.7	1.0	53.8	2.5	203.0	9.4	679.0	31.6	3.6E+03	165
Pu-240	21.5	21.7	1.0	53.8	2.5	203.0	9.4	680.0	31.6	3.6E+03	166
Pu-241	45.0	45.0	1.0	47.0	1.0	94.0	2.1	181.0	4.0	1.8E+03	40
Pu-242	22.7	22.9	1.0	56.7	2.5	213.0	9.4	715.0	31.5	3.7E+03	164
Sb-125	17.9	18.6	1.0	19.5	1.1	21.3	1.2	27.2	1.5	161.0	9
Sr-90	1.6	1.8	1.1	4.6	2.9	18.2	11.4	70.9	44.6	1.5E+03	969
Tc-99	11.3	11.6	1.0	29.2	2.6	116.0	10.3	467.0	41.3	1.2E+04	1,027
U-234	18.0	18.0	1.0	25.0	1.4	57.0	3.2	123.0	6.8	1.3E+03	69
U-235	1.2	1.2	1.0	2.5	2.1	9.5	7.9	29.0	24.2	645.0	538
U-238	30.0	30.0	1.0	31.0	1.0	63.0	2.1	129.0	4.3	1.4E+03	46

NOTE: DCGL is in pCi/g

APPENDIX 5-2, STATISTICAL INFORMATION

The method described in NUREG-1575 (Reference 5-5) and NUREG-1505 (Reference 5-6) for determining the number of survey measurements necessary to assure a population set sufficient for statistical analysis is summarized here in the manner it is applied at the SNEC Facility. An effective survey design slightly overestimates both the number of survey measurements and the standard deviation to ensure adequate power of the statistical test. This ensures that a survey unit is not subjected to additional remediation simply because the final survey is not sensitive enough to detect that residual radioactivity is below the DCGL.

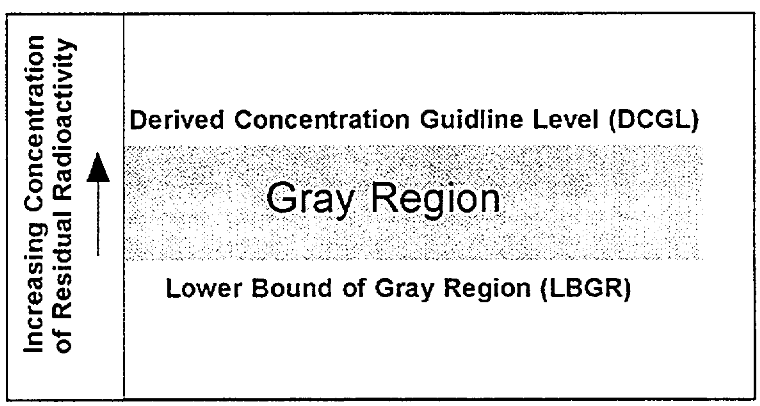
TERMS AND STATISTICAL PARAMETERS

A minimum number of measurements are needed to obtain sufficient statistical confidence that the conclusions drawn from the survey data are correct. Several terms and statistical parameters are described in this chapter that are used in determining the number of measurements needed to apply the statistical tests.

Lower Bound of Gray Region (LBGR)

The LBGR is the concentration to which the survey unit must be remediated in order to have an acceptable probability of passing the statistical test for meeting the site release criteria. It represents the lower bound of the area of uncertainty regarding the concentration of residual radioactivity in the survey unit. The DCGL represents the upper bound. The width of the gray region is equal to the difference between the DCGL and the LBGR, as illustrated in the Figure 5-3 below.

Figure 5-3
Gray Region Diagram



Initially, the LBGR is arbitrarily set at 0.5 times the DCGL. The LBGR is adjusted as needed to result in a relative shift of 1 to 3 (see NUREG-1575 and NUREG-1505 documents for full description of terms (Reference 5-5 and 5-6)).

The survey design goal is to achieve an LBGR between 0.5 and 1 times the DCGL. Since the LBGR serves as the remediation goal for decommissioning activities, generally the smaller the LBGR, the more rigorous are the requirements for dismantlement, decontamination, and post remediation surveys. As the LBGR approaches the value of the DCGL and the band of uncertainty narrows, the number of samples needed to demonstrate compliance with the site release criterion rises dramatically.

Standard Deviation (σ)

The standard deviation, denoted by σ, represents the spatial variability in the concentration of the residual radioactivity in the survey unit. The mean and standard deviation are calculated using standard equations.

An estimated value of σ may be calculated either from existing data or by taking limited preliminary measurements of the concentration of the residual radioactivity in the survey unit (sometimes called a pilot or scoping study). It is also acceptable to assume that σ equals 0.3 times the mean concentration. Alternatively, a reasonable estimate based on available site knowledge may be used.

The value selected as an estimate of σ for the survey unit may be based on data collected only from within that survey unit or from data collected from a much larger area of the site, since there may be some difficulty in determining which individual measurements from a preliminary survey may later represent a particular survey unit. The most practical solution may be to estimate σ for each area classification (Class 1, Class 2 and Class 3). If there are multiple types of materials within an area classification, additional estimates of σ may be required.

A separate estimate of σ may be obtained for every background reference area. If the σ in the background reference area is larger than the σ in the survey unit, the larger value may be used.

The survey design goal is to avoid an estimated σ that is overly optimistic or conservative. If the value is grossly underestimated, the number of measurements will be too few and may result in unnecessary remediation or re-survey. If the value is grossly overestimated, the number of measurements will be unnecessarily large.

Relative Shift (Δ/σ)

The number of measurements needed depends on a ratio involving the concentration to be measured relative to the variability in the concentration. The ratio is called the relative shift, denoted by Δ/σ. It is defined as (draft Regulatory Guide DG-4006, Equation 4) (Reference 5-4):

$$\Delta / \sigma = \frac{DCGL - LBGR}{\sigma}$$

where the variables have been previously defined.

The survey design goal is to achieve Δ/σ values between 1 and 3. The number of measurements needed rises dramatically when Δ/σ is smaller than one. Conversely, little is usually gained by making Δ/σ larger than about three. If Δ/σ is greater than three, the LBGR should be increased until the relative shift is equal to three.

DECISION ERRORS

The principal study question or statement is, **"are the levels of residual radioactivity in all survey units below applicable release criterion and can the site be released?"** Results from surveys and other environmental testing will be used to determine the answer to this question.

A decision error is the probability of making an error in the decision on a survey unit, either passing a survey unit that should fail or failing a survey unit that should pass. The first decision error, passing a survey unit that should fail, is referred to as a **false positive** or TYPE I decision error. The probability of making this error is denoted by α. Setting high value for α results in a higher risk of passing a survey unit that should fail. Setting low value of α lowers the risk of passing a survey unit that should fail.

The second decision error, failing a survey unit that should pass, is referred to as a **false negative** or TYPE II decision error and is denoted by β. Selecting a high value for β results in a higher risk of failing a survey unit that should pass and subjecting it to further investigation. Selecting a low value for β lowers the risk and minimizes these investigations. The cost of setting a low value for either α or β is a higher value for the other or an increased number of measurements to demonstrate compliance with the release criteria.

When using the statistical testing procedures as described in NUREG-1575 and NUREG-1505 (Reference 5-5 and 5-6) documents i.e., the **Sign Test** or the **Wilcoxon Rank Sum** (WRS), larger decision errors may be unavoidable when encountering difficult or adverse conditions. This is particularly true when trying to measure residual radioactivity concentrations close to the variability in the concentration of those materials in natural background. In order to avoid an unreasonable number of samples when Δ/σ is very small, larger values of α may be considered as shown in Table 5-16 below.

Table 5-16
Acceptable Decision Error α as A Function of DCGL

DCGL/σ	α
>3	0.05
1.2 to 3	0.10
0.6 to 1.2	0.25
<0.6	0.30

Table 5-16 values are based on the assumption that the LBGR should not have to be set to less than 0.5 times the DCGL, and that if α is allowed to increase, β will also be allowed to increase.

There are no constraints on the value of β. However, decreasing β increases the number of samples needed, making vary small values of β unattractive.

The survey design objective is then to establish the value of α equal to or less than 0.05 and to minimize the value of β while maintaining the minimum number of measurements at an optimal number.

NUMBER OF MEASUREMENTS

The statistical parameters α, β and Δ/σ are used to estimate the number of measurements that will produce the desired values of α and β. The number of measurements are based on the statistical test which is applied to the survey unit. The two statistical tests used in the final survey data analysis process are the Sign Test and the Wilcoxon Rank Sum (WRS) Test. The criteria for using these testing procedures are summarized in Table 5-17.

Table 5-17
Statistical Tests And Criteria For Their Use

Statistical Test	Criteria for Use
WRS Test	Radionuclide of concern appears in background, or measurements are used that are not radionuclide-specific.
Sign Test	Radionuclide of concern is not present in background and radionuclide-specific measurements are made, or radionuclides are present in background at such small fractions of the DCGL as to be considered insignificant.

NOTE: For specific information on statistical testing procedures, see Table 2.3 of NUREG-1505 (Reference 5-6).

The number of measurements is determined by rounding up the number calculated using the appropriate statistical test and adding 20% more measurements. Additional measurements are added to protect against the possibility of lost or unusable data.

Wilcoxon Rank Sum (WRS) Test
The two-sample WRS test is used when the radionuclide of concern appears in background or if measurements are used that are not radionuclide specific. Because gross activity measurements are not radionuclide specific, they must be performed for both the survey unit(s) being evaluated by the WRS test and for corresponding reference area(s). The number of measurements needed for the WRS test is determined from the following equation (draft Regulatory Guide DG-4006, Equation 5) (Reference 5-4):

$$n = (1/2)\frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{(3)(P_r - 0.5)^2}$$

Where:

n	=	number of measurements in survey unit
$Z_{1-\alpha}$	=	percentile represented by decision error α (NUREG-1575, Table 5.2)
$Z_{1-\beta}$	=	percentile represented by decision error β (NUREG-1575, Table 5.2)
P_r	=	probability that a random measurement from survey unit exceeds random measurement from background reference area by less than DCGL when survey unit median is equal to LBGR concentration above background (NUREG-1575, Table 5.1)
½	=	factor included in Equation 5-1 of NUREG-1575 to define *n* as the number of measurements in a survey unit

Additional n measurements are also needed in the background reference area.

Sign Test
The one sample Sign test is used if the radionuclide of concern is not present in background and radionuclide specific measurements are made. The Sign test may also be used if one or more radionuclides are present in background at such small fractions of the DCGL as to be considered insignificant. In this case, background concentrations of the radionuclides are

included with the residual radioactivity (in other words, the entire amount is attributed to facility operations). Thus, the total concentration of the radionuclides are compared to the release criteria. This option is only used if it is expected that ignoring the background concentration will not affect the outcome of the statistical tests. The advantage of ignoring a small background concentration is that no background reference area is needed, which simplifies the final survey considerably.

Since SNEC Facility radionuclides outside the SNEC CV are largely composed of Cs-137 and Co-60, which are relatively easy to measure, the Sign test is the most likely statistical testing procedure to be employed. Inclusion of Cs-137 and Co-60 background values into the DCGLs should not significantly effect meeting site release criteria.

The number of measurements needed for the Sign test is determined from the following equation (draft Regulatory Guide DG-4006, Equation 6) (Reference 5-4):

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(\text{Sign } \rho - 0.5)^2}$$

Where Sign ρ is the estimated probability that random measurement for a survey unit is less than the DCGL when the survey unit median concentration is actually at the LBGR, from Table 5.4 of NUREG-1575 (Reference 5-5). All other variables have been previously defined.

Elevated Measurement Comparison (EMC)

The EMC is used to determine if additional measurements may be needed when the level of residual radioactivity that can be detected by scanning (MDC_{scan}, see Section 5.5.2.5) is larger than the DCGL. The WRS and Sign tests evaluate whether or not the residual radioactivity exceeds the DCGL for contamination that is approximately uniform across the survey unit. These tests may not successfully detect small areas of elevated contamination. Instead, systematic measurements, in conjunction with surface scanning, are used to obtain adequate assurance that small areas of elevated radioactivity will meet the DCGL. When the MDC_{scan} exceeds the DCGL, the EMC provides the reasonable level of assurance that any small areas of elevated residual radioactivity that could be significant are not missed during the final survey.

The number of measurements needed to detect an elevated concentration, n_{EMC}, in a survey unit area, A, is (draft Regulatory Guide DG-4006, Equation 8) (Reference 5-4):

$$n_{EMC} = \frac{A}{A_{EMC}}$$

The A_{EMC} is the area over which elevated residual radioactivity (greater than the DCGL) may be distributed without requiring remediation. The A_{EMC} corresponds to an area factor. The area factor is the multiple of the DCGL that is permitted in the area of elevated concentration. It is equal to the ratio of the MDC_{scan} to the DCGL (draft Regulatory Guide DG-4006, Equation 7) (Reference 5-4):

$$Area\ Factor = \frac{MDC_{scan}}{DCGL}$$

Once the area factor is determined, the corresponding value for A_{EMC} can be obtained (see Appendix 5-1) and the value of n_{EMC} calculated.

If n_{EMC} is larger than n, additional samples (up to a total in the survey unit of as many as n_{EMC}) may be needed to demonstrate that areas of elevated residual radioactivity meet the site release criteria. In cases where n_{EMC} is larger than n, the site characterization should be considered and, based on what is known about the site, it may be possible to estimate a concentration that is unlikely to be exceeded. This maximum concentration may be converted into an area factor (multiple of the DCGL), and then the corresponding A_{EMC} value obtained (see Appendix 5-1) and used in the above equation. Similarly, based on knowledge of the site it may be possible to estimate the smallest area likely to have elevated levels of residual radioactivity. If this is so, that area can be used in the above equation. Likewise, knowledge of how the residual radioactivity would be likely to spread or diffuse could determine an area to be used in this equation. It should be noted that extensive experience with sampling suggests that at measurement densities of 1 measurement per m^2 in buildings and 1 measurement per 25 m^2 outdoors rarely need to be exceeded.

The EMC is only applied to Class 1 survey units, since areas of elevated residual radioactivity. should not be present in Class 2 or Class 3 survey units.

Optimizing the Number of Measurements

Once the acceptable design values have been established, survey design constraints may be changed to evaluate how these changes affect the number of measurements for several basic measurement designs. The survey design constraints are:

- Limits on the decision error probabilities α and β;
- Width of the band of uncertainty or gray region (by adjusting the LBGR); and
- Survey unit boundaries (it may be possible to reduce the number of measurements by changing or eliminating survey units that may require different decisions).

The process may be iterative in that the initial values selected must be modified to allow dependent variables to fall within the survey design constraints.

Selecting a Minimum Number of Measurements

As discussed above, the MARSSIM process incorporates design constraints that ensure that an adequate number of sample measurements are taken per survey unit. However, to simplify the final survey process and to ensure conservatism without an associated unreasonable expenditure of resources, a minimum number of 30 sample measurements per survey unit may be collected for survey units less than 10 m^2 whenever possible.

Grid Size Determination and Design

The sample size, determined in previous sections, provides the necessary input on setting sampling locations and survey patterns. The method is outlined in section 5.5.2.4 of NUREG-1575 (Reference 5-5). The reference grid system on which sampling patterns are superimposed, is a basic alpha numeric x-y layout unless otherwise determined to be impractical because of actual field conditions. Table 5-16 presents a summarized presentation of typical survey design parameters.

APPENDIX 5-3

BACKGROUND REFERENCE AREAS

Background reference areas are used if: (1) the residual radioactivity contains a radionuclide that occurs in background, or (2) the measurements to be made are not radionuclide-specific. Background reference areas are not needed when radionuclide-specific measurements are used to measure concentrations of a radionuclide that is not present in background. They also are not needed when one or more radionuclides are present in background at such small fractions of the DCGL as to be considered insignificant. Surveys are conducted in one or more background reference areas to determine background levels for comparison with the conditions determined in specific survey units.

SELECTION

Background reference areas are selected which have similar physical, chemical, radiological, and biological characteristics as the survey unit being evaluated. They are usually selected from non-impacted areas, but are not limited to natural areas undisturbed by human activities. Generally, background reference areas are not part of the survey unit being evaluated. However, where necessary, they may be associated with the survey unit being evaluated, but cannot be potentially contaminated by site activities. For example, background measurements may be taken from core samples of concrete, pavement, or other types of surface materials. Occasionally, the survey unit itself may serve as the background reference area when a surrogate radionuclide in the survey unit can be used to determine the background. For example, it may be possible to use the measured alpha- or beta-emitting fraction of an established radionuclide distribution in embedded piping to calculate a net activity and subtract it from a gross activity to determine background levels.

For materials present on-site, either in buildings or as non-soil materials present in outdoor survey units (e.g., concrete, brick, drywall, fly ash, petroleum product wastes, etc.), background reference areas of non-impacted materials that are as similar as possible to the materials on-site are used. Sometimes such materials are not available. In those situations, a good faith effort is made to find the most similar materials readily available or use appropriate published estimates.

Each background reference area should have an area at least as large as the survey unit, if practical, in order to include the full potential spatial variability in background concentrations.

MARKEDLY DIFFERENT SURVEY UNIT MATERIAL BACKGROUNDS

Survey units may sometimes contain a variety of materials with markedly different backgrounds. An example might be a room with drywall walls, concrete floor, glass windows, metal doors, wood trim, and plastic fixtures. A separate survey unit is not made for each material. If one material is predominant or if there is not too great a variation in background among materials, a background reference area comprised of the predominant material may be appropriate. For example, a room may be mostly concrete but with some metal beams, and the residual radioactivity may be mostly on the concrete. In this situation where the presence of concrete predominates, the background for concrete is used for the room. If a measurement location on the random-start grid falls on the metal beam, the measurement location may be moved to be on the nearest piece of concrete. Alternately, the measurement could be taken on the metal, but this is then noted on the survey record so that an unusual reading can be explained.

When there are different materials with substantially different backgrounds in a survey unit, a non-impacted room with roughly the same mix of materials may be used as a background reference area. Alternately, measured backgrounds for the different materials or for groups of similar materials may be used. In this case, it is acceptable to perform the Sign test on the difference between the paired measurements from the survey unit and from the appropriate background material.

MARKEDLY DIFFERENT BACKGROUND REFERENCE AREAS

If significant differences in backgrounds among background reference areas are found, a value of three times the standard deviation of the mean between the background reference areas is added to the mean background for all background reference areas to define a background concentration. The value of three times the standard deviation of the mean is chosen to minimize the likelihood that a survey unit that contains only background would fail the statistical test for release. The WRS test is then used to test whether the survey unit meets the radiological criteria for license termination.

BACKGROUND LEVEL DETERMINATIONS

In general, background levels will be established (as needed) for each type of instrument used for total surface contamination measurements, removable contamination measurements, and gamma exposure rate measurements. In addition, backgrounds will be determined for specialized detectors and detector systems on an as needed basis. These background measurements may include large area detector backgrounds for floor monitoring instrumentation, background determinations for detectors used for surveying piping interiors and background values for gamma-ray spectroscopy systems.

For soil and sediment samples, background levels will be determined for man-made radionuclides not resulting from plant activities.

The objectives of background determinations for the SNEC Facility final status survey measurements will be to:

- Establish reference background values for each type of detector system used in the SNEC Facility FSS survey.
- Assess the variability in background responses for principal detectors under different applications and conditions of use.
- Determine the need for correction factors or special measurements to establish the background for final status survey measurements in specific locations.
- Account for man-made radioactivity not resulting from plant operations.
- Measure reference values at different directions and distances from the center of the SNEC Facility outward, including down wind directions.

Background determinations will be performed in accordance with approved procedures and survey request work package guidance. Background values will be evaluated in accordance with NUREG-1575 (Reference 5-5) guidance. Methods used to determine background values for each type of final status survey measurement method are summarized below.

Background measurements will be performed on surfaces unaffected by licensed activities. The principal criteria for selection of measurement locations for building surfaces will be the location's similarity to SNEC Facility construction and freedom from radioactivity attributable to SNEC Facility operations. Instrumentation will be of the same type to be used for the SNEC Facility FSS process.

Soil and sediment samples will be collected from areas unaffected by licensed operations in order to establish the background levels of man-made radionuclides not resulting from plant operations. The background samples will be collected at locations similar to their respective on-site sampling locations whenever possible. Gamma-ray spectroscopy will be used to determine individual concentrations of radionuclides. Additionally, laboratory analysis for other non-gamma emitting radionuclides will be performed as necessary.

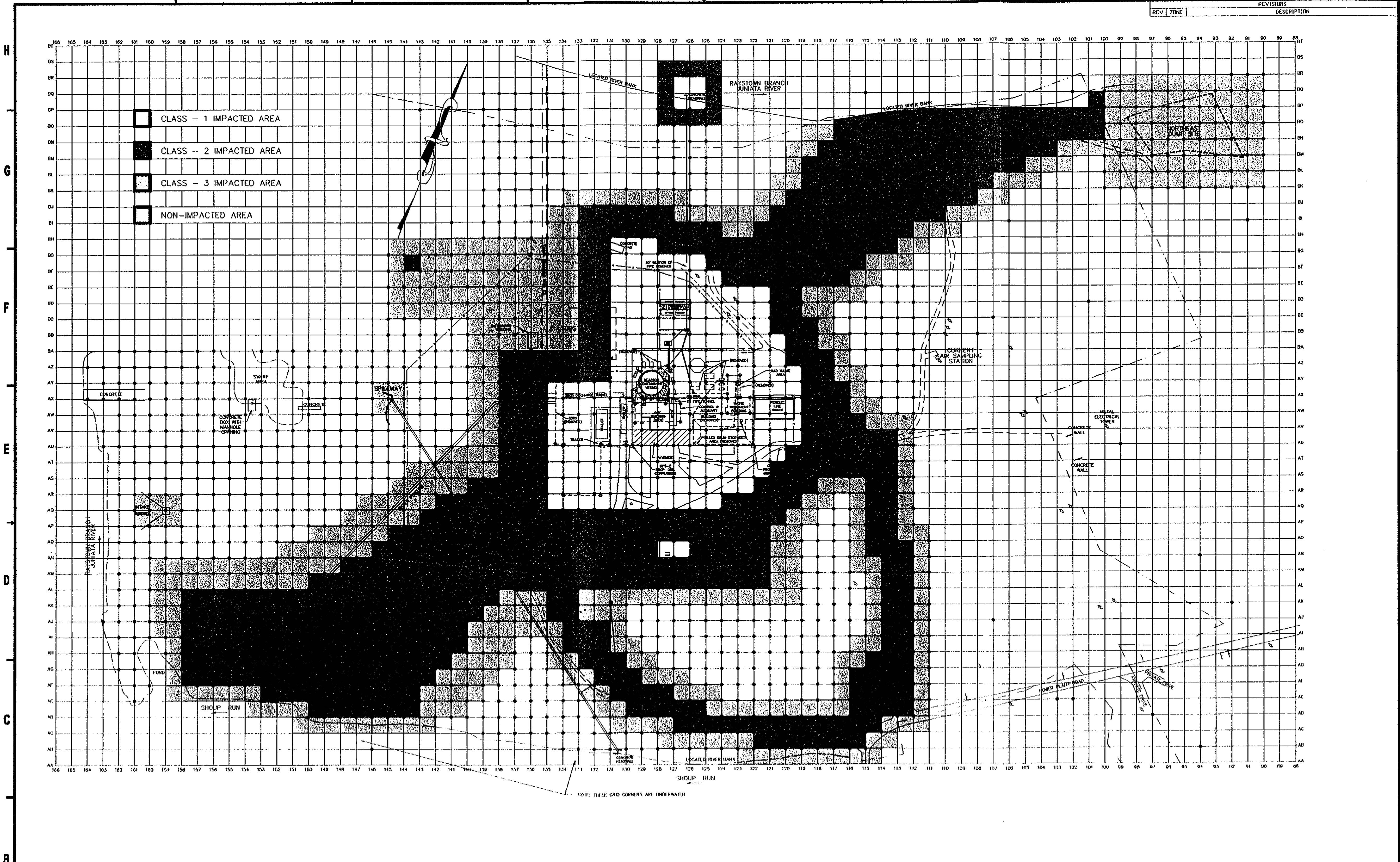
A pressurized ion chamber (PIC) will be used to establish the background gamma exposure rate for the site. The pressurized ion chamber will be used as the reference instrument for establishing gamma-ray exposure rate background and the true μR/h equivalent response of portable survey meters. Additionally, a Micro-Rem[a] Meter (or equivalent) will be used to evaluate site dose rates. Measurements obtained with this instrument will be compared to PIC measurements at selected locations. The Micro-Rem Meter will then be used for the bulk of the final status survey gamma-ray exposure rate measurements at the site.

Compiled background information will be used as the reference areas for most survey units as necessary. Where actual background conditions are shown to vary significantly, area-specific background values will be used whenever possible.

Alternatively, *in-situ* gamma spectroscopy may be used to identify those components of the background gamma exposure rate that are possibly due to plant contamination.

Background values of direct beta-gamma measurement instruments are affected by conditions in the immediate vicinity of the detector. Significant variations from background reference values may be observed. These variations are caused by the natural radioactivity composition in surrounding materials and by shielding effects in some cases. Consequently, background measurements for special conditions will be compiled for use in calculating values (net dpm/100 cm^2, etc.) to reduce the bias in survey unit population statistics. Special condition backgrounds may be compiled for poured concrete, steel and iron, aluminum and any other material as deemed appropriate.

[a] MicroRem Meter is product of the Bicron Instrument Company.



Cad File Name : SNECRM-020_S1_R0

FIGURE 5–1

1 GRID BLOCK = 10 SQUARE METERS

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GPU NUCLEAR

SNEC FACILITY
SITE AREA GRID MAP
GRADE ELEV. 812'

J. MARTIN 01/17/00

DWG. NO. SNECRM-020 SH. 1 REV. 0

INTERFACING CONCURRENCE

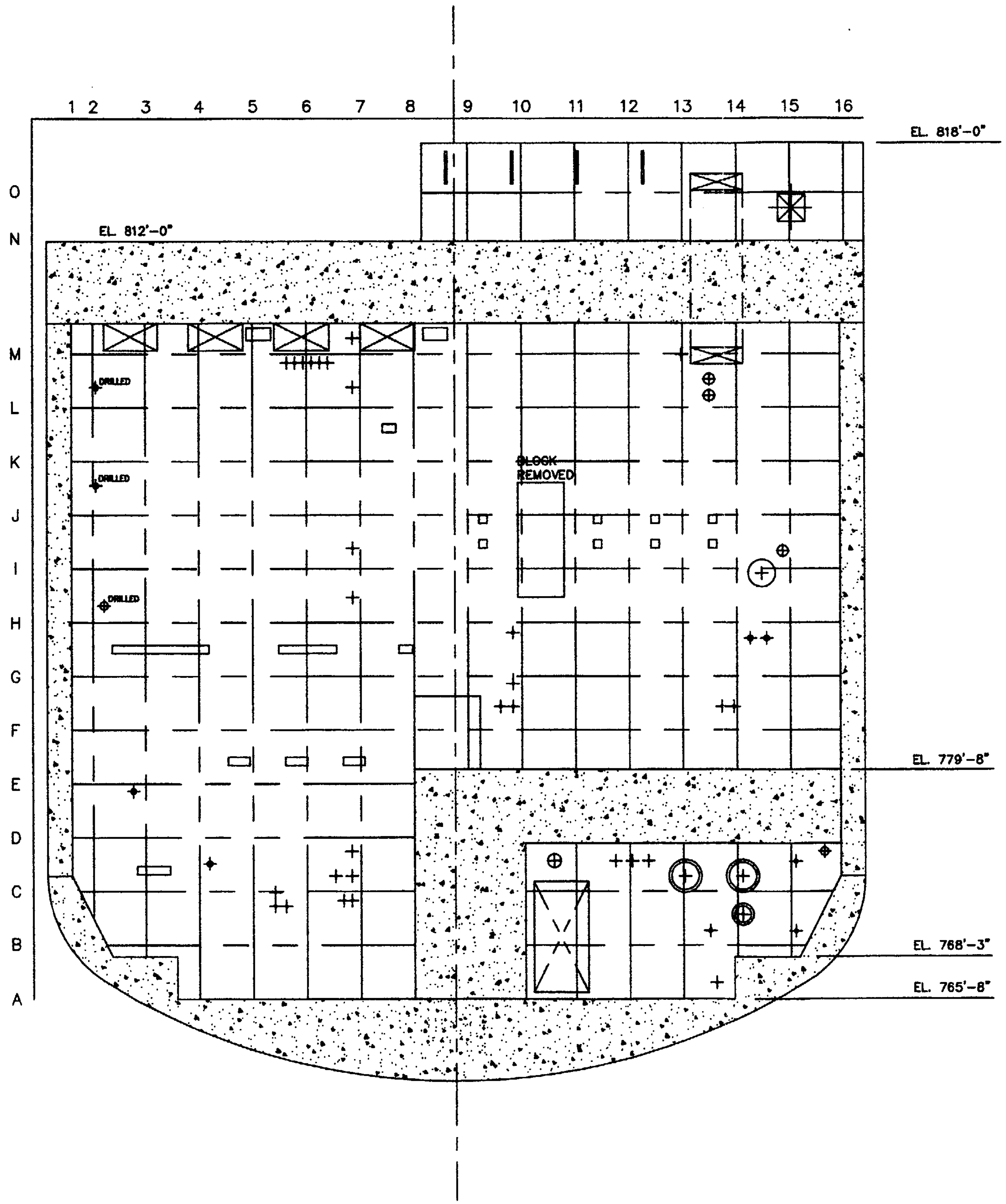
REVISIONS: REV | ZONE | DESCRIPTION

REFERENCES: NO. | DWG. NO. | TITLE

DWG.NO. SNECRM-004 SH. N/A

REVISIONS

REV	ZONE	DESCRIPTION



ELEVATION OF EAST-WEST WALL(LOOKING SOUTH)

NO.	DWG. NO.	TITLE
REFERENCES		

Cad File Name : SNECRM-004_R0

FIGURE 5-4
EXAMPLE OF STRUCTURAL GRIDING
(1 GRID = 1 sq. meter)

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GPU NUCLEAR

R. SCHAIBLE 04/27/99
R.A.KOCH 01/18/00

SNEC FACILITY
RADIATION SURVEY MAP
ELEVATION OF EAST-WEST WALL (LOOKING SOUTH)

SNEC | DWG. NO. SNECRM-004 | SH. N/A | REV. 0

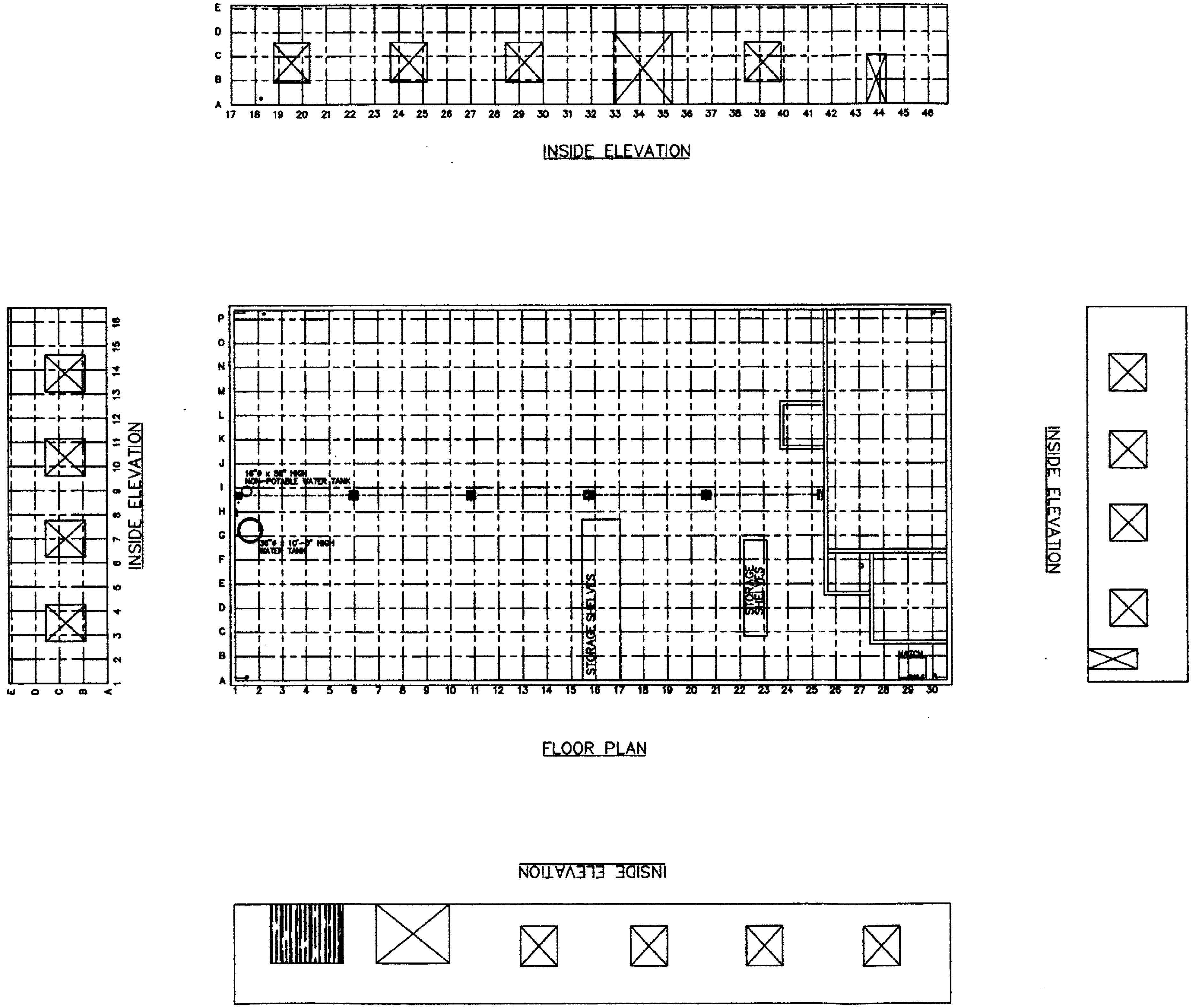
SCALE: 1/4"=1'-0"

INTERFACING CONCURRENCE

BA NO.

DWG.NO. SNECRM-013 SH. 1

REVISIONS		
REV	ZONE	DESCRIPTION



NOTES:

1. SEE SNECRM-013 SH. 3 FOR ELEVATIONS DENOTED BY ▸.

Cad File Name : SNECRM-013_S1_R0

FIGURE 5-5
EXAMPLE OF STRUCTURAL GRIDING
(1 GRID = 1 sq. meter)

THIS IS A COMPUTER GENERATED DRAWING DO NOT REVISE IT MANUALLY

GPU NUCLEAR

R. SCHAIBLE 07/15/99
R.A.KOCH 01/17/00

SNEC FACILITY
PENELEC WAREHOUSE
FLOOR PLAN AND EXTERIOR WALL ELEVATIONS

TMI-1 DWG. NO. SNECRM-013 SH. 1 REV. 0
SCALE: 1/8"=1'-0"

INTERFACING CONCURRENCE
BA NO.

NO.	DWG. NO.	TITLE
REFERENCES		

6.0 COMPLIANCE WITH THE RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION

6.1 DISCUSSION

The SNEC decommissioning objective is to release the site for unrestricted use per 10 CFR 50 and Subpart E of 10 CFR Part 20.1402. This section of the SNEC LTP will briefly discuss the methods and assumptions to demonstrate that the total effective dose equivalent (TEDE) from residual radioactivity is less than 25 mrem per year (0.25 mSv) to an average member of the critical group. Draft NUREG-1549 "Using Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination" has been used to determine the appropriate methodologies for meeting site release criteria. These methodologies are also described in Chapter 5 of the SNEC License Termination Plan (LTP).

6.2 DOSE MODELING

The distribution and variability of radioactivity in the environment, and dose rates from natural sources, provide the framework for developing models in determining compliance with criteria for site cleanup and restoration. The recommended level of 25 mrem TEDE in any year is of approximately the same magnitude as the geographic variability of doses from natural background. It is comparable to the difference in annual doses likely to be experienced by a person who moves from one location to another. The TEDE, adopted by the NRC (1991), is the sum over all tissues of the committed dose equivalent from penetrating external radiation and from intakes of radioactive materials. For site cleanup and restoration standards the dose limit is applied to all site-specific sources, including natural radionuclides whose concentrations have been enhanced by site activities.

Dose modeling is used to estimate the TEDE to an average member of the critical group from residual radioactivity. The critical group means the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances. A framework has been developed to use screening approaches to meet the release criteria followed by the use of appropriate ALARA principles.

Data and information related to types and amounts of radioactive material on the SNEC site have been documented in the Site Characterization Plan. Prior to site release consideration, all radioactive waste will have been disposed, sources will have been transferred to another licensee, all buildings and open land areas remediated, and minor amounts of contamination will have been detected and documented via surveys.

Dose models are based on two types of conceptualizations, i.e. two-dimensional surface area geometry and a three-dimensional volumetric geometry. Key input parameters are discussed below. Results of the computer runs and supporting information are contained in Appendix 6-1.

6.2.1 Two-Dimensional Model (D and D)

For the two-dimensional surface area model the building occupancy scenario is used as the best representation. This model applies to the SNEC Containment Vessel (CV) for purposes of final remediation, NRC release survey verification and subsequent demolition. Since the CV will be demolished the building renovation scenario is not representative and is the least conservative. Input parameters and DCGLs for the building occupancy scenario model have been identified in Appendix 6-1 and Chapter 5 of the SNEC LTP. Other buildings (garages and support structures) left behind will be surveyed, remediated, if contaminated, and released using the building occupancy scenario. D and D Version 1.0 has been used as the preferred modeling software for the building occupancy scenario. Surface contamination DCGLs were developed through the use of the D and D computer code using the standard default parameters. The results from the D and D runs for each of the 26 site related radionuclides are in units of mrem TEDE per dpm/100 cm^2. These values were then scaled to the 25 mrem TEDE limit to determine the total surface contamination limits (DCGLs) in dpm/100 cm^2.

6.2.2 Volumetric Model (RESRAD)

For the volumetric geometry, i.e. open land areas, RESRAD, Version 5.82 has been used to determine the appropriate screening guidelines. Input parameters, pathways and derived soil DCGLs for open land areas, including area factors, are described in Appendix 6-1 and Chapter 5 of the SNEC LTP.

6.2.2.1 Selected Scenario

The screening guidelines are based on the resident farmer scenario. Although other scenarios were considered (e.g. urban construction and recreation) the resident farmer scenario was selected, since it was the most conservative. For the urban construction scenario reuse of subsurface building structures is not considered practical due to the area being in a flood plain and the existence of a high groundwater level.

6.2.2.2 Contaminated Zone Description

The soil guideline (DCGL) is defined as the radiological concentration in soil that is acceptable if the site is to be used without radiological restrictions. The SNEC model is based on a 10,000 m^2 contaminated zone grid, one meter thick and no cover material. For areas less than 10,000 m^2, area factors have been developed and listed in Chapter 5, Table 5-15. Soil is defined as unconsolidated earth materials, including concrete and other structural debris that might be present.

6.2.2.3 Selected Pathways

RESRAD uses a pathway analysis method in which the relation between radionuclide concentration in soil and dose to a member of a critical population group is expressed as a pathway sum, which is the sum of products of "pathway factors". Pathway factors correspond to pathway segments connecting compartments in the environment between which radionuclides can be transported or radiation emitted.

For the resident farmer scenario eight environmental pathways are applicable:

- Direct exposure
- Inhalation of particulates
- Ingestion of plant foods
- Ingestion of meat
- Ingestion of milk
- Ingestion of aquatic foods
- Drinking water
- Ingestion of soil

6.2.2.4 Dose Calculation Times (years)

Radiation doses, health risks, soil guidelines and media concentrations are calculated over user-specified time intervals. The source is adjusted over time to account for radioactive decay and ingrowth, leaching, erosion and mixing. Although the regulatory recommendation is to use a 1000-year period, a 10,000-year period (more conservative assumption) was used to account for in-growth and decay of specific long lived transuranic nuclides (Am-241, Pu-241, and U-234/235/238) that have a potential impact on the ground water pathway dose. RESRAD uses a one-dimensional groundwater model that accounts for different transport of parent and daughter radionuclides with different distribution coefficients (K_d).

6.2.2.5 Radionuclide Selection

Twenty-six (26) radionuclides (see Chapter 5, Table 5-1) have been identified to be present on the SNEC site with Cs-137 being predominant. These radionuclides have been loaded into both RESRAD and DandD software codes to determine applicable DCGLs for each respective model.

6.2.2.6 Site Geometry and Hydrology

Site-specific geometry (cross-section view) and hydrology data was used for input into the RESRAD code. This input data was either based on studies by a contracted geology firm (Haley & Aldrich) or default parameters contained within the RESRAD code, whichever was more conservative.

6.2.2.7 Inhalation and Ingestion Inputs

RESRAD defaults were used for inhalation inputs. These default values were the most conservative in comparison against other references. Ingestion rates were taken from Regulatory Guide 1.109, Table E-5, based on the wide acceptance and use within the industry for conduct of radiological environmental monitoring programs. These ingestion values were more conservative than the RESRAD defaults.

6.3 DOSE ASSESSMENT

The DandD and RESRAD codes were run using the above information to determine compliance with 10CFR20.1402. Using the DCGLs derived from these runs, and listed in Chapter 5, Table 5-1 of the SNEC LTP, will ensure compliance. Detailed values from these computer runs are contained in Appendix 6-1. Where site specific information was not available the most conservative input parameters were used, based on professional judgement. The dose assessment using these values indicates that the dose will be at or below 25 mrem/year TEDE and 4 mrem/year groundwater dose. Therefore, there is a high confidence that additional refinement of the source terms and modeling assumptions are unnecessary and the site can be released for unrestricted use.

6.4 ALARA ANALYSIS

Subpart E of 10 CFR 20 contains specific requirements for a demonstration that residual radioactivity has been reduced to a level that is ALARA (10 CFR 20.1402). Section 3 of Draft Regulatory Guide DG-4006 (Reference 6-5) describes a method for determining whether levels of residual radioactivity are ALARA. The method presented is used to estimate when a remedial action provides a net benefit of dose reduction when compared to the cost of performing that action. It also provides example calculations of various remedial actions, some of which can be applied at the SNEC Facility to reach the DCGLs for surface and soil contamination. As stated in Chapter 4, comprehensive remediation will be performed at the SNEC Facility Site. DG-4006 states that, the ALARA requirement is met by performing the remediated action where appropriate. The guide further states that if a remedial action is performed there is no need to evaluate whether it is necessary to meet the ALARA requirement.

Our remediation goal for all structure surfaces is to reduce contamination levels to or below the screening levels established by using the default parameters in D and D, (Reference 6-5). These values were determined using highly conservative parameters to ensure that any residual radioactivity remaining at the site would not result in any significant threat to public health and safety. Therefore, further demonstration need not be performed. Thus, based on these remediation levels and the sample calculations in DG-4006, future action to further reduce activity such as bulk concrete removal and disposal is not justified.

In the case of soil contamination, SNEC Facility remediation plans are to remove residual contamination to below those levels established in Chapter 5. As stated in DG-4006, (Reference 6-5), for sites that select the unrestricted release criteria, a mathematical ALARA analysis for removing residual radioactivity from soil at these sites is not necessary, largely because of the high costs of waste disposal. Thus in the case of the SNEC Facility, no further ALARA evaluation is required after the removal of soil contamination to reach the DCGLs.

6.5 REFERENCES

6-1 Code of Federal regulations, Title 10, Part 1402, "Radiological Criteria for Unrestricted Use."

6-2 Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," January 1999.

6-3 RESRAD, Version 5.82, United States Department of Energy and Argonne National Laboratory, April 1998.

6-4 D and D, Version 3.1 for Windows, United States Nuclear Regulatory Commission and Sandia National Laboratory, July 1996.

6-5 Regulatory Guide DG-4006, "Demonstrating Compliance with the Radiological Criteria for License Termination," August 1998.

APPENDIX 6.1

SAXTON NUCLEAR EXPERIMENTAL CORPORATION FACILITY

DERIVED CONCENTRATION GUIDELINE LIMIT (DCGL) CALCULATION

GPU NUCLEAR

Calculation Sheet

Subject	**Calc. No.**	**Rev. No.**	**Sheet No.**
Determine Derived Concentration Guideline Level (DCGL) for SNEC	6575-99-046	1	1 of ~~12~~ 35

Originator	**Date**	**Reviewed by**	**Date**
Pat Donnachie	12/16/99	Art Paynter	~~12/16/99~~

1). Problem Statement:

To determine the DCGL for Saxton Nuclear Experimental Corporation (SNEC) Facility release criteria for structural surfaces, sediment and soil based on 25 mRem/year Total Effective Dose Equivalent (TEDE) and 4 mRem/year drinking water.

2). Results Summary:

The results of the applicable computer runs, input data and supporting information are attached. See Section 5, Data and Calculations for specific table and appendices.

3). References:

1. RESRAD Version 5.82 - Used to calculate open land DCGLs.
2. DandD Version 1.0 - Used to calculate surface area DCGLs.
3. Haley & Aldrich letter dated March 31, 1999, "RESRAD Hydrological Input Summary Saxton Nuclear Experimental Corporation."
4. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I", Revision 1, October 1977, Table E-5.
5. J.E. Till and H.R. Meyer, NUREG/CR 3332, "Radiological Assessment, A Textbook on Environmental Dose Analysis," USNRC, September 1983, Table 3.2, pg. 3-37.
6. Federal Register: Wednesday, November 18, 1998 (Volume 63, Number 222) Notices, pg. 64133, Table 1 - "Acceptable License Termination Screening Values of Common Radionuclides for Building Surface Contamination."
7. Federal Register: December 7, 1999 (Volume 64, Number 234) Notice, pp. 68395-68396, Table 3.1.

4). Assumptions:

For calculation of the open land DCGLs, which include soil and sediment, assumptions are as stated in RESRAD run file Site1.Rad and the attached hard copy. This run uses a contaminated area zone of 10,000 m^2 and a contaminated thickness of one meter. Other input parameters are based on site-specific knowledge determined by empirical testing or default inputs. as conservatively determined by the code or from best technical literature sources (see references above). Hydrological inputs were taken from Reference 3 above. Five additional runs were made changing only the size of the contaminated area zone (2500, 400, 100, 25, & 1 m^2 respectively) with dimension adjustments to the length parallel to aquifer flow input parameter. Results of these calculations were compared to the 10,000 m^2 DCGLs in a

Microsoft EXCEL spreadsheet, ratios determined and area factors calculated for each nuclide. The graphics package from RESRAD was used to determine minimum DCGLs for nuclides (Am-241, Pu-241, and U-234/235/238) which limit the site dose for the drinking water pathway.

For calculation of building surface area DCGLs the DandD code was used to determine values. These values were based on using the building occupancy scenario and are in agreement with Reference 6. A hard copy of the DandD run is attached.

5). Data and Calculations:

Hard copies of DandD and RESRAD computer calculations for DCGL determination are attached. The results from the DandD runs for each individual radionuclide are in units of mrem TEDE per dpm/100 cm^2. These values were then scaled to **25** mrem TEDE limit to determine the total surface contamination limit in dpm/100 cm^2. DCGL values for surface and open land areas are listed in Table 1. DCGL Area factors are listed in Table 2. Applicable computer files are listed in Table 2 for the RESRAD runs and also provided on disk. Other reference documents are provided in the attached appendices.

Table 1 - SNEC Screening DCGLs
Table 2 - SNEC Area Factors for Open Land Areas

Appendix A - RESRAD Run for Open Land Areas (Site.Rad file)
Appendix B - DandD Run for Surface Areas
Appendix C - Haley & Aldrich Recommendations for RESRAD Hydrology Inputs
Appendix D - RESRAD Summary Runs for Development of Area Factors
(Grid Areas = 2500 m^2, 400m^2, 100 m^2, 25 m^2, and 1 m^2)

GPU NUCLEAR

Calculation Sheet

Subject	Calc. No.	Rev. No.	Sheet No.
Determine Derived Concentration Guideline Level (DCGL) for SNEC	6575-99-046	1	1 of 1

Originator	Date	Reviewed by	Date
Pat Donnachie	12/16/99	Art Paynter	12/16/99

Table 1

SNEC Screening DCGL's

Radionuclide	Surface Area (dpm/cm^2)	Open Land Areas (pCi/g)
Am-241	2.7E+01	1.5E-00*
C-14	3.7E+06	3.7E-00
Cm-243	3.9E+01	2.2E+01
Cm-244	4.9E+01	3.8E+01
Co-60	7.0E+03	2.5E-00
Cs-134	1.3E+04	3.6E-00
Cs-137	2.8E+04	8.5E-00
Eu-152	1.3E+04	6.3E-00
Eu-154	1.1E+04	5.7E-00
Eu-155	1.6E+05	2.3E+02
Fe-55	4.5E+06	4.2E+04
H-3	1.2E+08	2.6E+02
Nb-94	8.3E+03	4.5E-00
Ni-59	4.2E+06	4.6E+03
Ni-63	1.8E+06	1.7E+03
Pu-238	3.0E+01	2.4E+01
Pu-239	2.8E+01	2.2E+01
Pu-240	2.8E+01	2.2E+01
Pu-241	8.8E+02	4.5E+01*
Pu-242	2.9E+01	2.3E+01
Sb-125	4.4E+04	1.8E+01
Sr-90	8.7E+03	1.6E-00
Tc-99	1.3E+06	1.1E+01
U-234	9.0E+01	1.8E+01*
U-235	9.1E+01	1.2E-00*
U-238	1.0E+02	3.0E+01*

*** DCGL based on 4 mrem/year drinking water dose.**

Table 2

Area Factors for Open Land Areas

Isotope	DCGL 10000 m2	DCGL 2500 m2	AF	DCGL 400 m2	AF	DCGL 100 m2	AF	DCGL 25 m2	AF	DCGL 1 m2	AF
Am-241	1.5	1.5	1.0	1.5	1.0	3.0	2.0	6.1	4.1	47.0	31
C-14	3.7	8.4	2.3	50.7	13.7	197.0	53.2	398.0	107.6	3.3E+03	900
Cm-243	21.7	22.0	1.0	38.9	1.8	66.5	3.1	98.7	4.5	569.0	26
Cm-244	38.0	38.2	1.0	94.4	2.5	355.0	9.3	1.2E+03	31.3	6.2E+03	162
Co-60	2.5	2.6	1.0	2.9	1.2	3.2	1.3	4.2	1.7	26.0	10
Cs-134	3.6	4.1	1.1	4.8	1.3	5.5	1.5	7.1	2.0	43.0	12
Cs-137	8.5	9.8	1.2	12.4	1.5	15.0	1.8	19.6	2.3	119.0	14
Eu-152	6.3	6.5	1.0	6.9	1.1	7.5	1.2	9.7	1.5	58.7	9
Eu-154	5.7	5.9	1.0	6.3	1.1	6.9	1.2	8.8	1.5	54.4	10
Eu-155	234.0	242.0	1.0	253.0	1.1	274.0	1.2	345.0	1.5	1,875.0	8
Fe-55	4.2E+04	8.5E+04	2.0	2.7E+05	6.3	1.1E+06	25.0	4.2E+06	100.0	9.3E+07	2,182
H-3	258.0	295.0	1.1	7.6E+02	2.9	3.0E+03	11.8	1.2E+04	46.5	2.9E+05	1,120
Nb-94	4.5	4.7	1.1	5.0	1.1	5.5	1.2	7.0	1.6	42.2	9
Ni-59	4.6E+03	6.8E+03	1.5	1.9E+04	4.1	7.6E+04	16.4	3.0E+05	65.4	7.5E+06	1,617
Ni-63	1.7E+03	2.5E+03	1.5	6.9E+03	4.1	2.8E+04	16.4	1.1E+05	65.5	2.7E+06	1,619
Pu-238	23.8	24.1	1.0	59.5	2.5	224.0	9.4	750.0	31.5	3.9E+03	164
Pu-239	21.5	21.7	1.0	53.8	2.5	203.0	9.4	679.0	31.6	3.6E+03	165
Pu-240	21.5	21.7	1.0	53.8	2.5	203.0	9.4	680.0	31.6	3.6E+03	166
Pu-241	45.0	45.0	1.0	47.0	1.0	94.0	2.1	181.0	4.0	1.8E+03	40
Pu-242	22.7	22.9	1.0	56.7	2.5	213.0	9.4	715.0	31.5	3.7E+03	164
Sb-125	17.9	18.6	1.0	19.5	1.1	21.3	1.2	27.2	1.5	161.0	9
Sr-90	1.6	1.8	1.1	4.6	2.9	18.2	11.4	70.9	44.6	1.5E+03	969
Tc-99	11.3	11.6	1.0	29.2	2.6	116.0	10.3	467.0	41.3	1.2E+04	1,027
U-234	18.0	18.0	1.0	25.0	1.4	57.0	3.2	123.0	6.8	1.3E+03	69
U-235	1.2	1.2	1.0	2.5	2.1	9.5	7.9	29.0	24.2	645.0	538
U-238	30.0	30.0	1.0	31.0	1.0	63.0	2.1	129.0	4.3	1.4E+03	46
File Name	Site1.rad	SADCGL2.rad		SADCGL3.rad		SADCGL4.rad		SADCGL5.rad		SADCGL6.rad	

Appendix A

RESRAD Run for Open Land Areas
(Site.Rad file)

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- Ingestion rates based on RG 1.109 Table E-5 (Max. Exposed Ind.)
- Specific hydrology inputs from Haley + Aldrich recommendations letter dated 3/31/99.
- Non default Kd inputs based on NUREG/CR 3332 "Radiological Assessments" Till + Meyer Table 3.2 pg 3-37

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	Am-243+D	4.400E-01	4.400E-01	DCF2(3)
B-1	C-14	2.090E-06	2.090E-06	DCF2(4)
B-1	Cm-243	3.070E-01	3.070E-01	DCF2(5)
B-1	Cm-244	2.480E-01	2.480E-01	DCF2(7)
B-1	Co-60	2.190E-04	2.190E-04	DCF2(8)
B-1	Cs-134	4.630E-05	4.630E-05	DCF2(9)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(10)
B-1	Eu-152	2.210E-04	2.210E-04	DCF2(11)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(13)
B-1	Eu-155	4.140E-05	4.140E-05	DCF2(14)
B-1	Fe-55	2.690E-06	2.690E-06	DCF2(15)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(16)
B-1	H-3	6.400E-08	6.400E-08	DCF2(17)
B-1	Nb-94	4.140E-04	4.140E-04	DCF2(18)
B-1	Ni-59	2.700E-06	2.700E-06	DCF2(19)
B-1	Ni-63	6.290E-06	6.290E-06	DCF2(20)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(21)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(22)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(23)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(24)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(25)
B-1	Pu-240	4.290E-01	4.290E-01	DCF2(26)
B-1	Pu-241+D	8.250E-03	8.250E-03	DCF2(27)
B-1	Pu-242	4.110E-01	4.110E-01	DCF2(29)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(30)
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(31)
B-1	Sb-125+D	1.220E-05	1.220E-05	DCF2(32)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(33)
B-1	Tc-99	8.330E-06	8.330E-06	DCF2(34)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(35)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(36)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(37)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(38)
B-1	U-233	1.350E-01	1.350E-01	DCF2(39)
B-1	U-234	1.320E-01	1.320E-01	DCF2(40)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(41)
B-1	U-236	1.250E-01	1.250E-01	DCF2(42)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(43)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	Am-243+D	3.630E-03	3.630E-03	DCF3(3)
D-1	C-14	2.090E-06	2.090E-06	DCF3(4)
D-1	Cm-243	2.510E-03	2.510E-03	DCF3(5)
D-1	Cm-244	2.020E-03	2.020E-03	DCF3(7)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(8)
D-1	Cs-134	7.330E-05	7.330E-05	DCF3(9)

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(10)
D-1	Eu-152	6.480E-06	6.480E-06	DCF3(11)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(13)
D-1	Eu-155	1.530E-06	1.530E-06	DCF3(14)
D-1	Fe-55	6.070E-07	6.070E-07	DCF3(15)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(16)
D-1	H-3	6.400E-08	6.400E-08	DCF3(17)
D-1	Nb-94	7.140E-06	7.140E-06	DCF3(18)
D-1	Ni-59	2.100E-07	2.100E-07	DCF3(19)
D-1	Ni-63	5.770E-07	5.770E-07	DCF3(20)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(21)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(22)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(23)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(24)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(25)
D-1	Pu-240	3.540E-03	3.540E-03	DCF3(26)
D-1	Pu-241+D	6.850E-05	6.850E-05	DCF3(27)
D-1	Pu-242	3.360E-03	3.360E-03	DCF3(29)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(30)
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(31)
D-1	Sb-125+D	2.810E-06	2.810E-06	DCF3(32)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(33)
D-1	Tc-99	1.460E-06	1.460E-06	DCF3(34)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(35)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(36)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(37)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(38)
D-1	U-233	2.890E-04	2.890E-04	DCF3(39)
D-1	U-234	2.830E-04	2.830E-04	DCF3(40)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(41)
D-1	U-236	2.690E-04	2.690E-04	DCF3(42)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(43)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	Am-243+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Am-243+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(3,2)
D-34	Am-243+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(3,3)
D-34				
D-34	C-14 , plant/soil concentration ratio, dimensionless	5.500E+00	5.500E+00	RTF(4,1)
D-34	C-14 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.100E-02	3.100E-02	RTF(4,2)
D-34	C-14 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.200E-02	1.200E-02	RTF(4,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Cm-243 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Cm-243 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,2)
D-34	Cm-243 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(5,3)
D-34				
D-34	Cm-244 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Cm-244 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(7,2)
D-34	Cm-244 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(7,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(8,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(8,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(8,3)
D-34				
D-34	Cs-134 , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(9,1)
D-34	Cs-134 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(9,2)
D-34	Cs-134 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(9,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(10,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(10,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(10,3)
D-34				
D-34	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(11,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(11,3)
D-34				
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(13,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(13,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(13,3)
D-34				
D-34	Eu-155 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(14,1)
D-34	Eu-155 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(14,2)
D-34	Eu-155 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(14,3)
D-34				
D-34	Fe-55 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(15,1)
D-34	Fe-55 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(15,2)
D-34	Fe-55 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(15,3)
D-34				
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(16,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(16,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(16,3)
D-34				
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(17,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(17,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(17,3)
D-34				
D-34	Nb-94 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(18,1)
D-34	Nb-94 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-07	3.000E-07	RTF(18,2)
D-34	Nb-94 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(18,3)
D-34				
D-34	Ni-59 , plant/soil concentration ratio, dimensionless	5.000E-02	5.000E-02	RTF(19,1)
D-34	Ni-59 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(19,2)
D-34	Ni-59 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(19,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Ni-63 , plant/soil concentration ratio, dimensionless	5.000E-02	5.000E-02	RTF(20,1)
D-34	Ni-63 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(20,2)
D-34	Ni-63 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(20,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(21,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(21,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(21,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(22,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(22,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(22,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(23,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(23,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(23,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(24,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(24,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(24,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(25,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(25,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(25,3)
D-34				
D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(26,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(26,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(26,3)
D-34				
D-34	Pu-241+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(27,1)
D-34	Pu-241+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(27,2)
D-34	Pu-241+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(27,3)
D-34				
D-34	Pu-242 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(29,1)
D-34	Pu-242 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(29,2)
D-34	Pu-242 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(29,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(30,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(30,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(30,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(31,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(31,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(31,3)
D-34				
D-34	Sb-125+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(32,1)
D-34	Sb-125+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(32,2)
D-34	Sb-125+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-04	1.000E-04	RTF(32,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(33,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(33,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(33,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Tc-99 , plant/soil concentration ratio, dimensionless	5.000E+00	5.000E+00	RTF(34,1)
D-34	Tc-99 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(34,2)
D-34	Tc-99 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(34,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(35,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(35,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(35,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(36,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(36,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(36,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(37,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(37,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(37,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(38,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(38,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(38,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(39,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(39,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(39,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(40,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(40,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(40,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(41,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(41,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(41,3)
D-34				
D-34	U-236 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(42,1)
D-34	U-236 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(42,2)
D-34	U-236 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(42,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(43,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(43,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(43,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Am-243+D , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Am-243+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(3,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
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Menu	Parameter	Current Value	Default	Parameter Name
D-5	C-14 , fish	5.000E+04	5.000E+04	BIOFAC(4,1)
D-5	C-14 , crustacea and mollusks	9.100E+03	9.100E+03	BIOFAC(4,2)
D-5				
D-5	Cm-243 , fish	3.000E+01	3.000E+01	BIOFAC(5,1)
D-5	Cm-243 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)
D-5				
D-5	Cm-244 , fish	3.000E+01	3.000E+01	BIOFAC(7,1)
D-5	Cm-244 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(7,2)
D-5				
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(8,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(8,2)
D-5				
D-5	Cs-134 , fish	2.000E+03	2.000E+03	BIOFAC(9,1)
D-5	Cs-134 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(9,2)
D-5				
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(10,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(10,2)
D-5				
D-5	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(11,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(11,2)
D-5				
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(13,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(13,2)
D-5				
D-5	Eu-155 , fish	5.000E+01	5.000E+01	BIOFAC(14,1)
D-5	Eu-155 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(14,2)
D-5				
D-5	Fe-55 , fish	2.000E+02	2.000E+02	BIOFAC(15,1)
D-5	Fe-55 , crustacea and mollusks	3.200E+03	3.200E+03	BIOFAC(15,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(16,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(16,2)
D-5				
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(17,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(17,2)
D-5				
D-5	Nb-94 , fish	3.000E+02	3.000E+02	BIOFAC(18,1)
D-5	Nb-94 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(18,2)
D-5				
D-5	Ni-59 , fish	1.000E+02	1.000E+02	BIOFAC(19,1)
D-5	Ni-59 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(19,2)
D-5				
D-5	Ni-63 , fish	1.000E+02	1.000E+02	BIOFAC(20,1)
D-5	Ni-63 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(20,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(21,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(21,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(22,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(22,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
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Menu	Parameter	Current Value	Default	Parameter Name
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(23,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(23,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(24,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(24,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(25,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(25,2)
D-5				
D-5	Pu-240 , fish	3.000E+01	3.000E+01	BIOFAC(26,1)
D-5	Pu-240 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(26,2)
D-5				
D-5	Pu-241+D , fish	3.000E+01	3.000E+01	BIOFAC(27,1)
D-5	Pu-241+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(27,2)
D-5				
D-5	Pu-242 , fish	3.000E+01	3.000E+01	BIOFAC(29,1)
D-5	Pu-242 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(29,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(30,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(30,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(31,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(31,2)
D-5				
D-5	Sb-125+D , fish	1.000E+02	1.000E+02	BIOFAC(32,1)
D-5	Sb-125+D , crustacea and mollusks	1.000E+01	1.000E+01	BIOFAC(32,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(33,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(33,2)
D-5				
D-5	Tc-99 , fish	2.000E+01	2.000E+01	BIOFAC(34,1)
D-5	Tc-99 , crustacea and mollusks	5.000E+00	5.000E+00	BIOFAC(34,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(35,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(35,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(36,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(36,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(37,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(37,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(38,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(38,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(39,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(39,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(40,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(40,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
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Menu	Parameter	Current Value	Default	Parameter Name
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(41,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(41,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(42,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(42,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(43,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(43,2)

Site-Specific Parameter Summary

Menu	Parameter		User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)		1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)		1.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)		1.130E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)		2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)		0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)		1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)		3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)		1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)		3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)		1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)		3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)		1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)		1.000E+04	0.000E+00	---	T(9)
R011	Times for calculations (yr)		not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g):	Am-241	1.000E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g):	C-14	1.000E+00	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g):	Cm-243	1.000E+00	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g):	Cm-244	1.000E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g):	Co-60	1.000E+00	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g):	Cs-134	1.000E+00	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g):	Cs-137	1.000E+00	0.000E+00	---	S1(10)
R012	Initial principal radionuclide (pCi/g):	Eu-152	1.000E+00	0.000E+00	---	S1(11)
R012	Initial principal radionuclide (pCi/g):	Eu-154	1.000E+00	0.000E+00	---	S1(13)
R012	Initial principal radionuclide (pCi/g):	Eu-155	1.000E+00	0.000E+00	---	S1(14)
R012	Initial principal radionuclide (pCi/g):	Fe-55	1.000E+00	0.000E+00	---	S1(15)
R012	Initial principal radionuclide (pCi/g):	H-3	1.000E+00	0.000E+00	---	S1(17)
R012	Initial principal radionuclide (pCi/g):	Nb-94	1.000E+00	0.000E+00	---	S1(18)
R012	Initial principal radionuclide (pCi/g):	Ni-59	1.000E+00	0.000E+00	---	S1(19)
R012	Initial principal radionuclide (pCi/g):	Ni-63	1.000E+00	0.000E+00	---	S1(20)
R012	Initial principal radionuclide (pCi/g):	Pu-238	1.000E+00	0.000E+00	---	S1(24)
R012	Initial principal radionuclide (pCi/g):	Pu-239	1.000E+00	0.000E+00	---	S1(25)
R012	Initial principal radionuclide (pCi/g):	Pu-240	1.000E+00	0.000E+00	---	S1(26)
R012	Initial principal radionuclide (pCi/g):	Pu-241	1.000E+00	0.000E+00	---	S1(27)
R012	Initial principal radionuclide (pCi/g):	Pu-242	1.000E+00	0.000E+00	---	S1(29)
R012	Initial principal radionuclide (pCi/g):	Sb-125	1.000E+00	0.000E+00	---	S1(32)
R012	Initial principal radionuclide (pCi/g):	Sr-90	1.000E+00	0.000E+00	---	S1(33)
R012	Initial principal radionuclide (pCi/g):	Tc-99	1.000E+00	0.000E+00	---	S1(34)
R012	Initial principal radionuclide (pCi/g):	U-234	1.000E+00	0.000E+00	---	S1(40)
R012	Initial principal radionuclide (pCi/g):	U-235	1.000E+00	0.000E+00	---	S1(41)
R012	Initial principal radionuclide (pCi/g):	U-238	1.000E+00	0.000E+00	---	S1(43)
R012	Concentration in groundwater (pCi/L):	Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L):	C-14	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L):	Cm-243	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L):	Cm-244	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L):	Co-60	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L):	Cs-134	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L):	Cs-137	not used	0.000E+00	---	W1(10)
R012	Concentration in groundwater (pCi/L):	Eu-152	not used	0.000E+00	---	W1(11)
R012	Concentration in groundwater (pCi/L):	Eu-154	not used	0.000E+00	---	W1(13)
R012	Concentration in groundwater (pCi/L):	Eu-155	not used	0.000E+00	---	W1(14)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R012	Concentration in groundwater (pCi/L): Fe-55	not used	0.000E+00	---	W1(15)
R012	Concentration in groundwater (pCi/L): H-3	not used	0.000E+00	---	W1(17)
R012	Concentration in groundwater (pCi/L): Nb-94	not used	0.000E+00	---	W1(18)
R012	Concentration in groundwater (pCi/L): Ni-59	not used	0.000E+00	---	W1(19)
R012	Concentration in groundwater (pCi/L): Ni-63	not used	0.000E+00	---	W1(20)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(24)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(25)
R012	Concentration in groundwater (pCi/L): Pu-240	not used	0.000E+00	---	W1(26)
R012	Concentration in groundwater (pCi/L): Pu-241	not used	0.000E+00	---	W1(27)
R012	Concentration in groundwater (pCi/L): Pu-242	not used	0.000E+00	---	W1(29)
R012	Concentration in groundwater (pCi/L): Sb-125	not used	0.000E+00	---	W1(32)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(33)
R012	Concentration in groundwater (pCi/L): Tc-99	not used	0.000E+00	---	W1(34)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(40)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(41)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(43)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	3.450E-04	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.500E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	3.500E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.733E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	1.050E+01	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.867E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	8.000E+00	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.940E-01	5.000E-01	Input from Haley + Aldrich	EVAPTR
R013	Precipitation (m/yr)	1.024E+00	1.000E+00	letter dated 31 March 1999,	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	File No 74582-000	IDITCH
R013	Runoff coefficient	3.500E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	5.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03		EPS
R014	Density of saturated zone (g/cm**3)	1.480E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.500E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	3.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.733E+01	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	3.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	1.050E+01	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	5.000E-04	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	3.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.860E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	6.100E-01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.600E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.500E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	3.500E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	1.050E+01	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.733E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(2,1
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.088E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for C-14				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(4,1
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.181E+00	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Cm-243				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	1.378E+03	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	1.378E+03	DCNUCU(5,1
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	1.378E+03	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.594E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Cm-244				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	1.378E+03	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	1.378E+03	DCNUCU(7,1
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	1.378E+03	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.594E-04	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+03	1.000E+03	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+03	1.000E+03	---	DCNUCU(8,1
R016	Saturated zone (cm**3/g)	5.000E+03	1.000E+03	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.393E-05	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Cs-134				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCU(9,1
R016	Saturated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.196E-04	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)

Handwritten notes: "Input from Haley & Aldrich letter dated 31 March 1999 File No 74582-000" (beside R015 rows); "Till" (beside Co-60 Kd rows).

Site Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCU(10,1
R016	Saturated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.196E-04	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCU(11,1
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.662E-04	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCU(13,1
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.662E-04	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for Eu-155				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(14)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCU(14,1
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.662E-04	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
R016	Distribution coefficients for Fe-55				
R016	Contaminated zone (cm**3/g)	5.000E+03	1.000E+03	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+03	1.000E+03	---	DCNUCU(15,1
R016	Saturated zone (cm**3/g)	5.000E+03	1.000E+03	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.393E-05	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(17)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(17,1
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(17)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.181E+00	ALEACH(17)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(17)
R016	Distribution coefficients for Nb-94				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(18)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(18,1
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(18)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.181E+00	ALEACH(18)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(18)

Till

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Ni-59				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(19)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCU(19,1
R016	Saturated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCS(19)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.196E-04	ALEACH(19)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(19)
R016	Distribution coefficients for Ni-63				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(20)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCU(20,1
R016	Saturated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCS(20)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.196E-04	ALEACH(20)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(20)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(24)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(24,1
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(24)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.098E-04	ALEACH(24)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(24)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(25)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(25,1
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(25)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.098E-04	ALEACH(25)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(25)
R016	Distribution coefficients for Pu-240				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(26)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(26,1
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(26)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.098E-04	ALEACH(26)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(26)
R016	Distribution coefficients for Pu-241				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(27)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(27,1
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(27)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.098E-04	ALEACH(27)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(27)
R016	Distribution coefficients for Pu-242				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(29)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(29,1
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(29)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.098E-04	ALEACH(29)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(29)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Sb-125				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(32)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(32,1
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(32)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.181E+00	ALEACH(32)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(32)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	1.000E+03	3.000E+01	---	DCNUCC(33)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	3.000E+01	---	DCNUCU(33,1
R016	Saturated zone (cm**3/g)	1.000E+03	3.000E+01	---	DCNUCS(33)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.196E-04	ALEACH(33)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(33)
R016	Distribution coefficients for Tc-99				
R016	Contaminated zone (cm**3/g)	5.000E+00	0.000E+00	---	DCNUCC(34)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+00	0.000E+00	---	DCNUCU(34,1
R016	Saturated zone (cm**3/g)	5.000E+00	0.000E+00	---	DCNUCS(34)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.235E-02	ALEACH(34)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(34)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(40)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(40,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(40)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.377E-03	ALEACH(40)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(40)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(41)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(41,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(41)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.377E-03	ALEACH(41)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(41)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(43)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(43,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(43)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.377E-03	ALEACH(43)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(43)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.088E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Am-243				
R016	Contaminated zone (cm**3/g)	5.000E+03	2.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+03	2.000E+01	---	DCNUCU(3,1
R016	Saturated zone (cm**3/g)	5.000E+03	2.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.393E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(16)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCU(16,1
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.662E-04	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(21)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCU(21,1
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCS(21)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.526E-04	ALEACH(21)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(21)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(22)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(22,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(22)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.377E-03	ALEACH(22)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(22)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(23)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(23,1
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(23)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.192E-03	ALEACH(23)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(23)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(30)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(30,1
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(30)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.129E-03	ALEACH(30)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(30)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(31)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(31,1
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(31)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.129E-03	ALEACH(31)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(31)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(35)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(35,1
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(35)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.661E-06	ALEACH(35)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(35)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(36)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(36,1
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(36)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.661E-06	ALEACH(36)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(36)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(37)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(37,1
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(37)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.661E-06	ALEACH(37)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(37)
R016	Distribution coefficients for daughter Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(38)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(38,1
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(38)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.661E-06	ALEACH(38)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(38)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	3.000E+02	5.000E+01	---	DCNUCC(39)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+02	5.000E+01	---	DCNUCU(39,1
R016	Saturated zone (cm**3/g)	3.000E+02	5.000E+01	---	DCNUCS(39)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.317E-04	ALEACH(39)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(39)
R016	Distribution coefficients for daughter U-236				
R016	Contaminated zone (cm**3/g)	3.000E+02	5.000E+01	---	DCNUCC(42)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+02	5.000E+01	---	DCNUCU(42,1
R016	Saturated zone (cm**3/g)	3.000E+02	5.000E+01	---	DCNUCS(42)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.317E-04	ALEACH(42)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(42)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(1
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(1
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(1
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	5.200E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	6.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	3.100E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	1.100E+02	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	2.100E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	5.000E+00	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD

RG 1.109 Table E-5

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	2.000E-05	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	3.000E-02	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	2.000E-02	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	9.800E-01	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	3.000E-01	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	7.000E-07	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	1.000E-10	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	8.000E-01	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	2.000E-01	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	suppressed

Contaminated Zone Dimensions

Area:	10000.00 square meters
Thickness:	1.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

Am-241	1.000E+00
C-14	1.000E+00
Cm-243	1.000E+00
Cm-244	1.000E+00
Co-60	1.000E+00
Cs-134	1.000E+00
Cs-137	1.000E+00
Eu-152	1.000E+00
Eu-154	1.000E+00
Eu-155	1.000E+00
Fe-55	1.000E+00
H-3	1.000E+00
Nb-94	1.000E+00
Ni-59	1.000E+00
Ni-63	1.000E+00
Pu-238	1.000E+00
Pu-239	1.000E+00
Pu-240	1.000E+00
Pu-241	1.000E+00
Pu-242	1.000E+00
Sb-125	1.000E+00
Sr-90	1.000E+00
Tc-99	1.000E+00
U-234	1.000E+00
U-235	1.000E+00
U-238	1.000E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
TDOSE(t):	6.831E+01	5.327E+01	4.582E+01	3.310E+01	1.980E+01	8.655E+00	7.386E+00	4.434E+00	1.320E-01
M(t):	2.732E+00	2.131E+00	1.833E+00	1.324E+00	7.919E-01	3.462E-01	2.954E-01	1.773E-01	5.279E-03

Maximum TDOSE(t): 6.831E+01 mrem/yr   at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	2.544E-02	0.0004	1.655E-02	0.0002	0.000E+00	0.0000	1.064E+00	0.0156	5.688E-03	0.0001	6.264E-04	0.0000	9.965E-02
C-14	7.887E-06	0.0000	4.380E-04	0.0000	0.000E+00	0.0000	5.433E+00	0.0795	6.711E-01	0.0098	5.516E-01	0.0081	5.721E-05
Cm-243	3.330E-01	0.0049	1.144E-02	0.0002	0.000E+00	0.0000	7.335E-01	0.0107	1.569E-03	0.0000	4.320E-04	0.0000	6.871E-02
Cm-244	7.560E-05	0.0000	9.243E-03	0.0001	0.000E+00	0.0000	5.903E-01	0.0086	1.263E-03	0.0000	3.476E-04	0.0000	5.530E-02
Co-60	9.146E+00	0.1339	8.162E-06	0.0000	0.000E+00	0.0000	6.284E-01	0.0092	1.758E-01	0.0026	4.086E-02	0.0006	7.364E-04
Cs-134	5.318E+00	0.0779	1.726E-06	0.0000	0.000E+00	0.0000	8.562E-01	0.0125	3.895E-01	0.0057	2.454E-01	0.0036	2.007E-03
Cs-137	1.915E+00	0.0280	1.189E-06	0.0000	0.000E+00	0.0000	5.840E-01	0.0085	2.657E-01	0.0039	1.674E-01	0.0025	1.369E-03
Eu-152	3.951E+00	0.0578	8.237E-06	0.0000	0.000E+00	0.0000	4.732E-03	0.0001	4.777E-04	0.0000	1.281E-05	0.0000	1.774E-04
Eu-154	4.339E+00	0.0635	1.066E-05	0.0000	0.000E+00	0.0000	6.974E-03	0.0001	7.040E-04	0.0000	1.888E-05	0.0000	2.614E-04
Eu-155	1.054E-01	0.0015	1.543E-06	0.0000	0.000E+00	0.0000	1.117E-03	0.0000	1.128E-04	0.0000	3.024E-06	0.0000	4.188E-05
Fe-55	0.000E+00	0.0000	1.003E-07	0.0000	0.000E+00	0.0000	1.774E-04	0.0000	3.794E-04	0.0000	1.567E-05	0.0000	1.662E-05
H-3	0.000E+00	0.0000	4.570E-04	0.0000	0.000E+00	0.0000	8.032E-02	0.0012	5.917E-03	0.0001	1.013E-02	0.0001	1.752E-06
Nb-94	5.436E+00	0.0796	1.543E-05	0.0000	0.000E+00	0.0000	2.085E-02	0.0003	1.390E-07	0.0000	2.324E-06	0.0000	1.955E-04
Ni-59	0.000E+00	0.0000	1.006E-07	0.0000	0.000E+00	0.0000	3.066E-03	0.0000	2.252E-04	0.0000	2.116E-03	0.0000	5.749E-06
Ni-63	0.000E+00	0.0000	2.344E-07	0.0000	0.000E+00	0.0000	8.424E-03	0.0001	6.189E-04	0.0000	5.814E-03	0.0001	1.580E-05
Pu-238	8.972E-05	0.0000	1.461E-02	0.0002	0.000E+00	0.0000	9.351E-01	0.0137	1.000E-02	0.0001	2.754E-04	0.0000	8.760E-02
Pu-239	1.700E-04	0.0000	1.599E-02	0.0002	0.000E+00	0.0000	1.034E+00	0.0151	1.106E-02	0.0002	3.046E-04	0.0000	9.691E-02
Pu-240	8.723E-05	0.0000	1.599E-02	0.0002	0.000E+00	0.0000	1.034E+00	0.0151	1.106E-02	0.0002	3.046E-04	0.0000	9.691E-02
Pu-241	1.085E-05	0.0000	3.075E-04	0.0000	0.000E+00	0.0000	2.002E-02	0.0003	2.141E-04	0.0000	5.894E-06	0.0000	1.875E-03
Pu-242	7.587E-05	0.0000	1.532E-02	0.0002	0.000E+00	0.0000	9.819E-01	0.0144	1.050E-02	0.0002	2.891E-04	0.0000	9.198E-02
Sb-125	1.384E+00	0.0203	4.547E-07	0.0000	0.000E+00	0.0000	8.206E-03	0.0001	1.824E-04	0.0000	4.574E-05	0.0000	7.692E-05
Sr-90	1.476E-02	0.0002	4.882E-05	0.0000	0.000E+00	0.0000	1.340E+01	0.1962	1.407E+00	0.0206	8.063E-01	0.0118	4.188E-03
Tc-99	7.235E-05	0.0000	3.105E-07	0.0000	0.000E+00	0.0000	2.132E+00	0.0312	2.734E-03	0.0000	6.235E-02	0.0009	3.997E-05
U-234	2.338E-04	0.0000	4.920E-03	0.0001	0.000E+00	0.0000	2.067E-01	0.0030	3.547E-03	0.0001	1.678E-02	0.0002	7.747E-03
U-235	4.324E-01	0.0063	4.584E-03	0.0001	0.000E+00	0.0000	1.950E-01	0.0029	3.346E-03	0.0000	1.583E-02	0.0002	7.309E-03
U-238	7.752E-02	0.0011	4.398E-03	0.0001	0.000E+00	0.0000	1.964E-01	0.0029	3.371E-03	0.0000	1.595E-02	0.0002	7.364E-03
Total	3.248E+01	0.4755	1.143E-01	0.0017	0.000E+00	0.0000	3.016E+01	0.4415	2.982E+00	0.0437	1.943E+00	0.0284	6.305E-01

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Path
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.212E+00
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.656E+00
Cm-243	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.149E+00
Cm-244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.565E-01
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.992E+00
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.811E+00
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.934E+00
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.956E+00
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.347E+00
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.067E-01
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.891E-04
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.683E-02
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.457E+00
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.413E-03
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.487E-02
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.048E+00
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.159E+00
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.159E+00
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.243E-02
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.100E+00
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.392E+00
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.564E+01
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.197E+00
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.399E-01
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.585E-01
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.050E-01
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.831E+01

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	2.513E-02	0.0005	1.634E-02	0.0003	0.000E+00	0.0000	1.051E+00	0.0197	5.621E-03	0.0001	6.188E-04	0.0000	9.841E-02
C-14	3.169E-09	0.0000	1.760E-07	0.0000	0.000E+00	0.0000	2.948E-03	0.0001	1.087E-03	0.0000	5.926E-04	0.0000	2.299E-08
Cm-243	3.250E-01	0.0061	1.117E-02	0.0002	0.000E+00	0.0000	7.158E-01	0.0134	1.531E-03	0.0000	4.215E-04	0.0000	6.705E-02
Cm-244	7.276E-05	0.0000	8.896E-03	0.0002	0.000E+00	0.0000	5.681E-01	0.0107	1.216E-03	0.0000	3.346E-04	0.0000	5.322E-02
Co-60	8.019E+00	0.1505	7.156E-06	0.0000	0.000E+00	0.0000	5.509E-01	0.0103	1.541E-01	0.0029	3.583E-02	0.0007	6.456E-04
Cs-134	3.799E+00	0.0713	1.233E-06	0.0000	0.000E+00	0.0000	6.116E-01	0.0115	2.782E-01	0.0052	1.753E-01	0.0033	1.433E-03
Cs-137	1.871E+00	0.0351	1.162E-06	0.0000	0.000E+00	0.0000	5.706E-01	0.0107	2.596E-01	0.0049	1.636E-01	0.0031	1.337E-03
Eu-152	3.750E+00	0.0704	7.817E-06	0.0000	0.000E+00	0.0000	4.491E-03	0.0001	4.534E-04	0.0000	1.216E-05	0.0000	1.684E-04
Eu-154	4.009E+00	0.0753	9.849E-06	0.0000	0.000E+00	0.0000	6.444E-03	0.0001	6.506E-04	0.0000	1.744E-05	0.0000	2.416E-04
Eu-155	9.161E-02	0.0017	1.341E-06	0.0000	0.000E+00	0.0000	9.713E-04	0.0000	9.806E-05	0.0000	2.629E-06	0.0000	3.641E-05
Fe-55	0.000E+00	0.0000	7.755E-08	0.0000	0.000E+00	0.0000	1.372E-04	0.0000	2.935E-04	0.0000	1.212E-05	0.0000	1.285E-05
H-3	0.000E+00	0.0000	2.347E-05	0.0000	0.000E+00	0.0000	4.567E-03	0.0001	5.103E-04	0.0000	7.505E-04	0.0000	8.997E-08
Nb-94	1.668E+00	0.0313	4.735E-06	0.0000	0.000E+00	0.0000	6.666E-03	0.0001	4.964E-08	0.0000	7.744E-07	0.0000	5.999E-05
Ni-59	0.000E+00	0.0000	1.006E-07	0.0000	0.000E+00	0.0000	3.065E-03	0.0001	2.252E-04	0.0000	2.115E-03	0.0000	5.747E-06
Ni-63	0.000E+00	0.0000	2.327E-07	0.0000	0.000E+00	0.0000	8.362E-03	0.0002	6.143E-04	0.0000	5.771E-03	0.0001	1.568E-05
Pu-238	8.901E-05	0.0000	1.449E-02	0.0003	0.000E+00	0.0000	9.277E-01	0.0174	9.920E-03	0.0002	2.732E-04	0.0000	8.690E-02
Pu-239	1.699E-04	0.0000	1.599E-02	0.0003	0.000E+00	0.0000	1.034E+00	0.0194	1.106E-02	0.0002	3.046E-04	0.0000	9.689E-02
Pu-240	8.721E-05	0.0000	1.599E-02	0.0003	0.000E+00	0.0000	1.034E+00	0.0194	1.106E-02	0.0002	3.045E-04	0.0000	9.689E-02
Pu-241	4.993E-05	0.0000	3.187E-04	0.0000	0.000E+00	0.0000	2.073E-02	0.0004	2.133E-04	0.0000	6.590E-06	0.0000	1.942E-03
Pu-242	7.587E-05	0.0000	1.532E-02	0.0003	0.000E+00	0.0000	9.818E-01	0.0184	1.050E-02	0.0002	2.891E-04	0.0000	9.197E-02
Sb-125	3.307E-01	0.0062	1.087E-07	0.0000	0.000E+00	0.0000	2.043E-03	0.0000	5.070E-05	0.0000	1.187E-05	0.0000	1.838E-05
Sr-90	1.441E-02	0.0003	4.766E-05	0.0000	0.000E+00	0.0000	1.308E+01	0.2456	1.374E+00	0.0258	7.872E-01	0.0148	4.089E-03
Tc-99	6.935E-05	0.0000	2.976E-07	0.0000	0.000E+00	0.0000	2.046E+00	0.0384	2.641E-03	0.0000	6.008E-02	0.0011	3.831E-05
U-234	2.328E-04	0.0000	4.898E-03	0.0001	0.000E+00	0.0000	2.058E-01	0.0039	3.533E-03	0.0001	1.671E-02	0.0003	7.713E-03
U-235	4.305E-01	0.0081	4.565E-03	0.0001	0.000E+00	0.0000	1.948E-01	0.0037	3.398E-03	0.0001	1.577E-02	0.0003	7.283E-03
U-238	7.718E-02	0.0014	4.379E-03	0.0001	0.000E+00	0.0000	1.956E-01	0.0037	3.358E-03	0.0001	1.588E-02	0.0003	7.332E-03
Total	2.441E+01	0.4583	1.125E-01	0.0021	0.000E+00	0.0000	2.383E+01	0.4474	2.134E+00	0.0401	1.282E+00	0.0241	6.237E-01

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Path
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.197E+00
C-14	1.006E-01	0.0019	1.471E-01	0.0028	0.000E+00	0.0000	4.669E-02	0.0009	5.693E-03	0.0001	3.039E-02	0.0006	3.352E-01
Cm-243	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.121E+00
Cm-244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.319E-01
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.761E+00
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.866E+00
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.866E+00
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.755E+00
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.017E+00
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.272E-02
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.557E-04
H-3	2.914E-03	0.0001	1.011E-07	0.0000	0.000E+00	0.0000	6.788E-04	0.0000	7.487E-05	0.0000	4.588E-04	0.0000	9.978E-03
Nb-94	3.439E-01	0.0065	3.120E-03	0.0001	0.000E+00	0.0000	6.470E-02	0.0012	1.020E-06	0.0000	3.478E-05	0.0000	2.087E+00
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.412E-03
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.476E-02
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.039E+00
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.159E+00
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.159E+00
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.326E-02
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.100E+00
Sb-125	1.054E-01	0.0020	3.023E-04	0.0000	0.000E+00	0.0000	1.982E-02	0.0004	1.042E-03	0.0000	5.328E-04	0.0000	4.599E-01
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.526E+01
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.109E+00
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.389E-01
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.563E-01
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.037E-01
Total	5.528E-01	0.0104	1.505E-01	0.0028	0.000E+00	0.0000	1.319E-01	0.0025	6.810E-03	0.0001	3.142E-02	0.0006	5.327E+01

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	2.451E-02	0.0005	1.594E-02	0.0003	0.000E+00	0.0000	1.025E+00	0.0224	5.483E-03	0.0001	6.035E-04	0.0000	9.598E-02
C-14	5.046E-16	0.0000	2.802E-14	0.0000	0.000E+00	0.0000	4.696E-10	0.0000	1.733E-10	0.0000	9.447E-11	0.0000	3.660E-15
Cm-243	3.094E-01	0.0068	1.063E-02	0.0002	0.000E+00	0.0000	6.816E-01	0.0149	1.459E-03	0.0000	4.014E-04	0.0000	6.385E-02
Cm-244	6.739E-05	0.0000	8.241E-03	0.0002	0.000E+00	0.0000	5.263E-01	0.0115	1.128E-03	0.0000	3.099E-04	0.0000	4.930E-02
Co-60	6.164E+00	0.1345	5.501E-06	0.0000	0.000E+00	0.0000	4.235E-01	0.0092	1.185E-01	0.0026	2.754E-02	0.0006	4.963E-04
Cs-134	1.939E+00	0.0423	6.291E-07	0.0000	0.000E+00	0.0000	3.121E-01	0.0068	1.420E-01	0.0031	8.947E-02	0.0020	7.315E-04
Cs-137	1.786E+00	0.0390	1.109E-06	0.0000	0.000E+00	0.0000	5.445E-01	0.0119	2.477E-01	0.0054	1.561E-01	0.0034	1.276E-03
Eu-152	3.378E+00	0.0737	7.041E-06	0.0000	0.000E+00	0.0000	4.045E-03	0.0001	4.084E-04	0.0000	1.095E-05	0.0000	1.516E-04
Eu-154	3.423E+00	0.0747	8.409E-06	0.0000	0.000E+00	0.0000	5.502E-03	0.0001	5.554E-04	0.0000	1.489E-05	0.0000	2.062E-04
Eu-155	6.924E-02	0.0015	1.014E-06	0.0000	0.000E+00	0.0000	7.341E-04	0.0000	7.411E-05	0.0000	1.987E-06	0.0000	2.752E-05
Fe-55	0.000E+00	0.0000	4.641E-08	0.0000	0.000E+00	0.0000	8.211E-05	0.0000	1.756E-04	0.0000	7.253E-06	0.0000	7.691E-06
H-3	0.000E+00	0.0000	6.167E-08	0.0000	0.000E+00	0.0000	1.200E-05	0.0000	1.341E-06	0.0000	1.973E-06	0.0000	2.364E-10
Nb-94	1.572E-01	0.0034	4.460E-07	0.0000	0.000E+00	0.0000	6.279E-04	0.0000	4.675E-09	0.0000	7.295E-08	0.0000	5.650E-06
Ni-59	0.000E+00	0.0000	1.006E-07	0.0000	0.000E+00	0.0000	3.064E-03	0.0001	2.251E-04	0.0000	2.114E-03	0.0000	5.745E-06
Ni-63	0.000E+00	0.0000	2.293E-07	0.0000	0.000E+00	0.0000	8.238E-03	0.0002	6.052E-04	0.0000	5.685E-03	0.0001	1.545E-05
Pu-238	8.759E-05	0.0000	1.426E-02	0.0003	0.000E+00	0.0000	9.129E-01	0.0199	9.763E-03	0.0002	2.690E-04	0.0000	8.552E-02
Pu-239	1.699E-04	0.0000	1.598E-02	0.0003	0.000E+00	0.0000	1.034E+00	0.0226	1.106E-02	0.0002	3.045E-04	0.0000	9.687E-02
Pu-240	8.717E-05	0.0000	1.598E-02	0.0003	0.000E+00	0.0000	1.034E+00	0.0226	1.106E-02	0.0002	3.044E-04	0.0000	9.684E-02
Pu-241	1.212E-04	0.0000	3.388E-04	0.0000	0.000E+00	0.0000	2.200E-02	0.0005	2.107E-04	0.0000	7.852E-06	0.0000	2.060E-03
Pu-242	7.585E-05	0.0000	1.531E-02	0.0003	0.000E+00	0.0000	9.815E-01	0.0214	1.050E-02	0.0002	2.890E-04	0.0000	9.195E-02
Sb-125	1.888E-02	0.0004	6.205E-09	0.0000	0.000E+00	0.0000	1.167E-04	0.0000	2.895E-06	0.0000	6.776E-07	0.0000	1.050E-06
Sr-90	1.373E-02	0.0003	4.543E-05	0.0000	0.000E+00	0.0000	1.247E+01	0.2722	1.309E+00	0.0286	7.503E-01	0.0164	3.897E-03
Tc-99	6.372E-05	0.0000	2.734E-07	0.0000	0.000E+00	0.0000	1.880E+00	0.0410	2.426E-03	0.0001	5.520E-02	0.0012	3.520E-05
U-234	2.309E-04	0.0000	4.856E-03	0.0001	0.000E+00	0.0000	2.040E-01	0.0045	3.502E-03	0.0001	1.657E-02	0.0004	7.646E-03
U-235	4.268E-01	0.0093	4.528E-03	0.0001	0.000E+00	0.0000	1.944E-01	0.0042	3.512E-03	0.0001	1.563E-02	0.0003	7.233E-03
U-238	7.651E-02	0.0017	4.341E-03	0.0001	0.000E+00	0.0000	1.939E-01	0.0042	3.329E-03	0.0001	1.575E-02	0.0003	7.268E-03
Total	1.779E+01	0.3882	1.105E-01	0.0024	0.000E+00	0.0000	2.246E+01	0.4903	1.883E+00	0.0411	1.137E+00	0.0248	6.114E-01

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Path
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.168E+00
C-14	2.199E-01	0.0048	3.297E-01	0.0072	0.000E+00	0.0000	1.081E-01	0.0024	1.508E-02	0.0003	6.775E-02	0.0015	7.405E-01
Cm-243	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.067E+00
Cm-244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.854E-01
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.734E+00
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.483E+00
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.735E+00
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.382E+00
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.429E+00
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.007E-02
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.727E-04
H-3	5.693E-03	0.0001	2.025E-07	0.0000	0.000E+00	0.0000	1.396E-03	0.0000	1.709E-04	0.0000	9.166E-04	0.0000	8.192E-03
Nb-94	7.515E-01	0.0164	6.993E-03	0.0002	0.000E+00	0.0000	1.470E-01	0.0032	2.914E-06	0.0000	8.261E-05	0.0000	1.063E+00
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.409E-03
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.454E-02
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.023E+00
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.158E+00
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.158E+00
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.473E-02
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.100E+00
Sb-125	1.396E-01	0.0030	4.108E-04	0.0000	0.000E+00	0.0000	2.731E-02	0.0006	1.805E-03	0.0000	7.674E-04	0.0000	1.889E-01
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.455E+01
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.938E+00
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.368E-01
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.521E-01
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.011E-01
Total	1.117E+00	0.0244	3.371E-01	0.0074	0.000E+00	0.0000	2.838E-01	0.0062	1.706E-02	0.0004	6.951E-02	0.0015	4.582E+01

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr
Am-241	2.246E-02	0.0007	1.461E-02	0.0004	0.000E+00	0.0000	9.393E-01	0.0284	5.025E-03	0.0002	5.530E-04	0.0000	8.795E-02
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	2.607E-01	0.0079	8.961E-03	0.0003	0.000E+00	0.0000	5.745E-01	0.0174	1.231E-03	0.0000	3.382E-04	0.0000	5.382E-02
Cm-244	5.155E-05	0.0000	6.308E-03	0.0002	0.000E+00	0.0000	4.028E-01	0.0122	8.694E-04	0.0000	2.370E-04	0.0000	3.774E-02
Co-60	2.454E+00	0.0741	2.190E-06	0.0000	0.000E+00	0.0000	1.686E-01	0.0051	4.717E-02	0.0014	1.097E-02	0.0003	1.976E-04
Cs-134	1.840E-01	0.0056	5.972E-08	0.0000	0.000E+00	0.0000	2.963E-02	0.0009	1.348E-02	0.0004	8.493E-03	0.0003	6.944E-05
Cs-137	1.517E+00	0.0458	9.416E-07	0.0000	0.000E+00	0.0000	4.625E-01	0.0140	2.104E-01	0.0064	1.326E-01	0.0040	1.084E-03
Eu-152	2.343E+00	0.0708	4.884E-06	0.0000	0.000E+00	0.0000	2.806E-03	0.0001	2.833E-04	0.0000	7.595E-06	0.0000	1.052E-04
Eu-154	1.969E+00	0.0595	4.836E-06	0.0000	0.000E+00	0.0000	3.164E-03	0.0001	3.194E-04	0.0000	8.565E-06	0.0000	1.186E-04
Eu-155	2.598E-02	0.0008	3.804E-07	0.0000	0.000E+00	0.0000	2.755E-04	0.0000	2.781E-05	0.0000	7.457E-07	0.0000	1.033E-05
Fe-55	0.000E+00	0.0000	7.691E-09	0.0000	0.000E+00	0.0000	1.361E-05	0.0000	2.910E-05	0.0000	1.202E-06	0.0000	1.275E-06
H-3	0.000E+00	0.0000	5.524E-17	0.0000	0.000E+00	0.0000	1.075E-14	0.0000	1.203E-15	0.0000	1.769E-15	0.0000	2.118E-19
Nb-94	4.031E-05	0.0000	1.144E-10	0.0000	0.000E+00	0.0000	1.610E-07	0.0000	1.199E-12	0.0000	1.871E-11	0.0000	1.449E-09
Ni-59	0.000E+00	0.0000	1.004E-07	0.0000	0.000E+00	0.0000	3.059E-03	0.0001	2.247E-04	0.0000	2.111E-03	0.0001	5.736E-06
Ni-63	0.000E+00	0.0000	2.176E-07	0.0000	0.000E+00	0.0000	7.820E-03	0.0002	5.745E-04	0.0000	5.397E-03	0.0002	1.466E-05
Pu-238	8.282E-05	0.0000	1.349E-02	0.0004	0.000E+00	0.0000	8.631E-01	0.0261	9.231E-03	0.0003	2.546E-04	0.0000	8.086E-02
Pu-239	1.697E-04	0.0000	1.597E-02	0.0005	0.000E+00	0.0000	1.033E+00	0.0312	1.105E-02	0.0003	3.042E-04	0.0000	9.677E-02
Pu-240	8.704E-05	0.0000	1.595E-02	0.0005	0.000E+00	0.0000	1.032E+00	0.0312	1.104E-02	0.0003	3.040E-04	0.0000	9.670E-02
Pu-241	3.095E-04	0.0000	3.867E-04	0.0000	0.000E+00	0.0000	2.502E-02	0.0008	2.002E-04	0.0000	1.109E-05	0.0000	2.343E-03
Pu-242	7.579E-05	0.0000	1.530E-02	0.0005	0.000E+00	0.0000	9.808E-01	0.0296	1.049E-02	0.0003	2.888E-04	0.0000	9.188E-02
Sb-125	8.404E-07	0.0000	2.762E-13	0.0000	0.000E+00	0.0000	5.193E-09	0.0000	1.289E-10	0.0000	3.016E-11	0.0000	4.672E-11
Sr-90	1.161E-02	0.0004	3.840E-05	0.0000	0.000E+00	0.0000	1.054E+01	0.3184	1.107E+00	0.0334	6.341E-01	0.0192	3.294E-03
Tc-99	4.737E-05	0.0000	2.033E-07	0.0000	0.000E+00	0.0000	1.398E+00	0.0422	1.804E-03	0.0001	4.104E-02	0.0012	2.617E-05
U-234	2.250E-04	0.0000	4.710E-03	0.0001	0.000E+00	0.0000	1.978E-01	0.0060	3.396E-03	0.0001	1.607E-02	0.0005	7.416E-03
U-235	4.140E-01	0.0125	4.405E-03	0.0001	0.000E+00	0.0000	1.932E-01	0.0058	3.896E-03	0.0001	1.516E-02	0.0005	7.066E-03
U-238	7.420E-02	0.0022	4.210E-03	0.0001	0.000E+00	0.0000	1.881E-01	0.0057	3.228E-03	0.0001	1.527E-02	0.0005	7.049E-03
Total	9.276E+00	0.2802	1.043E-01	0.0032	0.000E+00	0.0000	1.905E+01	0.5754	1.441E+00	0.0435	8.835E-01	0.0267	5.745E-01

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Path
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.070E+00
C-14	2.322E-01	0.0070	3.484E-01	0.0105	0.000E+00	0.0000	1.144E-01	0.0035	1.605E-02	0.0005	7.158E-02	0.0022	7.826E-01
Cm-243	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.995E-01
Cm-244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.480E-01
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.681E+00
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.357E-01
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.323E+00
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.346E+00
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.972E+00
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.630E-02
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.520E-05
H-3	4.061E-03	0.0001	1.446E-07	0.0000	0.000E+00	0.0000	9.981E-04	0.0000	1.227E-04	0.0000	6.544E-04	0.0000	5.836E-03
Nb-94	7.938E-01	0.0240	7.394E-03	0.0002	0.000E+00	0.0000	1.555E-01	0.0047	3.111E-06	0.0000	8.757E-05	0.0000	9.568E-01
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.401E-03
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.381E-02
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.671E-01
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.157E+00
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.156E+00
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.827E-02
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.099E+00
Sb-125	2.559E-02	0.0008	7.537E-05	0.0000	0.000E+00	0.0000	5.015E-03	0.0002	3.343E-04	0.0000	1.412E-04	0.0000	3.116E-02
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.230E+01
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.441E+00
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.297E-01
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.377E-01
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.920E-01
Total	1.056E+00	0.0319	3.559E-01	0.0108	0.000E+00	0.0000	2.760E-01	0.0083	1.651E-02	0.0005	7.246E-02	0.0022	3.310E+01

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr
Am-241	1.750E-02	0.0009	1.138E-02	0.0006	0.000E+00	0.0000	7.319E-01	0.0370	3.917E-03	0.0002	4.309E-04	0.0000	6.852E-02
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	1.598E-01	0.0081	5.499E-03	0.0003	0.000E+00	0.0000	3.526E-01	0.0178	7.594E-04	0.0000	2.074E-04	0.0000	3.303E-02
Cm-244	2.403E-05	0.0000	2.948E-03	0.0001	0.000E+00	0.0000	1.883E-01	0.0095	4.194E-04	0.0000	1.103E-04	0.0000	1.764E-02
Co-60	1.768E-01	0.0089	1.577E-07	0.0000	0.000E+00	0.0000	1.214E-02	0.0006	3.397E-03	0.0002	7.897E-04	0.0000	1.423E-05
Cs-134	2.204E-04	0.0000	7.152E-11	0.0000	0.000E+00	0.0000	3.548E-05	0.0000	1.614E-05	0.0000	1.017E-05	0.0000	8.316E-08
Cs-137	9.512E-01	0.0481	5.906E-07	0.0000	0.000E+00	0.0000	2.901E-01	0.0147	1.320E-01	0.0067	8.316E-02	0.0042	6.799E-04
Eu-152	8.236E-01	0.0416	1.717E-06	0.0000	0.000E+00	0.0000	9.865E-04	0.0000	9.959E-05	0.0000	2.670E-06	0.0000	3.698E-05
Eu-154	4.052E-01	0.0205	9.954E-07	0.0000	0.000E+00	0.0000	6.513E-04	0.0000	6.575E-05	0.0000	1.763E-06	0.0000	2.441E-05
Eu-155	1.580E-03	0.0001	2.313E-08	0.0000	0.000E+00	0.0000	1.675E-05	0.0000	1.691E-06	0.0000	4.533E-08	0.0000	6.278E-07
Fe-55	0.000E+00	0.0000	4.526E-11	0.0000	0.000E+00	0.0000	8.009E-08	0.0000	1.713E-07	0.0000	7.075E-09	0.0000	7.502E-09
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	2.216E-15	0.0000	6.289E-21	0.0000	0.000E+00	0.0000	8.853E-18	0.0000	6.591E-23	0.0000	1.028E-21	0.0000	7.966E-20
Ni-59	0.000E+00	0.0000	9.994E-08	0.0000	0.000E+00	0.0000	3.045E-03	0.0002	2.237E-04	0.0000	2.101E-03	0.0001	5.709E-06
Ni-63	0.000E+00	0.0000	1.875E-07	0.0000	0.000E+00	0.0000	6.739E-03	0.0003	4.951E-04	0.0000	4.651E-03	0.0002	1.264E-05
Pu-238	7.057E-05	0.0000	1.149E-02	0.0006	0.000E+00	0.0000	7.354E-01	0.0371	7.864E-03	0.0004	2.177E-04	0.0000	6.889E-02
Pu-239	1.693E-04	0.0000	1.592E-02	0.0008	0.000E+00	0.0000	1.030E+00	0.0520	1.102E-02	0.0006	3.034E-04	0.0000	9.651E-02
Pu-240	8.666E-05	0.0000	1.589E-02	0.0008	0.000E+00	0.0000	1.028E+00	0.0519	1.099E-02	0.0006	3.027E-04	0.0000	9.628E-02
Pu-241	5.189E-04	0.0000	4.081E-04	0.0000	0.000E+00	0.0000	2.630E-02	0.0013	1.660E-04	0.0000	1.410E-05	0.0000	2.463E-03
Pu-242	7.562E-05	0.0000	1.527E-02	0.0008	0.000E+00	0.0000	9.786E-01	0.0494	1.047E-02	0.0005	2.882E-04	0.0000	9.167E-02
Sb-125	3.100E-19	0.0000	1.019E-25	0.0000	0.000E+00	0.0000	1.916E-21	0.0000	4.754E-23	0.0000	1.113E-23	0.0000	1.724E-23
Sr-90	7.180E-03	0.0004	2.375E-05	0.0000	0.000E+00	0.0000	6.519E+00	0.3293	6.844E-01	0.0346	3.922E-01	0.0198	2.037E-03
Tc-99	2.030E-05	0.0000	8.712E-08	0.0000	0.000E+00	0.0000	5.991E-01	0.0303	7.731E-04	0.0000	1.759E-02	0.0009	1.122E-05
U-234	2.154E-04	0.0000	4.317E-03	0.0002	0.000E+00	0.0000	1.813E-01	0.0092	3.112E-03	0.0002	1.472E-02	0.0007	6.797E-03
U-235	3.795E-01	0.0192	4.094E-03	0.0002	0.000E+00	0.0000	1.903E-01	0.0096	4.851E-03	0.0002	1.390E-02	0.0007	6.647E-03
U-238	6.798E-02	0.0034	3.857E-03	0.0002	0.000E+00	0.0000	1.723E-01	0.0087	2.958E-03	0.0001	1.399E-02	0.0007	6.458E-03
Total	2.992E+00	0.1511	9.109E-02	0.0046	0.000E+00	0.0000	1.305E+01	0.6591	8.780E-01	0.0443	5.450E-01	0.0275	4.977E-01

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Path*
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.336E-01
C-14	2.319E-01	0.0117	3.479E-01	0.0176	0.000E+00	0.0000	1.143E-01	0.0058	1.603E-02	0.0008	7.148E-02	0.0036	7.816E-01
Cm-243	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.518E-01
Cm-244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.094E-01
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.931E-01
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.823E-04
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.457E+00
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.248E-01
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.059E-01
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.599E-03
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.660E-07
H-3	1.323E-03	0.0001	4.712E-08	0.0000	0.000E+00	0.0000	3.252E-04	0.0000	3.997E-05	0.0000	2.132E-04	0.0000	1.902E-03
Nb-94	7.941E-01	0.0401	7.397E-03	0.0004	0.000E+00	0.0000	1.556E-01	0.0079	3.112E-06	0.0000	8.761E-05	0.0000	9.572E-01
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.376E-03
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.190E-02
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.239E-01
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.154E+00
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.151E+00
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.987E-02
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.096E+00
Sb-125	1.718E-04	0.0000	5.061E-07	0.0000	0.000E+00	0.0000	3.367E-05	0.0000	2.244E-06	0.0000	9.478E-07	0.0000	2.092E-04
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.605E+00
Tc-99	3.484E-03	0.0002	2.122E-06	0.0000	0.000E+00	0.0000	1.506E-03	0.0001	4.991E-06	0.0000	2.025E-04	0.0000	6.227E-01
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.105E-01
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.992E-01
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.675E-01
Total	1.031E+00	0.0521	3.553E-01	0.0179	0.000E+00	0.0000	2.717E-01	0.0137	1.608E-02	0.0008	7.199E-02	0.0036	1.980E+01

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	7.312E-03	0.0008	4.749E-03	0.0005	0.000E+00	0.0000	3.058E-01	0.0353	1.641E-03	0.0002	1.799E-04	0.0000	2.859E-02
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	2.880E-02	0.0033	1.006E-03	0.0001	0.000E+00	0.0000	6.453E-02	0.0075	1.474E-04	0.0000	3.768E-05	0.0000	6.045E-03
Cm-244	1.851E-06	0.0000	2.405E-04	0.0000	0.000E+00	0.0000	1.539E-02	0.0018	5.642E-05	0.0000	8.256E-06	0.0000	1.442E-03
Co-60	1.771E-05	0.0000	1.581E-11	0.0000	0.000E+00	0.0000	1.217E-06	0.0000	3.404E-07	0.0000	7.913E-08	0.0000	1.426E-09
Cs-134	1.310E-14	0.0000	4.251E-21	0.0000	0.000E+00	0.0000	2.109E-15	0.0000	9.594E-16	0.0000	6.046E-16	0.0000	4.943E-18
Cs-137	1.859E-01	0.0215	1.154E-07	0.0000	0.000E+00	0.0000	5.668E-02	0.0065	2.579E-02	0.0030	1.625E-02	0.0019	1.328E-04
Eu-152	2.122E-02	0.0025	4.425E-08	0.0000	0.000E+00	0.0000	2.542E-05	0.0000	2.566E-06	0.0000	6.881E-08	0.0000	9.530E-07
Eu-154	1.603E-03	0.0002	3.939E-09	0.0000	0.000E+00	0.0000	2.577E-06	0.0000	2.602E-07	0.0000	6.976E-09	0.0000	9.661E-08
Eu-155	8.751E-08	0.0000	1.281E-12	0.0000	0.000E+00	0.0000	9.278E-10	0.0000	9.367E-11	0.0000	2.511E-12	0.0000	3.478E-11
Fe-55	0.000E+00	0.0000	7.079E-19	0.0000	0.000E+00	0.0000	1.252E-15	0.0000	2.679E-15	0.0000	1.106E-16	0.0000	1.173E-16
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-59	0.000E+00	0.0000	9.835E-08	0.0000	0.000E+00	0.0000	2.997E-03	0.0003	2.201E-04	0.0000	2.068E-03	0.0002	5.619E-06
Ni-63	0.000E+00	0.0000	1.114E-07	0.0000	0.000E+00	0.0000	4.003E-03	0.0005	2.941E-04	0.0000	2.763E-03	0.0003	7.506E-06
Pu-238	4.032E-05	0.0000	6.559E-03	0.0008	0.000E+00	0.0000	4.198E-01	0.0485	4.490E-03	0.0005	1.262E-04	0.0000	3.932E-02
Pu-239	1.677E-04	0.0000	1.577E-02	0.0018	0.000E+00	0.0000	1.020E+00	0.1179	1.091E-02	0.0013	3.004E-04	0.0000	9.557E-02
Pu-240	8.537E-05	0.0000	1.565E-02	0.0018	0.000E+00	0.0000	1.012E+00	0.1170	1.083E-02	0.0013	2.982E-04	0.0000	9.484E-02
Pu-241	3.187E-04	0.0000	2.095E-04	0.0000	0.000E+00	0.0000	1.348E-02	0.0016	7.315E-05	0.0000	7.887E-06	0.0000	1.261E-03
Pu-242	7.503E-05	0.0000	1.515E-02	0.0018	0.000E+00	0.0000	9.710E-01	0.1122	1.038E-02	0.0012	2.859E-04	0.0000	9.096E-02
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sr-90	1.336E-03	0.0002	4.419E-06	0.0000	0.000E+00	0.0000	1.213E+00	0.1402	1.274E-01	0.0147	7.298E-02	0.0084	3.791E-04
Tc-99	1.047E-06	0.0000	4.492E-09	0.0000	0.000E+00	0.0000	3.089E-02	0.0036	3.986E-05	0.0000	9.069E-04	0.0001	5.783E-07
U-234	2.465E-04	0.0000	3.184E-03	0.0004	0.000E+00	0.0000	1.339E-01	0.0155	2.298E-03	0.0003	1.084E-02	0.0013	5.013E-03
U-235	2.803E-01	0.0324	3.236E-03	0.0004	0.000E+00	0.0000	1.773E-01	0.0205	6.873E-03	0.0008	1.026E-02	0.0012	5.456E-03
U-238	5.004E-02	0.0058	2.840E-03	0.0003	0.000E+00	0.0000	1.269E-01	0.0147	2.178E-03	0.0003	1.030E-02	0.0012	4.755E-03
Total	5.774E-01	0.0667	6.859E-02	0.0079	0.000E+00	0.0000	5.568E+00	0.6434	2.036E-01	0.0235	1.276E-01	0.0147	3.738E-01

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Path*
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	1.404E+00	0.1623	1.083E-02	0.0013	0.000E+00	0.0000	2.745E-01	0.0317	9.145E-04	0.0001	1.548E-04	0.0000	2.039E+00
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	9.838E-16	0.0000	7.145E-18	0.0000	0.000E+00	0.0000	1.917E-16	0.0000	2.515E-19	0.0000	1.077E-18	0.0000	1.006E-01
Cm-244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.714E-02
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.935E-05
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.678E-14
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.847E-01
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.125E-02
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.606E-03
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.857E-08
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.160E-15
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.291E-03
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.068E-03
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.703E-01
Pu-239	4.974E-12	0.0000	3.614E-14	0.0000	0.000E+00	0.0000	9.699E-13	0.0000	1.275E-15	0.0000	5.451E-15	0.0000	1.143E+00
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.134E+00
Pu-241	2.779E-02	0.0032	2.142E-04	0.0000	0.000E+00	0.0000	5.430E-03	0.0006	1.806E-05	0.0000	3.060E-06	0.0000	4.881E-02
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.088E+00
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.415E+00
Tc-99	7.075E-03	0.0008	4.313E-06	0.0000	0.000E+00	0.0000	3.063E-03	0.0004	1.020E-05	0.0000	4.122E-04	0.0000	4.240E-02
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.555E-01
U-235	5.014E-04	0.0001	3.644E-06	0.0000	0.000E+00	0.0000	9.783E-05	0.0000	1.290E-07	0.0000	5.502E-07	0.0000	4.840E-01
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.970E-01
Total	1.440E+00	0.1664	1.105E-02	0.0013	0.000E+00	0.0000	2.831E-01	0.0327	9.429E-04	0.0001	5.706E-04	0.0001	8.655E+00

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	6.142E-04	0.0001	3.914E-04	0.0001	0.000E+00	0.0000	2.558E-02	0.0035	1.439E-04	0.0000	1.491E-05	0.0000	2.357E-03
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	2.200E-04	0.0000	2.564E-05	0.0000	0.000E+00	0.0000	1.648E-03	0.0002	1.358E-05	0.0000	6.293E-07	0.0000	1.550E-04
Cm-244	2.276E-07	0.0000	4.167E-05	0.0000	0.000E+00	0.0000	2.685E-03	0.0004	2.877E-05	0.0000	7.956E-07	0.0000	2.526E-04
Co-60	6.643E-17	0.0000	5.928E-23	0.0000	0.000E+00	0.0000	4.546E-18	0.0000	1.272E-18	0.0000	2.957E-19	0.0000	5.348E-21
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-137	1.751E-03	0.0002	1.087E-09	0.0000	0.000E+00	0.0000	5.319E-04	0.0001	2.421E-04	0.0000	1.526E-04	0.0000	1.251E-06
Eu-152	6.126E-07	0.0000	1.277E-12	0.0000	0.000E+00	0.0000	7.308E-10	0.0000	7.400E-11	0.0000	1.984E-12	0.0000	2.750E-11
Eu-154	2.189E-10	0.0000	5.378E-16	0.0000	0.000E+00	0.0000	3.505E-13	0.0000	3.549E-14	0.0000	9.518E-16	0.0000	1.319E-14
Eu-155	6.034E-20	0.0000	8.835E-25	0.0000	0.000E+00	0.0000	6.373E-22	0.0000	6.452E-23	0.0000	1.730E-24	0.0000	2.398E-23
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-59	0.000E+00	0.0000	9.395E-08	0.0000	0.000E+00	0.0000	2.852E-03	0.0004	2.096E-04	0.0000	1.969E-03	0.0003	5.367E-06
Ni-63	0.000E+00	0.0000	2.516E-08	0.0000	0.000E+00	0.0000	9.006E-04	0.0001	6.620E-05	0.0000	6.219E-04	0.0001	1.695E-06
Pu-238	8.251E-06	0.0000	1.322E-03	0.0002	0.000E+00	0.0000	8.428E-02	0.0114	9.046E-04	0.0001	2.725E-05	0.0000	7.925E-03
Pu-239	1.631E-04	0.0000	1.534E-02	0.0021	0.000E+00	0.0000	9.885E-01	0.1338	1.061E-02	0.0014	2.921E-04	0.0000	9.296E-02
Pu-240	8.176E-05	0.0000	1.499E-02	0.0020	0.000E+00	0.0000	9.659E-01	0.1308	1.036E-02	0.0014	2.855E-04	0.0000	9.083E-02
Pu-241	2.740E-05	0.0000	1.755E-05	0.0000	0.000E+00	0.0000	1.141E-03	0.0002	6.345E-06	0.0000	6.674E-07	0.0000	1.057E-04
Pu-242	7.338E-05	0.0000	1.481E-02	0.0020	0.000E+00	0.0000	9.458E-01	0.1281	1.015E-02	0.0014	2.795E-04	0.0000	8.895E-02
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sr-90	1.094E-05	0.0000	3.620E-08	0.0000	0.000E+00	0.0000	9.900E-03	0.0013	1.039E-03	0.0001	5.957E-04	0.0001	3.106E-06
Tc-99	2.192E-10	0.0000	9.405E-13	0.0000	0.000E+00	0.0000	6.442E-06	0.0000	8.314E-09	0.0000	1.891E-07	0.0000	1.211E-10
U-234	5.869E-04	0.0001	1.341E-03	0.0002	0.000E+00	0.0000	5.828E-02	0.0079	1.000E-03	0.0001	4.578E-03	0.0006	2.121E-03
U-235	1.180E-01	0.0160	1.638E-03	0.0002	0.000E+00	0.0000	1.187E-01	0.0161	6.772E-03	0.0009	4.309E-03	0.0006	2.983E-03
U-238	2.085E-02	0.0028	1.184E-03	0.0002	0.000E+00	0.0000	5.269E-02	0.0071	9.072E-04	0.0001	4.292E-03	0.0006	1.983E-03
Total	1.424E-01	0.0193	5.110E-02	0.0069	0.000E+00	0.0000	3.259E+00	0.4413	4.246E-02	0.0057	1.742E-02	0.0024	2.906E-01

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Path*
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	2.622E+00	0.3550	2.022E-02	0.0027	0.000E+00	0.0000	5.128E-01	0.0694	1.712E-03	0.0002	2.892E-04	0.0000	3.186E+00
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	6.859E-12	0.0000	2.666E-14	0.0000	0.000E+00	0.0000	1.341E-12	0.0000	5.978E-14	0.0000	9.845E-14	0.0000	2.063E-03
Cm-244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.010E-03
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.255E-17
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.679E-03
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.134E-07
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.193E-10
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.107E-20
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.036E-03
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.590E-03
Pu-238	9.120E-06	0.0000	6.402E-09	0.0000	0.000E+00	0.0000	1.784E-06	0.0000	4.046E-08	0.0000	3.016E-07	0.0000	9.448E-02
Pu-239	9.044E-09	0.0000	3.288E-11	0.0000	0.000E+00	0.0000	1.769E-09	0.0000	7.742E-11	0.0000	1.424E-10	0.0000	1.108E+00
Pu-240	1.629E-29	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.202E-30	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.082E+00
Pu-241	8.745E-02	0.0118	6.744E-04	0.0001	0.000E+00	0.0000	1.710E-02	0.0023	5.710E-05	0.0000	9.646E-06	0.0000	1.066E-01
Pu-242	6.622E-10	0.0000	4.626E-13	0.0000	0.000E+00	0.0000	1.295E-10	0.0000	2.935E-12	0.0000	2.190E-11	0.0000	1.060E+00
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.155E-02
Tc-99	7.268E-03	0.0010	4.431E-06	0.0000	0.000E+00	0.0000	3.147E-03	0.0004	1.048E-05	0.0000	4.235E-04	0.0001	1.086E-02
U-234	6.260E-02	0.0085	4.402E-05	0.0000	0.000E+00	0.0000	1.224E-02	0.0017	2.780E-04	0.0000	2.071E-03	0.0003	1.451E-01
U-235	1.294E-01	0.0175	4.606E-04	0.0001	0.000E+00	0.0000	2.532E-02	0.0034	1.247E-03	0.0002	2.020E-03	0.0003	4.109E-01
U-238	5.957E-02	0.0081	4.161E-05	0.0000	0.000E+00	0.0000	1.165E-02	0.0016	2.643E-04	0.0000	1.971E-03	0.0003	1.554E-01
Total	2.968E+00	0.4019	2.145E-02	0.0029	0.000E+00	0.0000	5.822E-01	0.0788	3.569E-03	0.0005	6.784E-03	0.0009	7.386E+00

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr
Am-241	7.519E-06	0.0000	3.019E-07	0.0000	0.000E+00	0.0000	2.269E-04	0.0001	4.339E-06	0.0000	5.624E-08	0.0000	1.820E-06
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	4.321E-06	0.0000	1.657E-05	0.0000	0.000E+00	0.0000	7.803E-04	0.0002	1.105E-05	0.0000	3.096E-07	0.0000	1.004E-04
Cm-244	1.950E-07	0.0000	3.575E-05	0.0000	0.000E+00	0.0000	1.684E-03	0.0004	2.393E-05	0.0000	6.635E-07	0.0000	2.167E-04
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-137	1.421E-10	0.0000	8.819E-17	0.0000	0.000E+00	0.0000	3.153E-11	0.0000	1.518E-11	0.0000	9.665E-12	0.0000	1.015E-13
Eu-152	7.909E-23	0.0000	2.391E-16	0.0000	0.000E+00	0.0000	2.260E-15	0.0000	2.918E-16	0.0000	7.911E-18	0.0000	1.164E-16
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-59	0.000E+00	0.0000	8.005E-08	0.0000	0.000E+00	0.0000	1.775E-03	0.0004	1.367E-04	0.0000	1.295E-03	0.0003	4.573E-06
Ni-63	0.000E+00	0.0000	1.377E-10	0.0000	0.000E+00	0.0000	3.601E-06	0.0000	2.773E-07	0.0000	2.628E-06	0.0000	9.277E-09
Pu-238	5.036E-07	0.0000	4.909E-06	0.0000	0.000E+00	0.0000	2.296E-04	0.0001	3.282E-06	0.0000	2.928E-07	0.0000	2.920E-05
Pu-239	1.481E-04	0.0000	1.392E-02	0.0031	0.000E+00	0.0000	6.556E-01	0.1479	9.317E-03	0.0021	2.580E-04	0.0001	8.436E-02
Pu-240	7.030E-05	0.0000	1.288E-02	0.0029	0.000E+00	0.0000	6.069E-01	0.1369	8.625E-03	0.0019	2.391E-04	0.0001	7.809E-02
Pu-241	2.555E-07	0.0000	1.091E-08	0.0000	0.000E+00	0.0000	7.712E-06	0.0000	1.471E-07	0.0000	1.928E-09	0.0000	6.575E-08
Pu-242	6.786E-05	0.0000	1.370E-02	0.0031	0.000E+00	0.0000	6.393E-01	0.1442	9.085E-03	0.0020	2.516E-04	0.0001	8.226E-02
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sr-90	5.447E-13	0.0000	1.802E-15	0.0000	0.000E+00	0.0000	3.600E-10	0.0000	3.813E-11	0.0000	2.190E-11	0.0000	1.546E-13
Tc-99	2.910E-23	0.0000	1.249E-25	0.0000	0.000E+00	0.0000	6.249E-19	0.0000	8.070E-22	0.0000	1.836E-20	0.0000	1.608E-23
U-234	1.422E-03	0.0003	8.632E-05	0.0000	0.000E+00	0.0000	7.861E-03	0.0018	1.519E-04	0.0000	3.589E-04	0.0001	1.766E-04
U-235	5.706E-03	0.0013	1.235E-04	0.0000	0.000E+00	0.0000	9.394E-03	0.0021	8.067E-04	0.0002	1.952E-04	0.0000	2.544E-04
U-238	9.750E-04	0.0002	5.546E-05	0.0000	0.000E+00	0.0000	1.806E-03	0.0004	3.964E-05	0.0000	1.894E-04	0.0000	9.287E-05
Total	8.402E-03	0.0019	4.083E-02	0.0092	0.000E+00	0.0000	1.926E+00	0.4343	2.820E-02	0.0064	2.792E-03	0.0006	2.456E-01

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Path
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	9.216E-01	0.2079	7.108E-03	0.0016	0.000E+00	0.0000	1.802E-01	0.0407	6.025E-04	0.0001	1.017E-04	0.0000	1.110E+00
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	2.504E-10	0.0000	1.112E-12	0.0000	0.000E+00	0.0000	4.898E-11	0.0000	2.999E-12	0.0000	2.465E-12	0.0000	9.130E-04
Cm-244	6.085E-28	0.0000	1.912E-30	0.0000	0.000E+00	0.0000	1.197E-28	0.0000	7.778E-30	0.0000	3.332E-29	0.0000	1.961E-03
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.985E-10
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.915E-15
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.212E-03
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.516E-06
Pu-238	4.459E-05	0.0000	3.599E-08	0.0000	0.000E+00	0.0000	8.724E-06	0.0000	2.023E-07	0.0000	1.470E-06	0.0000	3.228E-04
Pu-239	2.288E-07	0.0000	1.015E-09	0.0000	0.000E+00	0.0000	4.477E-08	0.0000	2.742E-09	0.0000	2.257E-09	0.0000	7.636E-01
Pu-240	4.072E-25	0.0000	1.285E-27	0.0000	0.000E+00	0.0000	8.049E-26	0.0000	5.266E-27	0.0000	2.228E-26	0.0000	7.068E-01
Pu-241	3.066E-02	0.0069	2.365E-04	0.0001	0.000E+00	0.0000	5.997E-03	0.0014	2.004E-05	0.0000	3.383E-06	0.0000	3.693E-02
Pu-242	1.020E-08	0.0000	7.129E-12	0.0000	0.000E+00	0.0000	1.995E-09	0.0000	4.529E-11	0.0000	3.375E-10	0.0000	7.447E-01
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.207E-10
Tc-99	1.145E-08	0.0000	6.982E-12	0.0000	0.000E+00	0.0000	4.962E-09	0.0000	1.661E-11	0.0000	6.684E-10	0.0000	1.710E-08
U-234	1.350E-01	0.0305	1.127E-04	0.0000	0.000E+00	0.0000	2.642E-02	0.0060	6.160E-04	0.0001	4.448E-03	0.0010	1.767E-01
U-235	5.837E-01	0.1316	2.772E-03	0.0006	0.000E+00	0.0000	1.142E-01	0.0258	7.473E-03	0.0017	4.569E-03	0.0010	7.291E-01
U-238	1.267E-01	0.0286	8.862E-05	0.0000	0.000E+00	0.0000	2.479E-02	0.0056	5.628E-04	0.0001	4.194E-03	0.0009	1.595E-01
Total	1.798E+00	0.4055	1.032E-02	0.0023	0.000E+00	0.0000	3.517E-01	0.0793	9.274E-03	0.0021	1.332E-02	0.0030	4.434E+00

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+04 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-244	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+04 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Path
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
Am-241	8.326E-05	0.0006	2.994E-07	0.0000	0.000E+00	0.0000	1.636E-05	0.0001	1.086E-06	0.0000	2.910E-08	0.0000	1.010E-04
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cm-243	2.169E-09	0.0000	1.200E-11	0.0000	0.000E+00	0.0000	4.244E-10	0.0000	3.155E-11	0.0000	6.256E-12	0.0000	2.643E-09
Cm-244	1.544E-09	0.0000	1.079E-12	0.0000	0.000E+00	0.0000	3.021E-10	0.0000	6.858E-12	0.0000	5.111E-11	0.0000	1.906E-09
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-134	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Eu-152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Eu-154	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Eu-155	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Fe-55	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
H-3	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Nb-94	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-59	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Pu-238	3.573E-05	0.0003	2.871E-07	0.0000	0.000E+00	0.0000	7.016E-06	0.0001	3.935E-07	0.0000	8.777E-07	0.0000	4.430E-05
Pu-239	1.849E-06	0.0000	1.023E-08	0.0000	0.000E+00	0.0000	3.617E-07	0.0000	2.689E-08	0.0000	5.308E-09	0.0000	2.253E-06
Pu-240	5.704E-07	0.0000	3.985E-10	0.0000	0.000E+00	0.0000	1.116E-07	0.0000	2.533E-09	0.0000	1.888E-08	0.0000	7.038E-07
Pu-241	2.714E-06	0.0000	9.762E-09	0.0000	0.000E+00	0.0000	5.333E-07	0.0000	3.541E-08	0.0000	9.479E-10	0.0000	3.294E-06
Pu-242	2.124E-08	0.0000	1.630E-11	0.0000	0.000E+00	0.0000	4.155E-09	0.0000	9.561E-11	0.0000	7.011E-10	0.0000	2.620E-08
Sb-125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00
U-234	1.053E-01	0.7975	8.457E-04	0.0064	0.000E+00	0.0000	2.067E-02	0.1566	1.159E-03	0.0088	2.586E-03	0.0196	1.305E-01
U-235	6.998E-06	0.0001	3.725E-08	0.0000	0.000E+00	0.0000	1.370E-06	0.0000	1.286E-07	0.0000	1.427E-08	0.0000	8.548E-06
U-238	1.052E-03	0.0080	8.449E-06	0.0001	0.000E+00	0.0000	2.066E-04	0.0016	1.159E-05	0.0001	2.587E-05	0.0002	1.305E-03
Total	1.064E-01	0.8065	8.548E-04	0.0065	0.000E+00	0.0000	2.090E-02	0.1584	1.172E-03	0.0089	2.612E-03	0.0198	1.320E-01

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
Am-241	Am-241	1.000E+00	1.212E+00	1.197E+00	1.167E+00	1.070E+00	8.334E-01	2.039E+00	3.186E+00	1.110E+00	0.000E+00
Am-241	Np-237	1.000E+00	0.000E+00	8.446E-06	2.558E-05	8.208E-05	2.169E-04	4.786E-04	5.858E-04	3.057E-04	1.008E-04
Am-241	U-233	1.000E+00	0.000E+00	2.483E-13	1.774E-12	1.734E-11	1.384E-10	1.137E-09	5.595E-09	1.859E-08	2.307E-07
Am-241	Th-229	1.000E+00	0.000E+00	5.689E-17	1.408E-15	4.974E-14	1.246E-12	3.678E-11	5.788E-10	5.397E-09	2.682E-10
Am-241	∑DSR(j)		1.212E+00	1.197E+00	1.168E+00	1.070E+00	8.336E-01	2.039E+00	3.186E+00	1.110E+00	1.010E-04
C-14	C-14	1.000E+00	6.656E+00	3.352E-01	7.405E-01	7.826E-01	7.816E-01	1.600E-36	0.000E+00	0.000E+00	0.000E+00
Cm-243	Cm-243	9.976E-01	1.146E+00	1.118E+00	1.065E+00	8.971E-01	5.498E-01	9.908E-02	7.389E-04	2.211E-11	0.000E+00
Cm-243	Pu-239	9.976E-01	0.000E+00	3.288E-05	9.629E-05	2.951E-04	7.060E-04	1.231E-03	1.307E-03	9.014E-04	0.000E+00
Cm-243	U-235	9.976E-01	0.000E+00	9.105E-15	8.110E-14	8.459E-13	6.350E-12	4.025E-11	1.179E-10	2.275E-10	1.639E-10
Cm-243	Pa-231	9.976E-01	0.000E+00	3.128E-18	8.863E-17	3.171E-15	7.345E-14	1.634E-12	1.457E-11	7.922E-11	5.888E-10
Cm-243	Ac-227	9.976E-01	0.000E+00	1.366E-20	8.875E-19	9.044E-17	5.345E-15	2.690E-13	7.248E-12	1.768E-10	1.889E-09
Cm-243	∑DSR(j)		1.146E+00	1.118E+00	1.065E+00	8.974E-01	5.505E-01	1.003E-01	2.046E-03	9.014E-04	2.642E-09
Cm-243	Cm-243	2.400E-03	2.757E-03	2.690E-03	2.562E-03	2.158E-03	1.323E-03	2.384E-04	1.778E-06	5.319E-14	0.000E+00
Cm-243	Am-243	2.400E-03	0.000E+00	3.778E-07	1.106E-06	3.390E-06	8.109E-06	1.414E-05	1.503E-05	1.136E-05	0.000E+00
Cm-243	Pu-239	2.400E-03	0.000E+00	3.730E-12	3.303E-11	3.470E-10	2.681E-09	1.906E-08	7.653E-08	1.954E-07	0.000E+00
Cm-243	U-235	2.400E-03	0.000E+00	6.831E-22	1.842E-20	6.518E-19	1.535E-17	3.705E-16	4.060E-15	2.900E-14	8.764E-14
Cm-243	Pa-231	2.400E-03	0.000E+00	2.446E-25	1.500E-23	1.815E-21	1.304E-19	1.067E-17	3.380E-16	6.324E-15	2.839E-13
Cm-243	Ac-227	2.400E-03	0.000E+00	3.010E-25	4.290E-25	4.264E-23	7.817E-21	1.503E-18	1.097E-16	1.033E-14	9.104E-13
Cm-243	∑DSR(j)		2.757E-03	2.690E-03	2.563E-03	2.162E-03	1.331E-03	2.525E-04	1.688E-05	1.155E-05	1.282E-12
Cm-244	Cm-244	1.000E+00	6.565E-01	6.318E-01	5.850E-01	4.470E-01	2.073E-01	1.406E-02	6.431E-06	1.009E-17	0.000E+00
Cm-244	Pu-240	1.000E+00	0.000E+00	1.205E-04	3.480E-04	1.019E-03	2.179E-03	3.078E-03	3.003E-03	1.961E-03	0.000E+00
Cm-244	U-236	1.000E+00	0.000E+00	3.394E-13	3.056E-12	3.137E-11	2.244E-10	1.334E-09	4.462E-09	8.778E-09	1.906E-09
Cm-244	Th-232	1.000E+00	0.000E+00	2.717E-23	6.668E-22	2.242E-20	5.029E-19	1.134E-17	1.316E-16	1.031E-15	6.571E-18
Cm-244	Ra-228	1.000E+00	0.000E+00	1.404E-23	1.155E-21	1.187E-19	5.741E-18	2.028E-16	2.699E-15	2.218E-14	3.158E-15
Cm-244	Th-228	1.000E+00	0.000E+00	4.037E-25	7.069E-23	1.642E-20	1.277E-18	5.543E-17	7.784E-16	8.227E-15	6.642E-18
Cm-244	∑DSR(j)		6.565E-01	6.319E-01	5.854E-01	4.480E-01	2.094E-01	1.714E-02	3.010E-03	1.961E-03	1.906E-09
Co-60	Co-60	1.000E+00	9.992E+00	8.761E+00	6.734E+00	2.681E+00	1.931E-01	1.935E-05	7.255E-17	0.000E+00	0.000E+00
Cs-134	Cs-134	1.000E+00	6.811E+00	4.866E+00	2.483E+00	2.357E-01	2.823E-04	1.678E-14	7.987E-44	0.000E+00	0.000E+00
Cs-137	Cs-137	1.000E+00	2.934E+00	2.866E+00	2.735E+00	2.323E+00	1.457E+00	2.847E-01	2.679E-03	1.985E-10	0.000E+00
Eu-152	Eu-152	7.208E-01	2.852E+00	2.707E+00	2.438E+00	1.691E+00	5.945E-01	1.532E-02	4.421E-07	5.707E-23	0.000E+00
Eu-152	Eu-152	2.792E-01	1.105E+00	1.048E+00	9.443E-01	6.550E-01	2.303E-01	5.934E-03	1.713E-07	2.210E-23	0.000E+00
Eu-152	Gd-152	2.792E-01	0.000E+00	2.500E-16	7.123E-16	1.996E-15	3.867E-15	4.779E-15	4.542E-15	2.915E-15	0.000E+00
Eu-152	∑DSR(j)		1.105E+00	1.048E+00	9.443E-01	6.550E-01	2.303E-01	5.934E-03	1.713E-07	2.915E-15	0.000E+00
Eu-154	Eu-154	1.000E+00	4.347E+00	4.017E+00	3.429E+00	1.972E+00	4.059E-01	1.606E-03	2.193E-10	2.062E-34	0.000E+00
Eu-155	Eu-155	1.000E+00	1.067E-01	9.272E-02	7.007E-02	2.630E-02	1.599E-03	8.857E-08	6.107E-20	0.000E+00	0.000E+00

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	t= 0.000E+00	1.000E+00	3.000E+00	DSR(j,t) 1.000E+01	(mrem/yr)/(pCi/g) 3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
Fe-55	Fe-55	1.000E+00	5.891E-04	4.557E-04	2.727E-04	4.520E-05	2.660E-07	4.160E-15	2.071E-37	0.000E+00	0.000E+00
H-3	H-3	1.000E+00	9.683E-02	9.978E-03	8.192E-03	5.836E-03	1.902E-03	7.655E-41	0.000E+00	0.000E+00	0.000E+00
Nb-94	Nb-94	1.000E+00	5.457E+00	2.087E+00	1.063E+00	9.568E-01	9.572E-01	1.943E-36	0.000E+00	0.000E+00	0.000E+00
Ni-59	Ni-59	1.000E+00	5.413E-03	5.412E-03	5.409E-03	5.401E-03	5.376E-03	5.291E-03	5.036E-03	3.212E-03	0.000E+00
Ni-63	Ni-63	1.000E+00	1.487E-02	1.476E-02	1.454E-02	1.381E-02	1.190E-02	7.068E-03	1.590E-03	6.516E-06	0.000E+00
Pu-238	Pu-238	1.000E+00	1.048E+00	1.039E+00	1.023E+00	9.670E-01	8.239E-01	4.703E-01	9.444E-02	2.634E-04	0.000E+00
Pu-238	U-234	1.000E+00	0.000E+00	6.625E-07	1.990E-06	6.381E-06	1.694E-05	3.680E-05	4.454E-05	5.594E-05	2.525E-10
Pu-238	Th-230	1.000E+00	0.000E+00	2.625E-12	2.219E-11	2.346E-10	1.935E-09	1.626E-08	7.098E-08	1.030E-07	4.865E-09
Pu-238	Ra-226	1.000E+00	0.000E+00	3.847E-14	1.086E-12	3.986E-11	9.997E-10	2.826E-08	3.666E-07	1.535E-06	9.396E-06
Pu-238	Pb-210	1.000E+00	0.000E+00	4.306E-16	2.843E-14	3.010E-12	1.966E-10	1.324E-08	2.779E-07	1.760E-06	3.490E-05
Pu-238	∑DSR(j)		1.048E+00	1.039E+00	1.023E+00	9.671E-01	8.239E-01	4.703E-01	9.448E-02	3.228E-04	4.430E-05
Pu-239	Pu-239	1.000E+00	1.159E+00	1.159E+00	1.158E+00	1.157E+00	1.154E+00	1.143E+00	1.108E+00	7.636E-01	0.000E+00
Pu-239	U-235	1.000E+00	0.000E+00	6.426E-10	1.928E-09	6.337E-09	1.819E-08	5.213E-08	1.106E-07	1.990E-07	1.388E-07
Pu-239	Pa-231	1.000E+00	0.000E+00	3.387E-13	3.168E-12	3.502E-11	2.984E-10	2.710E-09	1.512E-08	7.086E-08	5.023E-07
Pu-239	Ac-227	1.000E+00	0.000E+00	1.793E-15	4.029E-14	1.277E-12	2.667E-11	4.983E-10	8.250E-09	1.610E-07	1.612E-06
Pu-239	∑DSR(j)		1.159E+00	1.159E+00	1.158E+00	1.157E+00	1.154E+00	1.143E+00	1.108E+00	7.636E-01	2.253E-06
Pu-240	Pu-240	1.000E+00	1.159E+00	1.159E+00	1.158E+00	1.156E+00	1.151E+00	1.134E+00	1.082E+00	7.068E-01	0.000E+00
Pu-240	U-236	1.000E+00	0.000E+00	6.609E-09	2.008E-08	6.701E-08	1.994E-07	6.434E-07	1.751E-06	3.229E-06	7.038E-07
Pu-240	Th-232	1.000E+00	0.000E+00	7.495E-19	6.382E-18	6.931E-17	6.161E-16	6.682E-15	5.628E-14	3.907E-13	2.487E-15
Pu-240	Ra-228	1.000E+00	0.000E+00	5.454E-19	1.475E-17	4.598E-16	8.027E-15	1.236E-13	1.160E-12	8.411E-12	1.195E-12
Pu-240	Th-228	1.000E+00	0.000E+00	1.754E-20	1.067E-18	7.246E-17	1.902E-15	3.422E-14	3.351E-13	3.120E-12	2.513E-15
Pu-240	∑DSR(j)		1.159E+00	1.159E+00	1.158E+00	1.156E+00	1.151E+00	1.134E+00	1.082E+00	7.068E-01	7.038E-07
Pu-241	Pu-241	1.000E+00	2.243E-02	2.137E-02	1.941E-02	1.385E-02	5.275E-03	1.801E-04	1.158E-08	1.894E-23	0.000E+00
Pu-241	Am-241	1.000E+00	0.000E+00	1.886E-03	5.327E-03	1.442E-02	2.459E-02	4.862E-02	1.066E-01	3.692E-02	0.000E+00
Pu-241	Np-237	1.000E+00	0.000E+00	6.463E-09	5.843E-08	5.738E-07	3.576E-06	1.385E-05	1.954E-05	1.018E-05	3.286E-06
Pu-241	U-233	1.000E+00	0.000E+00	1.482E-16	2.920E-15	8.503E-14	1.656E-12	2.673E-11	1.694E-10	5.999E-10	7.487E-09
Pu-241	Th-229	1.000E+00	0.000E+00	2.378E-20	1.669E-18	1.834E-16	1.172E-14	7.388E-13	1.643E-11	1.734E-10	8.918E-12
Pu-241	∑DSR(j)		2.243E-02	2.326E-02	2.473E-02	2.827E-02	2.987E-02	4.881E-02	1.066E-01	3.693E-02	3.294E-06
Pu-241	Pu-241	2.450E-05	5.496E-07	5.237E-07	4.755E-07	3.392E-07	1.293E-07	4.413E-09	2.836E-13	4.640E-28	0.000E+00
Pu-241	Np-237	2.450E-05	0.000E+00	2.034E-10	5.949E-10	1.697E-09	3.361E-09	4.139E-09	3.508E-09	1.428E-09	5.367E-11
Pu-241	U-233	2.450E-05	0.000E+00	6.002E-18	4.186E-17	3.784E-16	2.486E-15	1.316E-14	3.937E-14	6.049E-14	1.297E-13
Pu-241	Th-229	2.450E-05	0.000E+00	1.381E-21	3.358E-20	1.119E-18	2.413E-17	4.974E-16	5.204E-15	3.751E-14	1.685E-15
Pu-241	∑DSR(j)		5.496E-07	5.239E-07	4.761E-07	3.409E-07	1.326E-07	8.552E-09	3.508E-09	1.428E-09	5.380E-11

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
Pu-242	Pu-242	1.000E+00	1.100E+00	1.100E+00	1.100E+00	1.099E+00	1.096E+00	1.088E+00	1.060E+00	7.447E-01	0.000E+00
Pu-242	U-238	1.000E+00	0.000E+00	4.651E-11	1.403E-10	4.621E-10	1.328E-09	3.809E-09	8.542E-09	2.059E-08	2.563E-08
Pu-242	U-234	1.000E+00	0.000E+00	5.257E-17	4.706E-16	5.122E-15	4.347E-14	3.946E-13	2.663E-12	2.977E-11	3.298E-10
Pu-242	Th-230	1.000E+00	0.000E+00	8.968E-22	4.268E-21	1.250E-19	3.182E-18	1.010E-16	1.808E-15	1.635E-14	3.571E-14
Pu-242	Ra-226	1.000E+00	0.000E+00	6.290E-21	6.413E-21	2.193E-20	1.221E-18	1.267E-16	6.823E-15	2.609E-13	5.253E-11
Pu-242	Pb-210	1.000E+00	0.000E+00	3.439E-21	3.440E-21	4.399E-21	1.994E-19	5.033E-17	5.860E-15	5.187E-13	1.945E-10
Pu-242	∑DSR(j)		1.100E+00	1.100E+00	1.100E+00	1.099E+00	1.096E+00	1.088E+00	1.060E+00	7.447E-01	2.620E-08
Sb-125	Sb-125	1.000E+00	1.392E+00	4.599E-01	1.889E-01	3.116E-02	2.092E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	Sr-90	1.000E+00	1.564E+01	1.526E+01	1.455E+01	1.230E+01	7.605E+00	1.415E+00	1.155E-02	4.207E-10	0.000E+00
Tc-99	Tc-99	1.000E+00	2.197E+00	2.109E+00	1.938E+00	1.441E+00	6.227E-01	4.240E-02	1.086E-02	1.710E-08	0.000E+00
U-234	U-234	1.000E+00	2.399E-01	2.389E-01	2.368E-01	2.296E-01	2.104E-01	1.548E-01	1.415E-01	1.658E-01	3.234E-07
U-234	Th-230	1.000E+00	0.000E+00	1.784E-06	5.173E-06	1.680E-05	4.813E-05	1.384E-04	2.840E-04	2.954E-04	1.432E-05
U-234	Ra-226	1.000E+00	0.000E+00	4.182E-08	3.880E-07	4.286E-06	3.673E-05	3.408E-04	1.880E-03	4.754E-03	2.768E-02
U-234	Pb-210	1.000E+00	0.000E+00	5.731E-10	1.298E-08	4.187E-07	9.133E-06	1.869E-04	1.527E-03	5.819E-03	1.028E-01
U-234	∑DSR(j)		2.399E-01	2.389E-01	2.368E-01	2.297E-01	2.105E-01	1.555E-01	1.451E-01	1.767E-01	1.305E-01
U-235	U-235	1.000E+00	6.585E-01	6.556E-01	6.499E-01	6.303E-01	5.775E-01	4.251E-01	2.498E-01	1.623E-01	3.139E-07
U-235	Pa-231	1.000E+00	0.000E+00	7.098E-04	2.159E-03	7.035E-03	1.938E-02	4.754E-02	7.784E-02	1.384E-01	2.432E-06
U-235	Ac-227	1.000E+00	0.000E+00	5.067E-06	3.914E-05	3.691E-04	2.397E-03	1.134E-02	8.320E-02	4.284E-01	5.802E-06
U-235	∑DSR(j)		6.585E-01	6.563E-01	6.521E-01	6.377E-01	5.992E-01	4.840E-01	4.109E-01	7.291E-01	8.548E-06
U-238	U-238	1.000E+00	3.050E-01	3.037E-01	3.011E-01	2.920E-01	2.675E-01	1.969E-01	1.553E-01	1.590E-01	3.162E-07
U-238	U-234	1.000E+00	0.000E+00	6.772E-07	2.014E-06	6.510E-06	1.789E-05	4.390E-05	1.203E-04	4.708E-04	9.299E-09
U-238	Th-230	1.000E+00	0.000E+00	2.633E-12	2.227E-11	2.375E-10	2.005E-09	1.821E-08	9.519E-08	1.829E-07	1.880E-07
U-238	Ra-226	1.000E+00	0.000E+00	3.851E-14	1.089E-12	4.022E-11	1.027E-09	3.080E-08	5.258E-07	5.299E-06	2.773E-04
U-238	Pb-210	1.000E+00	0.000E+00	4.270E-16	2.850E-14	3.032E-12	2.010E-10	1.426E-08	5.811E-07	1.305E-05	1.027E-03
U-238	∑DSR(j)		3.050E-01	3.037E-01	3.011E-01	2.920E-01	2.675E-01	1.970E-01	1.554E-01	1.595E-01	1.305E-03

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
Am-241	2.063E+01	2.089E+01	2.141E+01	2.337E+01	2.999E+01	1.226E+01	7.846E+00	2.252E+01	2.475E+05
C-14	3.756E+00	7.459E+01	3.376E+01	3.195E+01	3.199E+01	*4.454E+12	*4.454E+12	*4.454E+12	*4.454E+12
Cm-243	2.176E+01	2.230E+01	2.342E+01	2.779E+01	4.530E+01	2.486E+02	1.212E+04	2.738E+04	9.458E+09
Cm-244	3.808E+01	3.956E+01	4.271E+01	5.580E+01	1.194E+02	1.458E+03	8.307E+03	1.275E+04	1.312E+10
Co-60	2.502E+00	2.854E+00	3.712E+00	9.323E+00	1.295E+02	1.292E+06	*1.131E+15	*1.131E+15	*1.131E+15
Cs-134	3.670E+00	5.138E+00	1.007E+01	1.061E+02	8.856E+04	*1.294E+15	*1.294E+15	*1.294E+15	*1.294E+15
Cs-137	8.522E+00	8.723E+00	9.140E+00	1.076E+01	1.716E+01	8.780E+01	9.333E+03	1.259E+11	*8.701E+13
Eu-152	6.319E+00	6.658E+00	7.392E+00	1.066E+01	3.031E+01	1.176E+03	4.076E+07	*1.765E+14	*1.765E+14
Eu-154	5.751E+00	6.224E+00	7.290E+00	1.268E+01	6.158E+01	1.556E+04	1.140E+11	*2.639E+14	*2.639E+14
Eu-155	2.344E+02	2.696E+02	3.568E+02	9.507E+02	1.564E+04	2.823E+08	*4.651E+14	*4.651E+14	*4.651E+14
Fe-55	4.243E+04	5.486E+04	9.167E+04	5.531E+05	9.399E+07	*2.409E+15	*2.409E+15	*2.409E+15	*2.409E+15
H-3	2.582E+02	2.506E+03	3.052E+03	4.284E+03	1.315E+04	*9.594E+15	*9.594E+15	*9.594E+15	*9.594E+15
Nb-94	4.581E+00	1.198E+01	2.351E+01	2.613E+01	2.612E+01	*1.875E+11	*1.875E+11	*1.875E+11	*1.875E+11
Ni-59	4.619E+03	4.620E+03	4.622E+03	4.629E+03	4.650E+03	4.725E+03	4.965E+03	7.784E+03	*8.085E+10
Ni-63	1.681E+03	1.693E+03	1.719E+03	1.811E+03	2.101E+03	3.537E+03	1.572E+04	3.837E+06	*5.916E+13
Pu-238	2.386E+01	2.405E+01	2.444E+01	2.585E+01	3.034E+01	5.315E+01	2.646E+02	7.746E+04	5.643E+05
Pu-239	2.157E+01	2.158E+01	2.158E+01	2.160E+01	2.166E+01	2.187E+01	2.257E+01	3.274E+01	1.110E+07
Pu-240	2.157E+01	2.158E+01	2.159E+01	2.162E+01	2.171E+01	2.204E+01	2.310E+01	3.537E+01	3.552E+07
Pu-241	1.115E+03	1.075E+03	1.011E+03	8.843E+02	8.369E+02	5.122E+02	2.346E+02	6.770E+02	7.590E+06
Pu-242	2.273E+01	2.273E+01	2.273E+01	2.275E+01	2.280E+01	2.298E+01	2.358E+01	3.357E+01	9.541E+08
Sb-125	1.796E+01	5.436E+01	1.323E+02	8.023E+02	1.195E+05	*1.033E+15	*1.033E+15	*1.033E+15	*1.033E+15
Sr-90	1.599E+00	1.638E+00	1.718E+00	2.033E+00	3.287E+00	1.767E+01	2.165E+03	5.943E+10	*1.365E+14
Tc-99	1.138E+01	1.185E+01	1.290E+01	1.735E+01	4.015E+01	5.896E+02	2.302E+03	1.462E+09	*1.696E+10
U-234	1.042E+02	1.047E+02	1.056E+02	1.089E+02	1.188E+02	1.608E+02	1.722E+02	1.415E+02	1.915E+02
U-235	3.797E+01	3.809E+01	3.834E+01	3.920E+01	4.172E+01	5.166E+01	6.085E+01	3.429E+01	*2.160E+06
U-238	8.196E+01	8.231E+01	8.303E+01	8.561E+01	9.344E+01	1.269E+02	1.609E+02	1.567E+02	1.916E+04

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)	Drinking H2O DCGLs (pCi/g)
Am-241	1.000E+00	237.0 ± 0.5	3.284E+00	7.613E+00	1.212E+00	2.063E+01	1.5
C-14	1.000E+00	0.000E+00	6.656E+00	3.756E+00	6.656E+00	3.756E+00	
Cm-243	1.000E+00	0.000E+00	1.149E+00	2.176E+01	1.149E+00	2.176E+01	
Cm-244	1.000E+00	0.000E+00	6.565E-01	3.808E+01	6.565E-01	3.808E+01	
Co-60	1.000E+00	0.000E+00	9.992E+00	2.502E+00	9.992E+00	2.502E+00	
Cs-134	1.000E+00	0.000E+00	6.811E+00	3.670E+00	6.811E+00	3.670E+00	
Cs-137	1.000E+00	0.000E+00	2.934E+00	8.522E+00	2.934E+00	8.522E+00	
Eu-152	1.000E+00	0.000E+00	3.956E+00	6.319E+00	3.956E+00	6.319E+00	
Eu-154	1.000E+00	0.000E+00	4.347E+00	5.751E+00	4.347E+00	5.751E+00	
Eu-155	1.000E+00	0.000E+00	1.067E-01	2.344E+02	1.067E-01	2.344E+02	
Fe-55	1.000E+00	0.000E+00	5.891E-04	4.243E+04	5.891E-04	4.243E+04	
H-3	1.000E+00	0.000E+00	9.683E-02	2.582E+02	9.683E-02	2.582E+02	
Nb-94	1.000E+00	0.000E+00	5.457E+00	4.581E+00	5.457E+00	4.581E+00	
Ni-59	1.000E+00	0.000E+00	5.413E-03	4.619E+03	5.413E-03	4.619E+03	
Ni-63	1.000E+00	0.000E+00	1.487E-02	1.681E+03	1.487E-02	1.681E+03	
Pu-238	1.000E+00	0.000E+00	1.048E+00	2.386E+01	1.048E+00	2.386E+01	
Pu-239	1.000E+00	0.000E+00	1.159E+00	2.157E+01	1.159E+00	2.157E+01	
Pu-240	1.000E+00	0.000E+00	1.159E+00	2.157E+01	1.159E+00	2.157E+01	
Pu-241	1.000E+00	262.3 ± 0.5	1.079E-01	2.317E+02	2.243E-02	1.115E+03	45
Pu-242	1.000E+00	0.000E+00	1.100E+00	2.273E+01	1.100E+00	2.273E+01	
Sb-125	1.000E+00	0.000E+00	1.392E+00	1.796E+01	1.392E+00	1.796E+01	
Sr-90	1.000E+00	0.000E+00	1.564E+01	1.599E+00	1.564E+01	1.599E+00	
Tc-99	1.000E+00	0.000E+00	2.197E+00	1.138E+01	2.197E+00	1.138E+01	
U-234	1.000E+00	7246 ± *	2.761E-01	9.056E+01	2.399E-01	1.042E+02	18
U-235	1.000E+00	7071 ± *	3.989E+00	6.267E+00	6.585E-01	3.797E+01	1.2
U-238	1.000E+00	0.000E+00	3.050E-01	8.196E+01	3.050E-01	8.196E+01	30

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
Am-241	Am-241	1.000E+00	1.212E+00	1.197E+00	1.167E+00	1.070E+00	8.334E-01	2.039E+00	3.186E+00	1.110E+00	0.000E+00
Am-241	Pu-241	1.000E+00	0.000E+00	1.886E-03	5.327E-03	1.442E-02	2.459E-02	4.862E-02	1.066E-01	3.692E-02	0.000E+00
Am-241	∑DOSE(j):		1.212E+00	1.199E+00	1.173E+00	1.084E+00	8.580E-01	2.087E+00	3.292E+00	1.147E+00	0.000E+00
Np-237	Am-241	1.000E+00	0.000E+00	8.446E-06	2.558E-05	8.208E-05	2.169E-04	4.786E-04	5.858E-04	3.057E-04	1.008E-04
Np-237	Pu-241	1.000E+00	0.000E+00	6.463E-09	5.843E-08	5.738E-07	3.576E-06	1.385E-05	1.954E-05	1.018E-05	3.286E-06
Np-237	Pu-241	2.450E-05	0.000E+00	2.034E-10	5.949E-10	1.697E-09	3.361E-09	4.139E-09	3.508E-09	1.428E-09	5.367E-11
Np-237	∑DOSE(j):		0.000E+00	8.453E-06	2.564E-05	8.265E-05	2.205E-04	4.924E-04	6.053E-04	3.159E-04	1.041E-04
U-233	Am-241	1.000E+00	0.000E+00	2.483E-13	1.774E-12	1.734E-11	1.384E-10	1.137E-09	5.595E-09	1.859E-08	2.307E-07
U-233	Pu-241	1.000E+00	0.000E+00	1.482E-16	2.920E-15	8.503E-14	1.656E-12	2.673E-11	1.694E-10	5.999E-10	7.487E-09
U-233	Pu-241	2.450E-05	0.000E+00	6.002E-18	4.186E-17	3.784E-16	2.486E-15	1.316E-14	3.937E-14	6.049E-14	1.297E-13
U-233	∑DOSE(j):		0.000E+00	2.484E-13	1.777E-12	1.743E-11	1.400E-10	1.163E-09	5.765E-09	1.919E-08	2.382E-07
Th-229	Am-241	1.000E+00	0.000E+00	5.689E-17	1.408E-15	4.974E-14	1.246E-12	3.678E-11	5.788E-10	5.397E-09	2.682E-10
Th-229	Pu-241	1.000E+00	0.000E+00	2.378E-20	1.669E-18	1.834E-16	1.172E-14	7.388E-13	1.643E-11	1.734E-10	8.918E-12
Th-229	Pu-241	2.450E-05	0.000E+00	1.381E-21	3.358E-20	1.119E-18	2.413E-17	4.974E-16	5.204E-15	3.751E-14	1.685E-15
Th-229	∑DOSE(j):		0.000E+00	5.692E-17	1.410E-15	4.993E-14	1.258E-12	3.752E-11	5.952E-10	5.571E-09	2.771E-10
C-14	C-14	1.000E+00	6.656E+00	3.352E-01	7.405E-01	7.826E-01	7.816E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cm-243	Cm-243	9.976E-01	1.146E+00	1.118E+00	1.065E+00	8.971E-01	5.498E-01	9.908E-02	7.389E-04	2.211E-11	0.000E+00
Cm-243	Cm-243	2.400E-03	2.757E-03	2.690E-03	2.562E-03	2.158E-03	1.323E-03	2.384E-04	1.778E-06	5.319E-14	0.000E+00
Cm-243	∑DOSE(j):		1.149E+00	1.121E+00	1.067E+00	8.992E-01	5.511E-01	9.932E-02	7.406E-04	2.216E-11	0.000E+00
Pu-239	Cm-243	9.976E-01	0.000E+00	3.288E-05	9.629E-05	2.951E-04	7.060E-04	1.231E-03	1.307E-03	9.014E-04	0.000E+00
Pu-239	Cm-243	2.400E-03	0.000E+00	3.730E-12	3.303E-11	3.470E-10	2.681E-09	1.906E-08	7.652E-08	1.954E-07	0.000E+00
Pu-239	Pu-239	1.000E+00	1.159E+00	1.159E+00	1.158E+00	1.157E+00	1.154E+00	1.143E+00	1.108E+00	7.636E-01	0.000E+00
Pu-239	∑DOSE(j):		1.159E+00	1.159E+00	1.159E+00	1.158E+00	1.155E+00	1.144E+00	1.109E+00	7.645E-01	0.000E+00
U-235	Cm-243	9.976E-01	0.000E+00	9.105E-15	8.110E-14	8.459E-13	6.350E-12	4.025E-11	1.179E-10	2.275E-10	1.639E-10
U-235	Cm-243	2.400E-03	0.000E+00	6.831E-22	1.842E-20	6.518E-19	1.535E-17	3.705E-16	4.060E-15	2.900E-14	8.764E-14
U-235	Pu-239	1.000E+00	0.000E+00	6.426E-10	1.928E-09	6.337E-09	1.819E-08	5.213E-08	1.106E-07	1.990E-07	1.388E-07
U-235	U-235	1.000E+00	6.585E-01	6.556E-01	6.499E-01	6.303E-01	5.775E-01	4.251E-01	2.498E-01	1.623E-01	3.139E-07
U-235	∑DOSE(j):		6.585E-01	6.556E-01	6.499E-01	6.303E-01	5.775E-01	4.251E-01	2.498E-01	1.623E-01	4.529E-07
Pa-231	Cm-243	9.976E-01	0.000E+00	3.128E-18	8.863E-17	3.171E-15	7.345E-14	1.634E-12	1.457E-11	7.922E-11	5.888E-10
Pa-231	Cm-243	2.400E-03	0.000E+00	2.446E-25	1.500E-23	1.815E-21	1.304E-19	1.067E-17	3.380E-16	6.324E-15	2.839E-13
Pa-231	Pu-239	1.000E+00	0.000E+00	3.387E-13	3.168E-12	3.502E-11	2.984E-10	2.710E-09	1.512E-08	7.086E-08	5.023E-07
Pa-231	U-235	1.000E+00	0.000E+00	7.098E-04	2.159E-03	7.035E-03	1.938E-02	4.754E-02	7.784E-02	1.384E-01	2.432E-06
Pa-231	∑DOSE(j):		0.000E+00	7.098E-04	2.159E-03	7.035E-03	1.938E-02	4.754E-02	7.784E-02	1.384E-01	2.935E-06
Ac-227	Cm-243	9.976E-01	0.000E+00	1.366E-20	8.875E-19	9.044E-17	5.345E-15	2.690E-13	7.248E-12	1.768E-10	1.889E-09
Ac-227	Cm-243	2.400E-03	0.000E+00	3.010E-25	4.290E-25	4.264E-23	7.817E-21	1.503E-18	1.097E-16	1.033E-14	9.104E-13
Ac-227	Pu-239	1.000E+00	0.000E+00	1.793E-15	4.029E-14	1.277E-12	2.667E-11	4.983E-10	8.250E-09	1.610E-07	1.612E-06
Ac-227	U-235	1.000E+00	0.000E+00	5.067E-06	3.914E-05	3.691E-04	2.397E-03	1.134E-02	8.320E-02	4.284E-01	5.802E-06
Ac-227	∑DOSE(j):		0.000E+00	5.067E-06	3.914E-05	3.691E-04	2.397E-03	1.134E-02	8.320E-02	4.284E-01	7.415E-06
Am-243	Cm-243	2.400E-03	0.000E+00	3.778E-07	1.106E-06	3.390E-06	8.109E-06	1.414E-05	1.503E-05	1.136E-05	0.000E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
Cm-244	Cm-244	1.000E+00	6.565E-01	6.318E-01	5.850E-01	4.470E-01	2.073E-01	1.406E-02	6.431E-06	1.009E-17	0.000E+00
Pu-240	Cm-244	1.000E+00	0.000E+00	1.205E-04	3.480E-04	1.019E-03	2.179E-03	3.078E-03	3.003E-03	1.961E-03	0.000E+00
Pu-240	Pu-240	1.000E+00	1.159E+00	1.159E+00	1.158E+00	1.156E+00	1.151E+00	1.134E+00	1.082E+00	7.068E-01	0.000E+00
Pu-240	∑DOSE(j):		1.159E+00	1.159E+00	1.158E+00	1.157E+00	1.154E+00	1.137E+00	1.085E+00	7.088E-01	0.000E+00
U-236	Cm-244	1.000E+00	0.000E+00	3.394E-13	3.056E-12	3.137E-11	2.244E-10	1.334E-09	4.462E-09	8.778E-09	1.906E-09
U-236	Pu-240	1.000E+00	0.000E+00	6.609E-09	2.008E-08	6.701E-08	1.994E-07	6.434E-07	1.751E-06	3.229E-06	7.038E-07
U-236	∑DOSE(j):		0.000E+00	6.609E-09	2.008E-08	6.704E-08	1.996E-07	6.447E-07	1.756E-06	3.238E-06	7.057E-07
Th-232	Cm-244	1.000E+00	0.000E+00	2.717E-23	6.668E-22	2.242E-20	5.029E-19	1.134E-17	1.316E-16	1.031E-15	6.571E-18
Th-232	Pu-240	1.000E+00	0.000E+00	7.495E-19	6.382E-18	6.931E-17	6.161E-16	6.682E-15	5.628E-14	3.907E-13	2.487E-15
Th-232	∑DOSE(j):		0.000E+00	7.495E-19	6.383E-18	6.934E-17	6.167E-16	6.694E-15	5.641E-14	3.918E-13	2.494E-15
Ra-228	Cm-244	1.000E+00	0.000E+00	1.404E-23	1.155E-21	1.187E-19	5.741E-18	2.028E-16	2.699E-15	2.218E-14	3.158E-15
Ra-228	Pu-240	1.000E+00	0.000E+00	5.454E-19	1.475E-17	4.598E-16	8.027E-15	1.236E-13	1.160E-12	8.411E-12	1.195E-12
Ra-228	∑DOSE(j):		0.000E+00	5.454E-19	1.475E-17	4.599E-16	8.033E-15	1.238E-13	1.163E-12	8.433E-12	1.198E-12
Th-228	Cm-244	1.000E+00	0.000E+00	4.037E-25	7.069E-23	1.642E-20	1.277E-18	5.543E-17	7.784E-16	8.227E-15	6.642E-18
Th-228	Pu-240	1.000E+00	0.000E+00	1.754E-20	1.067E-18	7.246E-17	1.902E-15	3.422E-14	3.351E-13	3.120E-12	2.513E-15
Th-228	∑DOSE(j):		0.000E+00	1.754E-20	1.067E-18	7.247E-17	1.903E-15	3.427E-14	3.359E-13	3.128E-12	2.519E-15
Co-60	Co-60	1.000E+00	9.992E+00	8.761E+00	6.734E+00	2.681E+00	1.931E-01	1.935E-05	7.255E-17	0.000E+00	0.000E+00
Cs-134	Cs-134	1.000E+00	6.811E+00	4.866E+00	2.483E+00	2.357E-01	2.823E-04	1.678E-14	0.000E+00	0.000E+00	0.000E+00
Cs-137	Cs-137	1.000E+00	2.934E+00	2.866E+00	2.735E+00	2.323E+00	1.457E+00	2.847E-01	2.679E-03	1.985E-10	0.000E+00
Eu-152	Eu-152	7.208E-01	2.852E+00	2.707E+00	2.438E+00	1.691E+00	5.945E-01	1.532E-02	4.421E-07	5.707E-23	0.000E+00
Eu-152	Eu-152	2.792E-01	1.105E+00	1.048E+00	9.443E-01	6.550E-01	2.303E-01	5.934E-03	1.713E-07	2.210E-23	0.000E+00
Eu-152	∑DOSE(j):		3.956E+00	3.755E+00	3.382E+00	2.346E+00	8.248E-01	2.125E-02	6.134E-07	7.917E-23	0.000E+00
Gd-152	Eu-152	2.792E-01	0.000E+00	2.500E-16	7.123E-16	1.996E-15	3.867E-15	4.779E-15	4.542E-15	2.915E-15	0.000E+00
Eu-154	Eu-154	1.000E+00	4.347E+00	4.017E+00	3.429E+00	1.972E+00	4.059E-01	1.606E-03	2.193E-10	0.000E+00	0.000E+00
Eu-155	Eu-155	1.000E+00	1.067E-01	9.272E-02	7.007E-02	2.630E-02	1.599E-03	8.857E-08	6.107E-20	0.000E+00	0.000E+00
Fe-55	Fe-55	1.000E+00	5.891E-04	4.557E-04	2.727E-04	4.520E-05	2.660E-07	4.160E-15	0.000E+00	0.000E+00	0.000E+00
H-3	H-3	1.000E+00	9.683E-02	9.978E-03	8.192E-03	5.836E-03	1.902E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	Nb-94	1.000E+00	5.457E+00	2.087E+00	1.063E+00	9.568E-01	9.572E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-59	Ni-59	1.000E+00	5.413E-03	5.412E-03	5.409E-03	5.401E-03	5.376E-03	5.291E-03	5.036E-03	3.212E-03	0.000E+00
Ni-63	Ni-63	1.000E+00	1.487E-02	1.476E-02	1.454E-02	1.381E-02	1.190E-02	7.068E-03	1.590E-03	6.516E-06	0.000E+00
Pu-238	Pu-238	1.000E+00	1.048E+00	1.039E+00	1.023E+00	9.670E-01	8.239E-01	4.703E-01	9.444E-02	2.634E-04	0.000E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
U-234	Pu-238	1.000E+00	0.000E+00	6.625E-07	1.990E-06	6.381E-06	1.694E-05	3.680E-05	4.454E-05	5.594E-05	2.525E-10
U-234	Pu-242	1.000E+00	0.000E+00	5.257E-17	4.706E-16	5.122E-15	4.347E-14	3.946E-13	2.663E-12	2.977E-11	3.298E-10
U-234	U-234	1.000E+00	2.399E-01	2.389E-01	2.368E-01	2.296E-01	2.104E-01	1.548E-01	1.415E-01	1.658E-01	3.234E-07
U-234	U-238	1.000E+00	0.000E+00	6.772E-07	2.014E-06	6.510E-06	1.789E-05	4.390E-05	1.203E-04	4.708E-04	9.299E-09
U-234	∑DOSE(j):		2.399E-01	2.389E-01	2.368E-01	2.296E-01	2.104E-01	1.549E-01	1.416E-01	1.663E-01	3.333E-07
Th-230	Pu-238	1.000E+00	0.000E+00	2.625E-12	2.219E-11	2.346E-10	1.935E-09	1.626E-08	7.098E-08	1.030E-07	4.865E-09
Th-230	Pu-242	1.000E+00	0.000E+00	8.968E-22	4.268E-21	1.250E-19	3.182E-18	1.010E-16	1.808E-15	1.635E-14	3.571E-14
Th-230	U-234	1.000E+00	0.000E+00	1.784E-06	5.173E-06	1.680E-05	4.813E-05	1.384E-04	2.840E-04	2.954E-04	1.432E-05
Th-230	U-238	1.000E+00	0.000E+00	2.633E-12	2.227E-11	2.375E-10	2.005E-09	1.821E-08	9.519E-08	1.829E-07	1.880E-07
Th-230	∑DOSE(j):		0.000E+00	1.784E-06	5.173E-06	1.680E-05	4.813E-05	1.384E-04	2.842E-04	2.957E-04	1.451E-05
Ra-226	Pu-238	1.000E+00	0.000E+00	3.847E-14	1.086E-12	3.986E-11	9.997E-10	2.826E-08	3.666E-07	1.535E-06	9.396E-06
Ra-226	Pu-242	1.000E+00	0.000E+00	6.290E-21	6.413E-21	2.193E-20	1.221E-18	1.267E-16	6.823E-15	2.609E-13	5.253E-11
Ra-226	U-234	1.000E+00	0.000E+00	4.182E-08	3.880E-07	4.286E-06	3.673E-05	3.408E-04	1.880E-03	4.754E-03	2.768E-02
Ra-226	U-238	1.000E+00	0.000E+00	3.851E-14	1.089E-12	4.022E-11	1.027E-09	3.080E-08	5.258E-07	5.299E-06	2.773E-04
Ra-226	∑DOSE(j):		0.000E+00	4.182E-08	3.880E-07	4.286E-06	3.673E-05	3.409E-04	1.881E-03	4.761E-03	2.796E-02
Pb-210	Pu-238	1.000E+00	0.000E+00	4.306E-16	2.843E-14	3.010E-12	1.966E-10	1.324E-08	2.779E-07	1.760E-06	3.490E-05
Pb-210	Pu-242	1.000E+00	0.000E+00	3.439E-21	3.440E-21	4.399E-21	1.994E-19	5.033E-17	5.860E-15	5.187E-13	1.945E-10
Pb-210	U-234	1.000E+00	0.000E+00	5.731E-10	1.298E-08	4.187E-07	9.133E-06	1.869E-04	1.527E-03	5.819E-03	1.028E-01
Pb-210	U-238	1.000E+00	0.000E+00	4.270E-16	2.850E-14	3.032E-12	2.010E-10	1.426E-08	5.811E-07	1.305E-05	1.027E-03
Pb-210	∑DOSE(j):		0.000E+00	5.731E-10	1.298E-08	4.187E-07	9.133E-06	1.869E-04	1.528E-03	5.834E-03	1.039E-01
Pu-241	Pu-241	1.000E+00	2.243E-02	2.137E-02	1.941E-02	1.385E-02	5.275E-03	1.801E-04	1.158E-08	1.894E-23	0.000E+00
Pu-241	Pu-241	2.450E-05	5.496E-07	5.237E-07	4.755E-07	3.392E-07	1.293E-07	4.413E-09	2.836E-13	4.636E-28	0.000E+00
Pu-241	∑DOSE(j):		2.243E-02	2.137E-02	1.941E-02	1.385E-02	5.276E-03	1.801E-04	1.158E-08	1.894E-23	0.000E+00
Pu-242	Pu-242	1.000E+00	1.100E+00	1.100E+00	1.100E+00	1.099E+00	1.096E+00	1.088E+00	1.060E+00	7.447E-01	0.000E+00
U-238	Pu-242	1.000E+00	0.000E+00	4.651E-11	1.403E-10	4.621E-10	1.328E-09	3.809E-09	8.542E-09	2.059E-08	2.563E-08
U-238	U-238	1.000E+00	3.050E-01	3.037E-01	3.011E-01	2.920E-01	2.675E-01	1.969E-01	1.553E-01	1.590E-01	3.162E-07
U-238	∑DOSE(j):		3.050E-01	3.037E-01	3.011E-01	2.920E-01	2.675E-01	1.969E-01	1.553E-01	1.590E-01	3.418E-07
Sb-125	Sb-125	1.000E+00	1.392E+00	4.599E-01	1.889E-01	3.116E-02	2.092E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	Sr-90	1.000E+00	1.564E+01	1.526E+01	1.455E+01	1.230E+01	7.605E+00	1.415E+00	1.155E-02	4.207E-10	0.000E+00
Tc-99	Tc-99	1.000E+00	2.197E+00	2.109E+00	1.938E+00	1.441E+00	6.227E-01	4.240E-02	1.086E-02	1.710E-08	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g								
		t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
Am-241	Am-241	1.000E+00	1.000E+00	9.876E-01	9.632E-01	8.826E-01	6.876E-01	2.869E-01	2.362E-02	3.783E-06	0.000E+00
Am-241	Pu-241	1.000E+00	0.000E+00	1.556E-03	4.394E-03	1.190E-02	2.029E-02	1.251E-02	1.059E-03	1.697E-07	0.000E+00
Am-241	∑S(j):		1.000E+00	9.891E-01	9.676E-01	8.945E-01	7.079E-01	2.994E-01	2.468E-02	3.953E-06	0.000E+00
Np-237	Am-241	1.000E+00	0.000E+00	3.217E-07	9.525E-07	3.032E-06	7.996E-06	1.758E-05	2.090E-05	1.187E-05	5.501E-09
Np-237	Pu-241	1.000E+00	0.000E+00	2.545E-10	2.199E-09	2.126E-08	1.319E-07	5.094E-07	7.000E-07	4.016E-07	1.861E-10
Np-237	Pu-241	2.450E-05	0.000E+00	7.744E-12	2.214E-11	6.266E-11	1.238E-10	1.524E-10	1.296E-10	7.136E-11	3.308E-14
Np-237	∑S(j):		0.000E+00	3.220E-07	9.547E-07	3.053E-06	8.128E-06	1.809E-05	2.160E-05	1.227E-05	5.687E-09
U-233	Am-241	1.000E+00	0.000E+00	7.049E-13	6.285E-12	6.760E-11	5.556E-10	4.592E-09	2.072E-08	5.008E-08	4.499E-10
U-233	Pu-241	1.000E+00	0.000E+00	3.728E-16	9.759E-15	3.252E-13	6.614E-12	1.081E-10	6.350E-10	1.654E-09	1.517E-11
U-233	Pu-241	2.450E-05	0.000E+00	1.707E-17	1.487E-16	1.479E-15	9.999E-15	5.344E-14	1.607E-13	3.236E-13	2.735E-15
U-233	∑S(j):		0.000E+00	7.053E-13	6.295E-12	6.793E-11	5.622E-10	4.700E-09	2.136E-08	5.174E-08	4.651E-10
Th-229	Am-241	1.000E+00	0.000E+00	2.222E-17	5.956E-16	2.152E-14	5.425E-13	1.604E-11	2.531E-10	2.739E-09	8.337E-09
Th-229	Pu-241	1.000E+00	0.000E+00	8.827E-21	6.976E-19	7.911E-17	5.099E-15	3.222E-13	7.184E-12	8.798E-11	2.777E-10
Th-229	Pu-241	2.450E-05	0.000E+00	5.394E-22	1.421E-20	4.841E-19	1.051E-17	2.170E-16	2.275E-15	1.904E-14	5.256E-14
Th-229	∑S(j):		0.000E+00	2.222E-17	5.963E-16	2.160E-14	5.476E-13	1.636E-11	2.602E-10	2.827E-09	8.614E-09
C-14	C-14	1.000E+00	1.000E+00	4.018E-04	6.398E-11	8.915E-35	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cm-243	Cm-243	9.976E-01	9.976E-01	9.735E-01	9.270E-01	7.810E-01	4.786E-01	8.626E-02	6.448E-04	2.330E-11	0.000E+00
Cm-243	Cm-243	2.400E-03	2.400E-03	2.342E-03	2.230E-03	1.879E-03	1.151E-03	2.075E-04	1.551E-06	5.604E-14	0.000E+00
Cm-243	∑S(j):		1.000E+00	9.758E-01	9.292E-01	7.829E-01	4.798E-01	8.646E-02	6.464E-04	2.335E-11	0.000E+00
Pu-239	Cm-243	9.976E-01	0.000E+00	2.838E-05	8.310E-05	2.547E-04	6.092E-04	1.062E-03	1.132E-03	1.028E-03	2.952E-04
Pu-239	Cm-243	2.400E-03	0.000E+00	3.220E-12	2.851E-11	2.994E-10	2.314E-09	1.645E-08	6.626E-08	2.227E-07	6.667E-07
Pu-239	Pu-239	1.000E+00	1.000E+00	9.999E-01	9.996E-01	9.986E-01	9.959E-01	9.862E-01	9.593E-01	8.706E-01	2.500E-01
Pu-239	∑S(j):		1.000E+00	9.999E-01	9.997E-01	9.989E-01	9.965E-01	9.873E-01	9.604E-01	8.716E-01	2.503E-01
U-235	Cm-243	9.976E-01	0.000E+00	1.401E-14	1.237E-13	1.286E-12	9.647E-12	6.113E-11	1.738E-10	2.346E-10	6.859E-11
U-235	Cm-243	2.400E-03	0.000E+00	1.058E-21	2.816E-20	9.919E-19	2.333E-17	5.628E-16	6.129E-15	3.925E-14	1.513E-13
U-235	Pu-239	1.000E+00	0.000E+00	9.826E-10	2.935E-09	9.630E-09	2.763E-08	7.917E-08	1.604E-07	1.994E-07	5.810E-08
U-235	U-235	1.000E+00	1.000E+00	9.956E-01	9.870E-01	9.572E-01	8.770E-01	6.455E-01	2.690E-01	1.257E-02	9.828E-20
U-235	∑S(j):		1.000E+00	9.956E-01	9.870E-01	9.572E-01	8.770E-01	6.455E-01	2.690E-01	1.257E-02	5.817E-08
Pa-231	Cm-243	9.976E-01	0.000E+00	9.896E-20	2.628E-18	9.188E-17	2.114E-15	4.692E-14	3.938E-13	1.083E-12	3.407E-13
Pa-231	Cm-243	2.400E-03	0.000E+00	5.532E-27	4.475E-25	5.275E-23	3.756E-21	3.065E-19	9.553E-18	1.375E-16	7.332E-16
Pa-231	Pu-239	1.000E+00	0.000E+00	1.039E-14	9.294E-14	1.011E-12	8.581E-12	7.781E-11	4.033E-10	9.297E-10	2.886E-10
Pa-231	U-235	1.000E+00	0.000E+00	2.107E-05	6.265E-05	2.025E-04	5.565E-04	1.364E-03	1.702E-03	2.631E-04	1.874E-20
Pa-231	∑S(j):		0.000E+00	2.107E-05	6.265E-05	2.025E-04	5.565E-04	1.364E-03	1.702E-03	2.631E-04	2.890E-10
Ac-227	Cm-243	9.976E-01	0.000E+00	7.823E-22	6.147E-20	6.836E-18	4.153E-16	2.101E-14	2.595E-13	8.030E-13	2.548E-13
Ac-227	Cm-243	2.400E-03	0.000E+00	8.811E-29	8.435E-27	3.167E-24	6.050E-22	1.177E-19	5.766E-18	9.854E-17	5.468E-16
Ac-227	Pu-239	1.000E+00	0.000E+00	1.091E-16	2.873E-15	9.746E-14	2.079E-12	3.865E-11	2.717E-10	6.902E-10	2.158E-10
Ac-227	U-235	1.000E+00	0.000E+00	3.311E-07	2.880E-06	2.848E-05	1.875E-04	8.440E-04	1.291E-03	2.128E-04	1.553E-20
Ac-227	∑S(j):		0.000E+00	3.311E-07	2.880E-06	2.848E-05	1.875E-04	8.440E-04	1.291E-03	2.128E-04	2.161E-10
Am-243	Cm-243	2.400E-03	0.000E+00	2.227E-07	6.519E-07	1.998E-06	4.779E-06	8.333E-06	8.879E-06	8.068E-06	2.333E-06

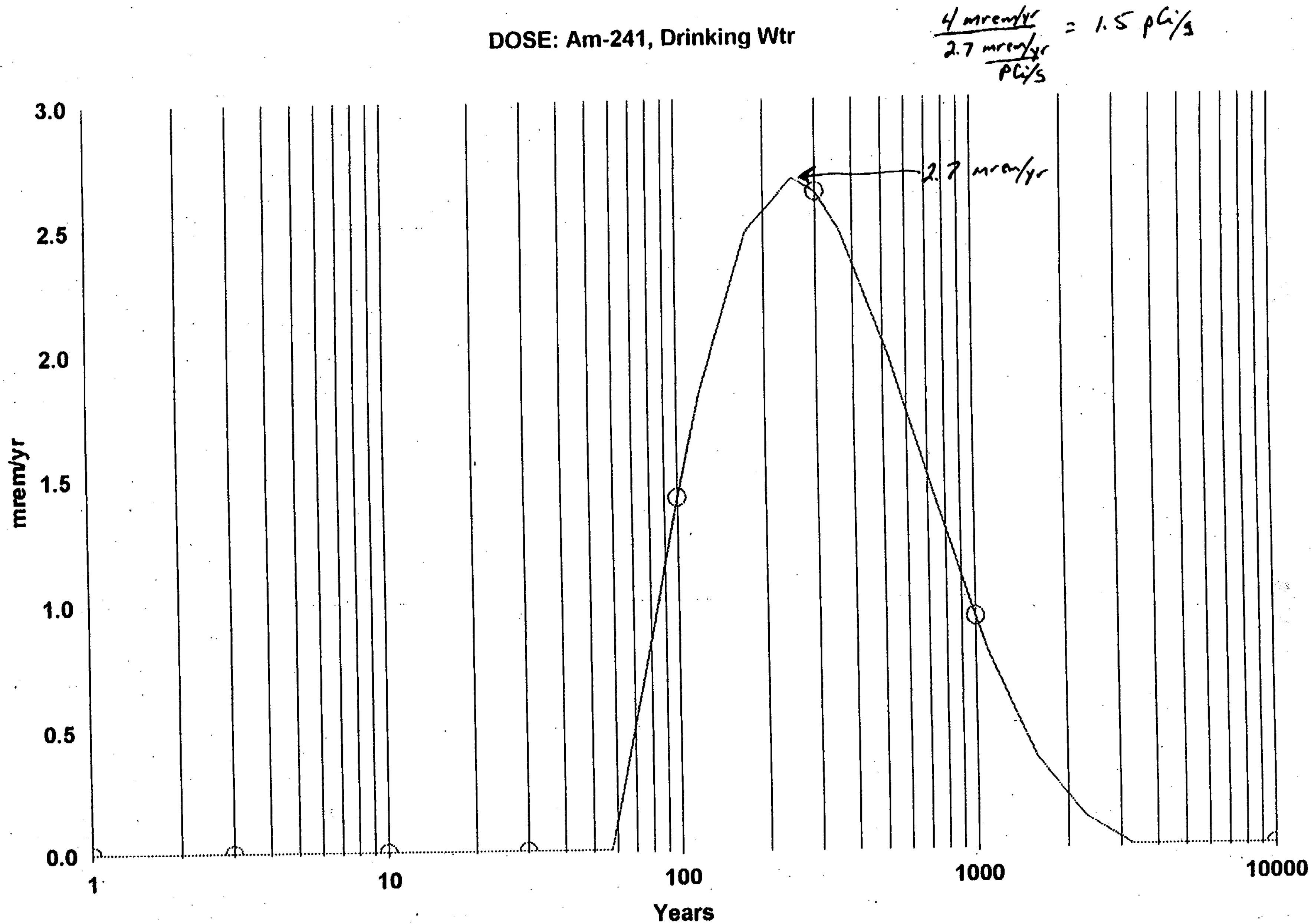
Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
Cm-244	Cm-244	1.000E+00	1.000E+00	9.623E-01	8.911E-01	6.809E-01	3.157E-01	2.142E-02	9.830E-06	2.035E-17	0.000E+00
Pu-240	Cm-244	1.000E+00	0.000E+00	1.040E-04	3.004E-04	8.793E-04	1.881E-03	2.656E-03	2.600E-03	2.236E-03	3.205E-04
Pu-240	Pu-240	1.000E+00	1.000E+00	9.998E-01	9.994E-01	9.978E-01	9.935E-01	9.786E-01	9.373E-01	8.059E-01	1.155E-01
Pu-240	ΣS(j):		1.000E+00	9.999E-01	9.997E-01	9.987E-01	9.954E-01	9.813E-01	9.399E-01	8.081E-01	1.158E-01
U-236	Cm-244	1.000E+00	0.000E+00	1.549E-12	1.358E-11	1.382E-10	9.858E-10	5.856E-09	1.965E-08	5.066E-08	1.828E-08
U-236	Pu-240	1.000E+00	0.000E+00	2.959E-08	8.868E-08	2.946E-07	8.756E-07	2.824E-06	7.712E-06	1.864E-05	6.590E-06
U-236	ΣS(j):		0.000E+00	2.959E-08	8.870E-08	2.948E-07	8.765E-07	2.829E-06	7.731E-06	1.869E-05	6.608E-06
Th-232	Cm-244	1.000E+00	0.000E+00	2.556E-23	6.767E-22	2.345E-20	5.307E-19	1.200E-17	1.398E-16	1.419E-15	2.088E-14
Th-232	Pu-240	1.000E+00	0.000E+00	7.300E-19	6.566E-18	7.279E-17	6.510E-16	7.075E-15	5.982E-14	5.379E-13	7.575E-12
Th-232	ΣS(j):		0.000E+00	7.300E-19	6.566E-18	7.281E-17	6.515E-16	7.087E-15	5.996E-14	5.393E-13	7.596E-12
Ra-228	Cm-244	1.000E+00	0.000E+00	7.530E-25	5.723E-23	5.716E-21	2.741E-19	9.656E-18	1.289E-16	1.364E-15	2.034E-14
Ra-228	Pu-240	1.000E+00	0.000E+00	2.845E-20	7.234E-19	2.207E-17	3.830E-16	5.884E-15	5.538E-14	5.171E-13	7.381E-12
Ra-228	ΣS(j):		0.000E+00	2.845E-20	7.234E-19	2.207E-17	3.832E-16	5.893E-15	5.551E-14	5.185E-13	7.402E-12
Th-228	Cm-244	1.000E+00	0.000E+00	5.170E-26	1.064E-23	2.608E-21	2.060E-19	8.986E-18	1.263E-16	1.357E-15	2.034E-14
Th-228	Pu-240	1.000E+00	0.000E+00	2.415E-21	1.630E-19	1.157E-17	3.073E-16	5.548E-15	5.439E-14	5.147E-13	7.380E-12
Th-228	ΣS(j):		0.000E+00	2.415E-21	1.630E-19	1.157E-17	3.075E-16	5.557E-15	5.451E-14	5.160E-13	7.401E-12
Co-60	Co-60	1.000E+00	1.000E+00	8.767E-01	6.739E-01	2.684E-01	1.932E-02	1.937E-06	7.263E-18	0.000E+00	0.000E+00
Cs-134	Cs-134	1.000E+00	1.000E+00	7.144E-01	3.645E-01	3.461E-02	4.144E-05	2.463E-15	1.541E-44	0.000E+00	0.000E+00
Cs-137	Cs-137	1.000E+00	1.000E+00	9.769E-01	9.324E-01	7.920E-01	4.967E-01	9.706E-02	9.143E-04	7.418E-11	0.000E+00
Eu-152	Eu-152	7.208E-01	7.208E-01	6.841E-01	6.162E-01	4.274E-01	1.503E-01	3.872E-03	1.118E-07	1.443E-23	0.000E+00
Eu-152	Eu-152	2.792E-01	2.792E-01	2.650E-01	2.387E-01	1.656E-01	5.820E-02	1.500E-03	4.329E-08	5.590E-24	0.000E+00
Eu-152	ΣS(j):		1.000E+00	9.491E-01	8.549E-01	5.929E-01	2.085E-01	5.372E-03	1.550E-07	2.002E-23	0.000E+00
Gd-152	Eu-152	2.792E-01	0.000E+00	1.746E-15	4.973E-15	1.394E-14	2.700E-14	3.337E-14	3.182E-14	2.641E-14	2.405E-15
Eu-154	Eu-154	1.000E+00	1.000E+00	9.240E-01	7.889E-01	4.537E-01	9.339E-02	3.695E-04	5.046E-11	4.747E-35	0.000E+00
Eu-155	Eu-155	1.000E+00	1.000E+00	8.693E-01	6.570E-01	2.466E-01	1.499E-02	8.304E-07	5.726E-19	0.000E+00	0.000E+00
Fe-55	Fe-55	1.000E+00	1.000E+00	7.735E-01	4.629E-01	7.672E-02	4.515E-04	7.060E-12	3.520E-34	0.000E+00	0.000E+00
H-3	H-3	1.000E+00	1.000E+00	5.135E-02	1.350E-04	1.209E-13	1.228E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-94	Nb-94	1.000E+00	1.000E+00	3.069E-01	2.891E-02	7.414E-06	4.076E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-59	Ni-59	1.000E+00	1.000E+00	9.998E-01	9.993E-01	9.977E-01	9.932E-01	9.774E-01	9.336E-01	7.955E-01	1.014E-01
Ni-63	Ni-63	1.000E+00	1.000E+00	9.926E-01	9.779E-01	9.283E-01	8.000E-01	4.752E-01	1.073E-01	5.874E-04	4.886E-33
Pu-238	Pu-238	1.000E+00	1.000E+00	9.920E-01	9.763E-01	9.230E-01	7.864E-01	4.489E-01	9.045E-02	3.322E-04	1.636E-35

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g: t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	1.000E+04
U-234	Pu-238	1.000E+00	0.000E+00	2.817E-06	8.348E-06	2.665E-05	7.066E-05	1.534E-04	1.393E-04	9.527E-06	7.460E-23
U-234	Pu-242	1.000E+00	0.000E+00	2.193E-16	1.962E-15	2.135E-14	1.812E-13	1.645E-12	8.553E-12	2.001E-11	7.911E-12
U-234	U-234	1.000E+00	1.000E+00	9.956E-01	9.869E-01	9.572E-01	8.769E-01	6.454E-01	2.688E-01	1.253E-02	9.554E-20
U-234	U-238	1.000E+00	0.000E+00	2.823E-06	8.394E-06	2.714E-05	7.458E-05	1.830E-04	2.287E-04	3.558E-05	2.747E-21
U-234	∑S(j):		1.000E+00	9.956E-01	9.870E-01	9.572E-01	8.770E-01	6.457E-01	2.692E-01	1.258E-02	7.911E-12
Th-230	Pu-238	1.000E+00	0.000E+00	1.271E-11	1.134E-10	1.224E-09	1.016E-08	8.553E-08	3.748E-07	7.017E-07	6.439E-07
Th-230	Pu-242	1.000E+00	0.000E+00	6.584E-22	1.770E-20	6.454E-19	1.667E-17	5.309E-16	9.542E-15	1.111E-13	1.130E-12
Th-230	U-234	1.000E+00	0.000E+00	8.982E-06	2.683E-05	8.807E-05	2.530E-04	7.285E-04	1.500E-03	2.010E-03	1.816E-03
Th-230	U-238	1.000E+00	0.000E+00	1.272E-11	1.138E-10	1.239E-09	1.052E-08	9.578E-08	5.024E-07	1.232E-06	1.180E-06
Th-230	∑S(j):		0.000E+00	8.982E-06	2.683E-05	8.807E-05	2.530E-04	7.286E-04	1.500E-03	2.012E-03	1.818E-03
Ra-226	Pu-238	1.000E+00	0.000E+00	1.835E-15	4.916E-14	1.771E-12	4.417E-11	1.246E-09	1.615E-08	7.441E-08	7.857E-08
Ra-226	Pu-242	1.000E+00	0.000E+00	7.040E-26	5.744E-24	6.971E-22	5.374E-20	5.591E-18	2.829E-16	8.363E-15	1.353E-13
Ra-226	U-234	1.000E+00	0.000E+00	1.945E-09	1.741E-08	1.899E-07	1.621E-06	1.503E-05	8.262E-05	2.240E-04	2.216E-04
Ra-226	U-238	1.000E+00	0.000E+00	1.837E-15	4.929E-14	1.787E-12	4.537E-11	1.358E-09	2.035E-08	1.242E-07	1.440E-07
Ra-226	∑S(j):		0.000E+00	1.945E-09	1.741E-08	1.899E-07	1.621E-06	1.503E-05	8.265E-05	2.242E-04	2.219E-04
Pb-210	Pu-238	1.000E+00	0.000E+00	1.418E-17	1.126E-15	1.299E-13	8.721E-12	5.929E-10	1.234E-08	6.832E-08	7.342E-08
Pb-210	Pu-242	1.000E+00	0.000E+00	0.000E+00	1.056E-25	4.121E-23	8.661E-21	2.252E-18	1.935E-16	7.308E-15	1.262E-13
Pb-210	U-234	1.000E+00	0.000E+00	2.000E-11	5.289E-10	1.826E-08	4.066E-07	8.380E-06	6.714E-05	2.070E-04	2.071E-04
Pb-210	U-238	1.000E+00	0.000E+00	1.402E-17	1.128E-15	1.309E-13	8.915E-12	6.388E-10	1.531E-08	1.133E-07	1.345E-07
Pb-210	∑S(j):		0.000E+00	2.000E-11	5.290E-10	1.826E-08	4.066E-07	8.382E-06	6.716E-05	2.071E-04	2.073E-04
Pu-241	Pu-241	1.000E+00	1.000E+00	9.529E-01	8.652E-01	6.173E-01	2.352E-01	8.030E-03	5.179E-07	1.115E-21	0.000E+00
Pu-241	Pu-241	2.450E-05	2.450E-05	2.335E-05	2.120E-05	1.512E-05	5.762E-06	1.967E-07	1.269E-11	2.733E-26	0.000E+00
Pu-241	∑S(j):		1.000E+00	9.529E-01	8.653E-01	6.173E-01	2.352E-01	8.031E-03	5.179E-07	1.115E-21	0.000E+00
Pu-242	Pu-242	1.000E+00	1.000E+00	9.999E-01	9.997E-01	9.989E-01	9.967E-01	9.889E-01	9.671E-01	8.944E-01	3.274E-01
U-238	Pu-242	1.000E+00	0.000E+00	1.548E-10	4.623E-10	1.517E-09	4.354E-09	1.249E-08	2.539E-08	3.207E-08	1.191E-08
U-238	U-238	1.000E+00	1.000E+00	9.956E-01	9.870E-01	9.572E-01	8.770E-01	6.455E-01	2.690E-01	1.257E-02	9.828E-20
U-238	∑S(j):		1.000E+00	9.956E-01	9.870E-01	9.572E-01	8.770E-01	6.455E-01	2.690E-01	1.257E-02	1.191E-08
Sb-125	Sb-125	1.000E+00	1.000E+00	2.390E-01	1.365E-02	6.074E-07	2.241E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	Sr-90	1.000E+00	1.000E+00	9.763E-01	9.305E-01	7.864E-01	4.864E-01	9.051E-02	7.415E-04	3.690E-11	0.000E+00
Tc-99	Tc-99	1.000E+00	1.000E+00	9.585E-01	8.807E-01	6.547E-01	2.806E-01	1.447E-02	3.029E-06	4.022E-19	0.000E+00

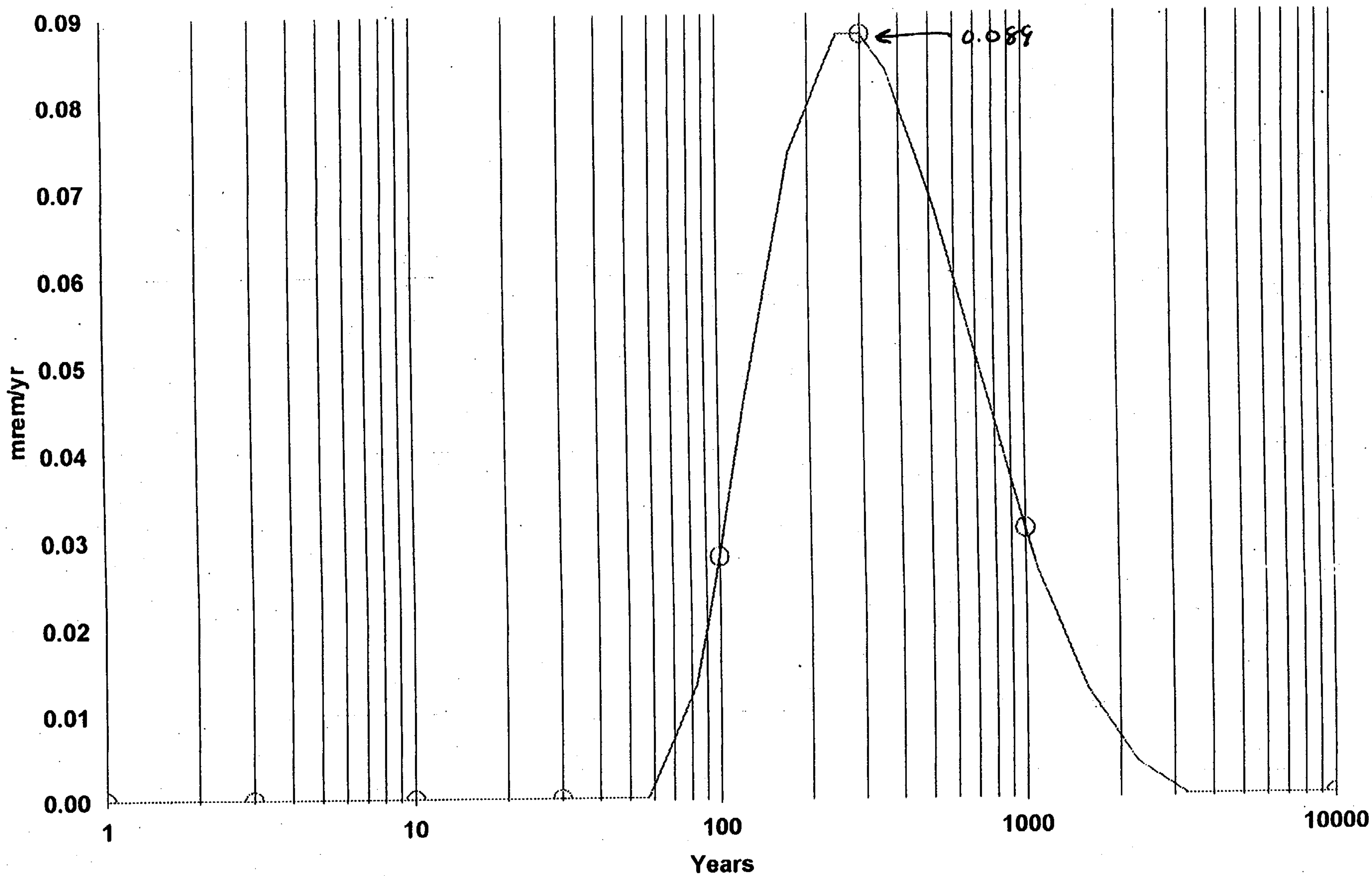
BRF(i) is the branch fraction of the parent nuclide.



SITE1.RAD 12/14/99 10:51

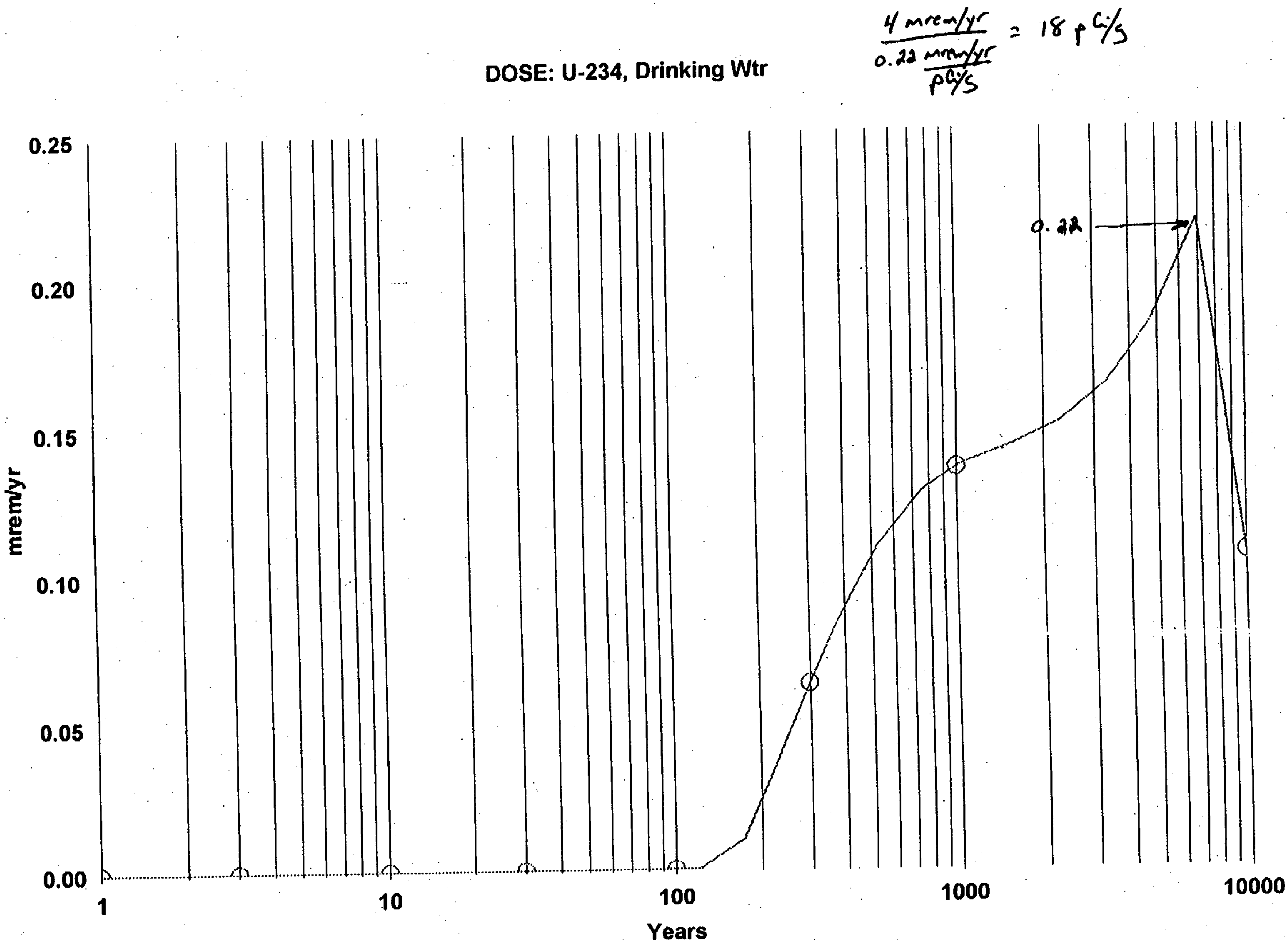
$$\frac{4 \text{ mrem/yr}}{0.089 \frac{\text{mrem/yr}}{\text{pCi/g}}} = 45 \text{ pCi/g}$$

DOSE: Pu-241a, Drinking Wtr

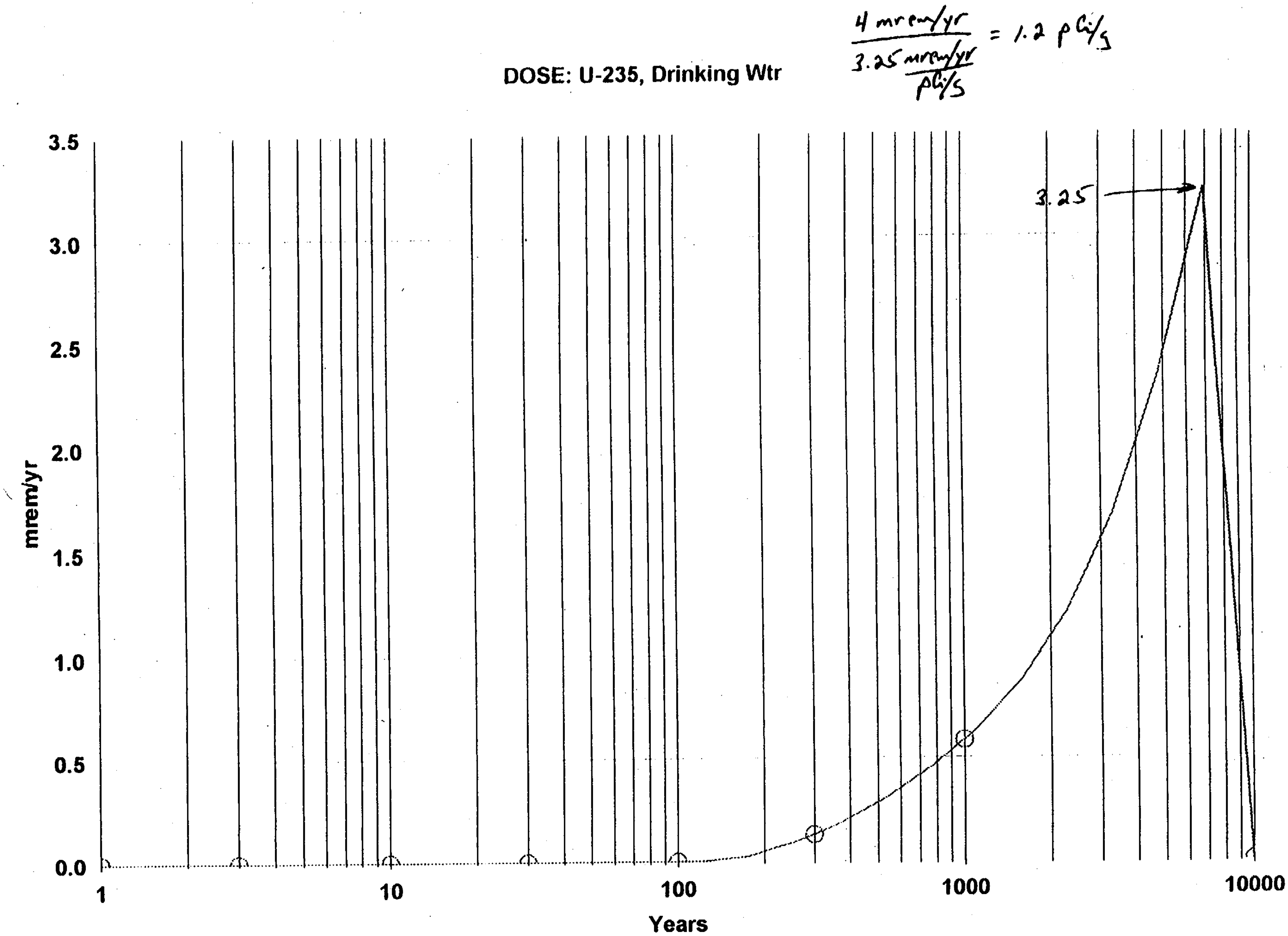


SITE1.RAD 12/14/99 10:51

DOSE: U-234, Drinking Wtr



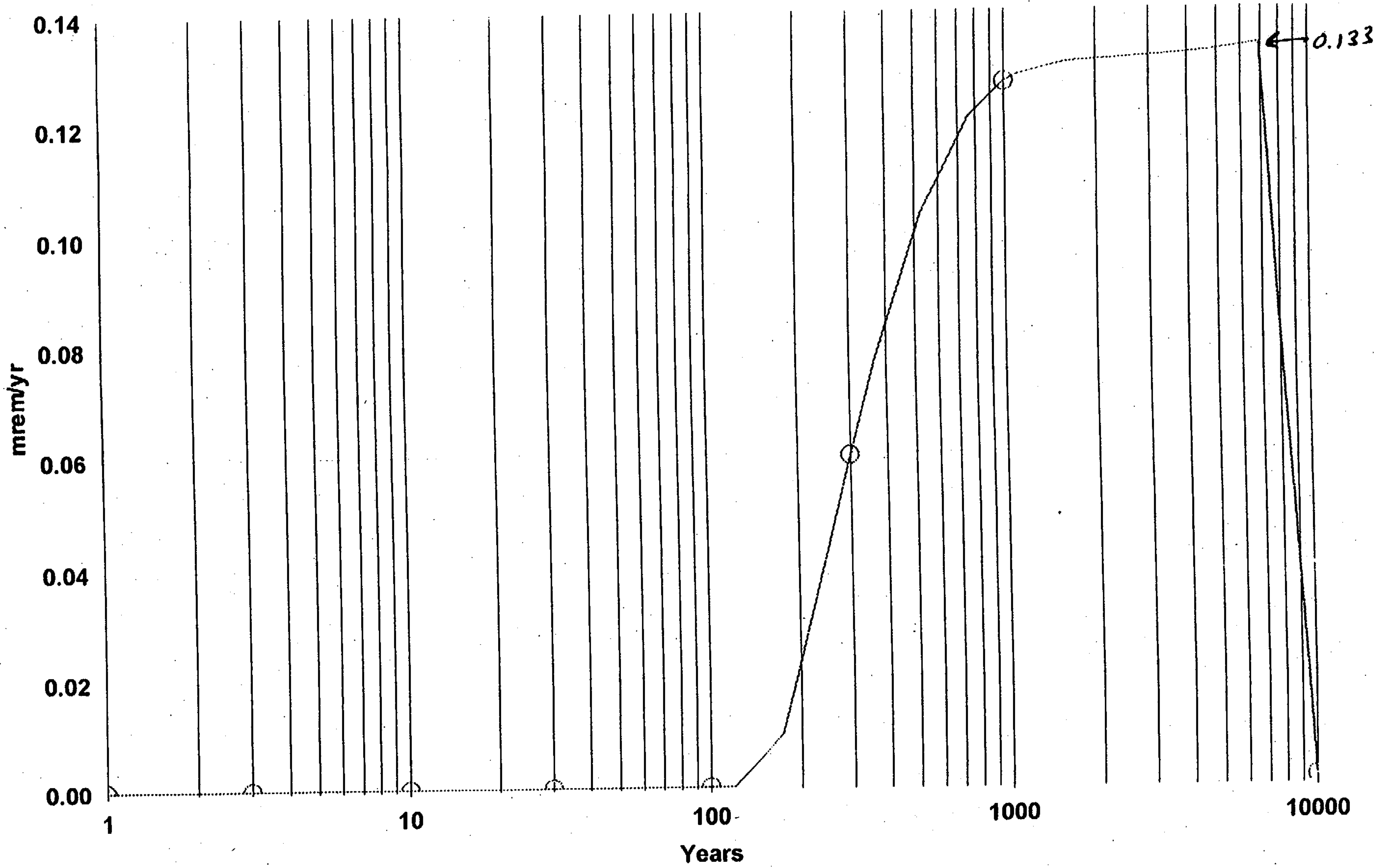
SITE1.RAD 12/14/99 10:51



SITE1.RAD 12/14/99 10:51

DOSE: U-238, Drinking Wtr

$\frac{4 \text{ mrem/yr}}{0.133 \frac{\text{mrem/yr}}{\text{pCi/g}}} = 30 \text{ pCi/g}$



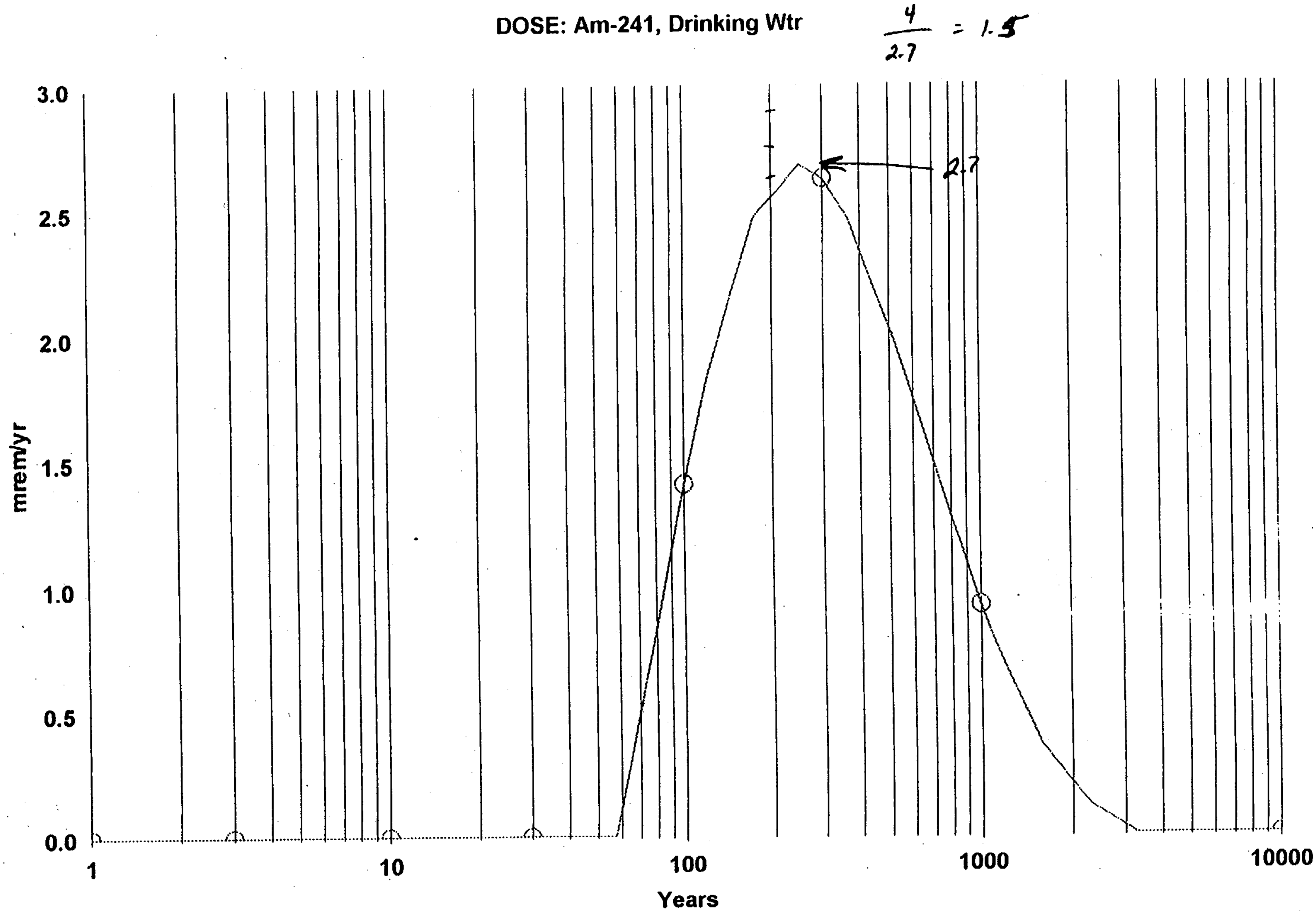
SITE1.RAD 12/14/99 10:51

Appendix B

DandD Run for Surface Areas

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

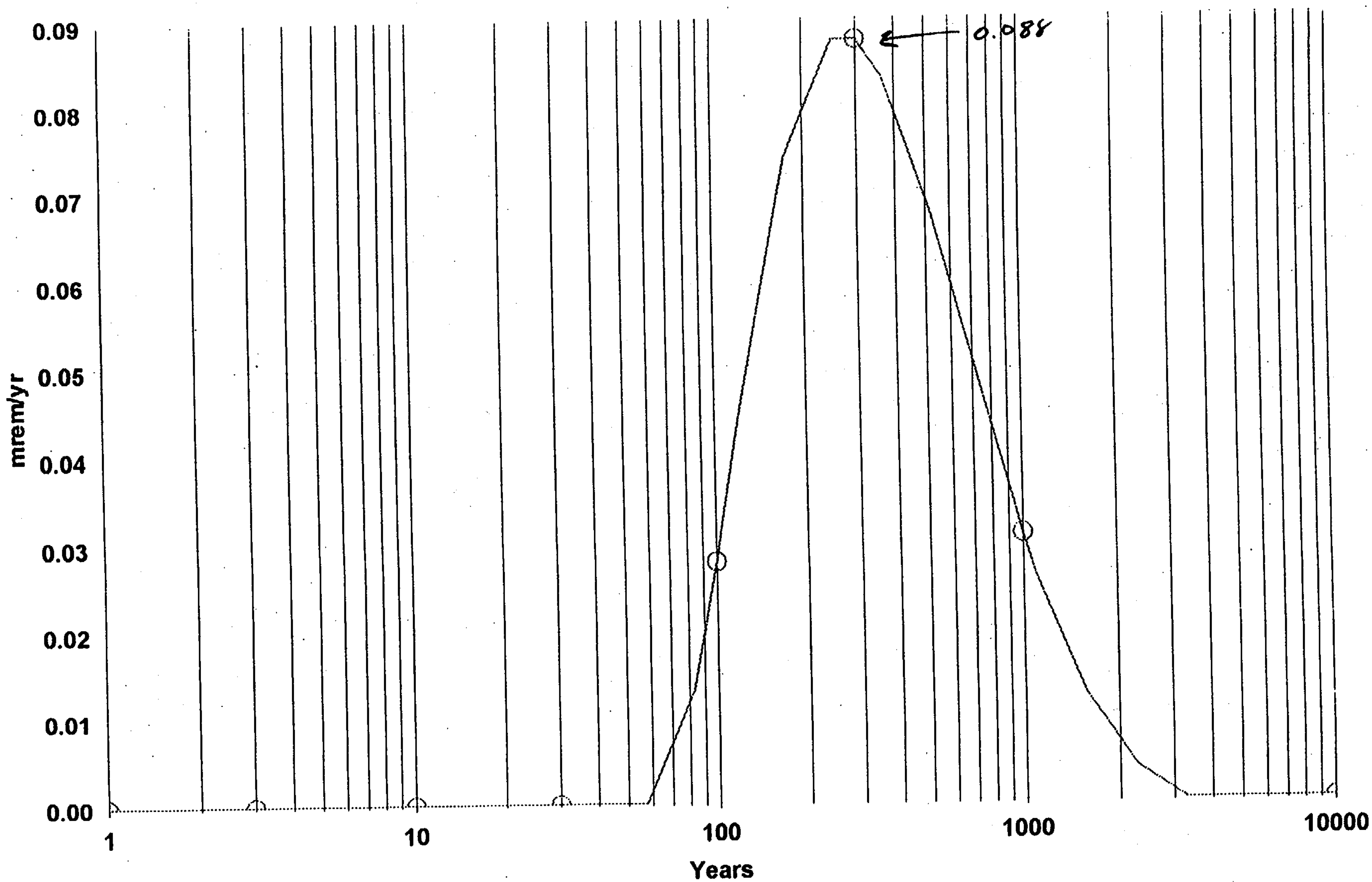
Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)	Drinking H2O DCGLs (pCi/g)
Am-241	1.000E+00	237.0 ± 0.5	3.266E+00	7.654E+00	1.204E+00	2.077E+01	1.5
C-14	1.000E+00	0.000E+00	2.948E+00	8.480E+00	2.948E+00	8.480E+00	
Cm-243	1.000E+00	0.000E+00	1.137E+00	2.199E+01	1.137E+00	2.199E+01	
Cm-244	1.000E+00	0.000E+00	6.540E-01	3.823E+01	6.540E-01	3.823E+01	
Co-60	1.000E+00	0.000E+00	9.529E+00	2.624E+00	9.529E+00	2.624E+00	
Cs-134	1.000E+00	0.000E+00	6.148E+00	4.067E+00	6.148E+00	4.067E+00	
Cs-137	1.000E+00	0.000E+00	2.541E+00	9.838E+00	2.541E+00	9.838E+00	
Eu-152	1.000E+00	0.000E+00	3.828E+00	6.531E+00	3.828E+00	6.531E+00	
Eu-154	1.000E+00	0.000E+00	4.205E+00	5.946E+00	4.205E+00	5.946E+00	
Eu-155	1.000E+00	0.000E+00	1.032E-01	2.423E+02	1.032E-01	2.423E+02	
Fe-55	1.000E+00	0.000E+00	2.928E-04	8.538E+04	2.928E-04	8.538E+04	
H-3	1.000E+00	0.000E+00	8.456E-02	2.956E+02	8.456E-02	2.956E+02	
Nb-94	1.000E+00	0.000E+00	5.266E+00	4.748E+00	5.266E+00	4.748E+00	
Ni-59	1.000E+00	0.000E+00	3.657E-03	6.836E+03	3.657E-03	6.836E+03	
Ni-63	1.000E+00	0.000E+00	1.005E-02	2.488E+03	1.005E-02	2.488E+03	
Pu-238	1.000E+00	0.000E+00	1.038E+00	2.409E+01	1.038E+00	2.409E+01	
Pu-239	1.000E+00	0.000E+00	1.148E+00	2.178E+01	1.148E+00	2.178E+01	
Pu-240	1.000E+00	0.000E+00	1.148E+00	2.178E+01	1.148E+00	2.178E+01	
Pu-241	1.000E+00	262.0 ± 0.5	1.073E-01	2.330E+02	2.222E-02	1.125E+03	45
Pu-242	1.000E+00	0.000E+00	1.090E+00	2.294E+01	1.090E+00	2.294E+01	
Sb-125	1.000E+00	0.000E+00	1.344E+00	1.860E+01	1.344E+00	1.860E+01	
Sr-90	1.000E+00	0.000E+00	1.398E+01	1.789E+00	1.398E+01	1.789E+00	
Tc-99	1.000E+00	0.000E+00	2.148E+00	1.164E+01	2.148E+00	1.164E+01	
U-234	1.000E+00	7246 ± *	2.693E-01	9.283E+01	2.240E-01	1.116E+02	18
U-235	1.000E+00	7070 ± *	3.934E+00	6.355E+00	6.320E-01	3.956E+01	1.2
U-238	1.000E+00	0.000E+00	2.875E-01	8.696E+01	2.875E-01	8.696E+01	31



SADCGL2.RAD 12/14/99 15:25

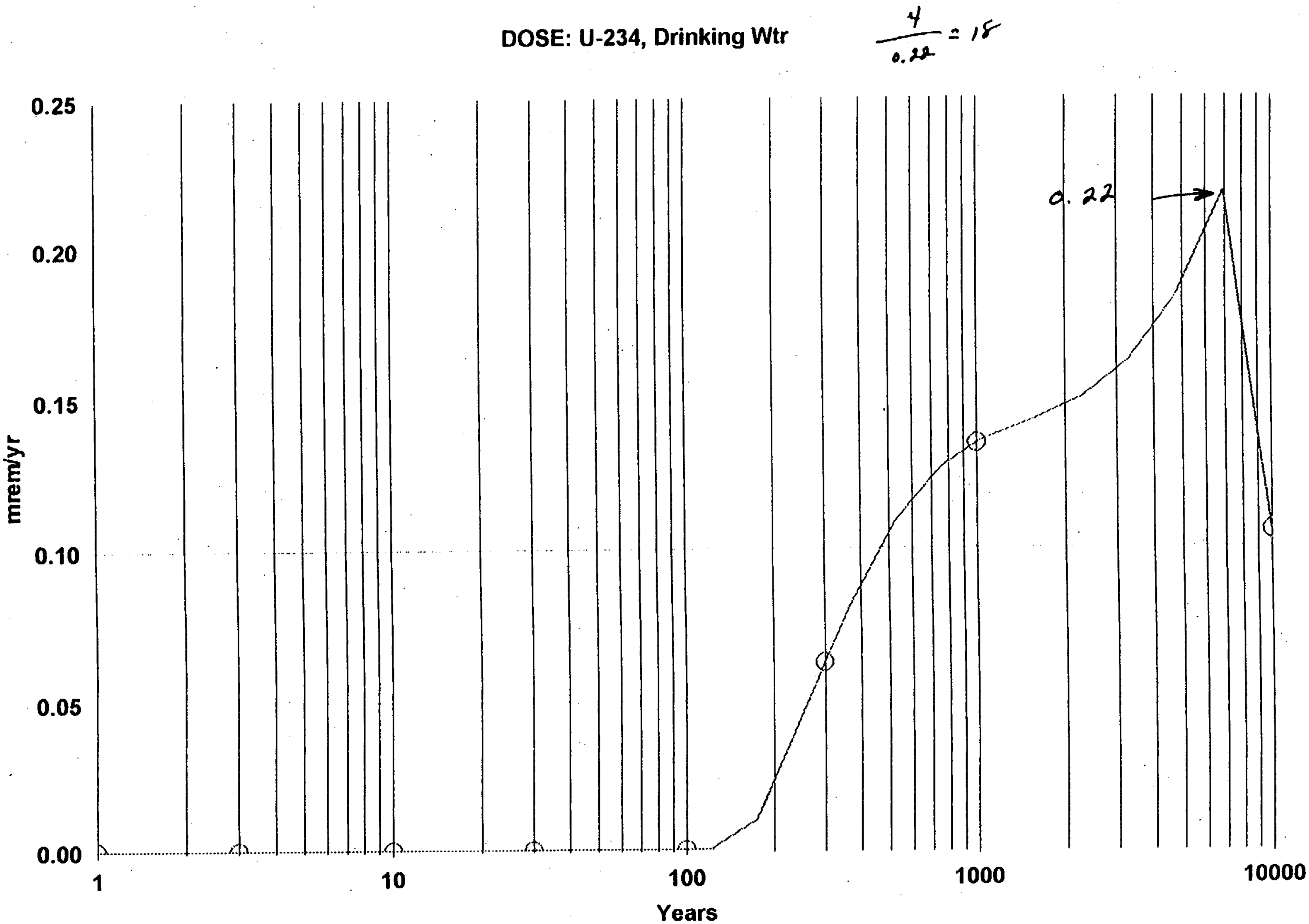
DOSE: Pu-241a, Drinking Wtr

$\frac{4}{.088} = 45$

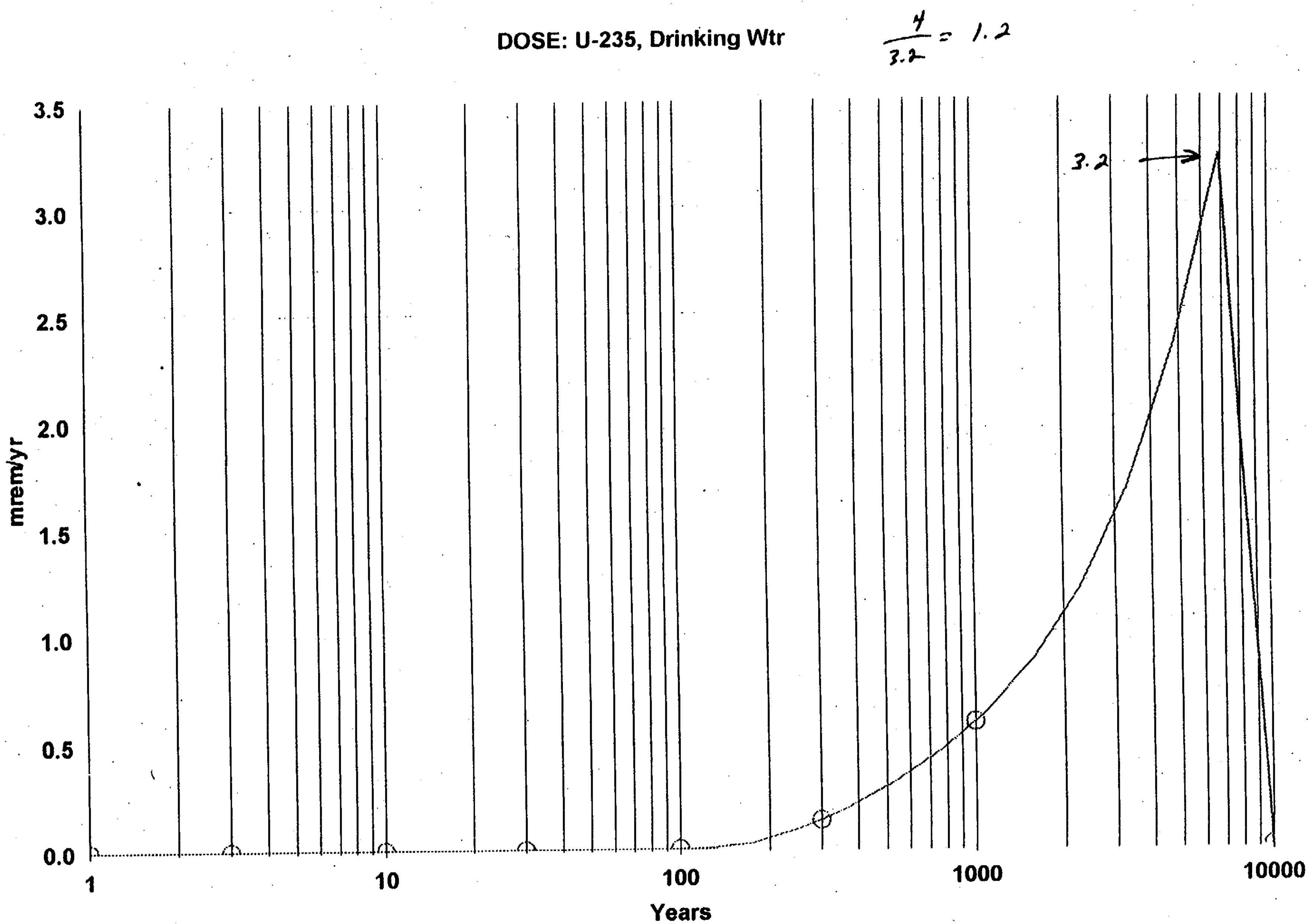


SADCGL2.RAD 12/14/99 15:25

DOSE: U-234, Drinking Wtr

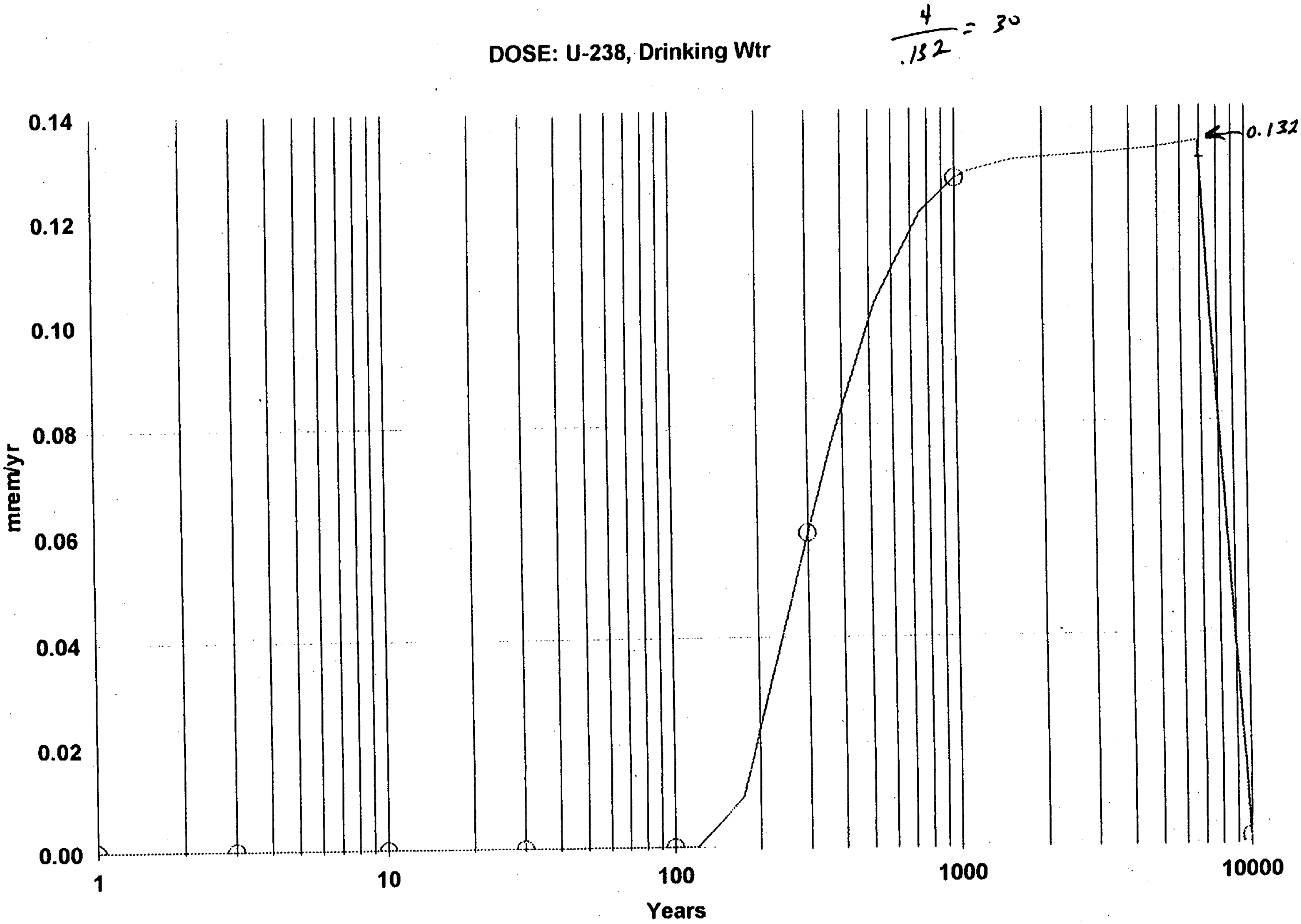


SADCGL2.RAD 12/14/99 15:25



SADCGL2.RAD 12/14/99 15:25

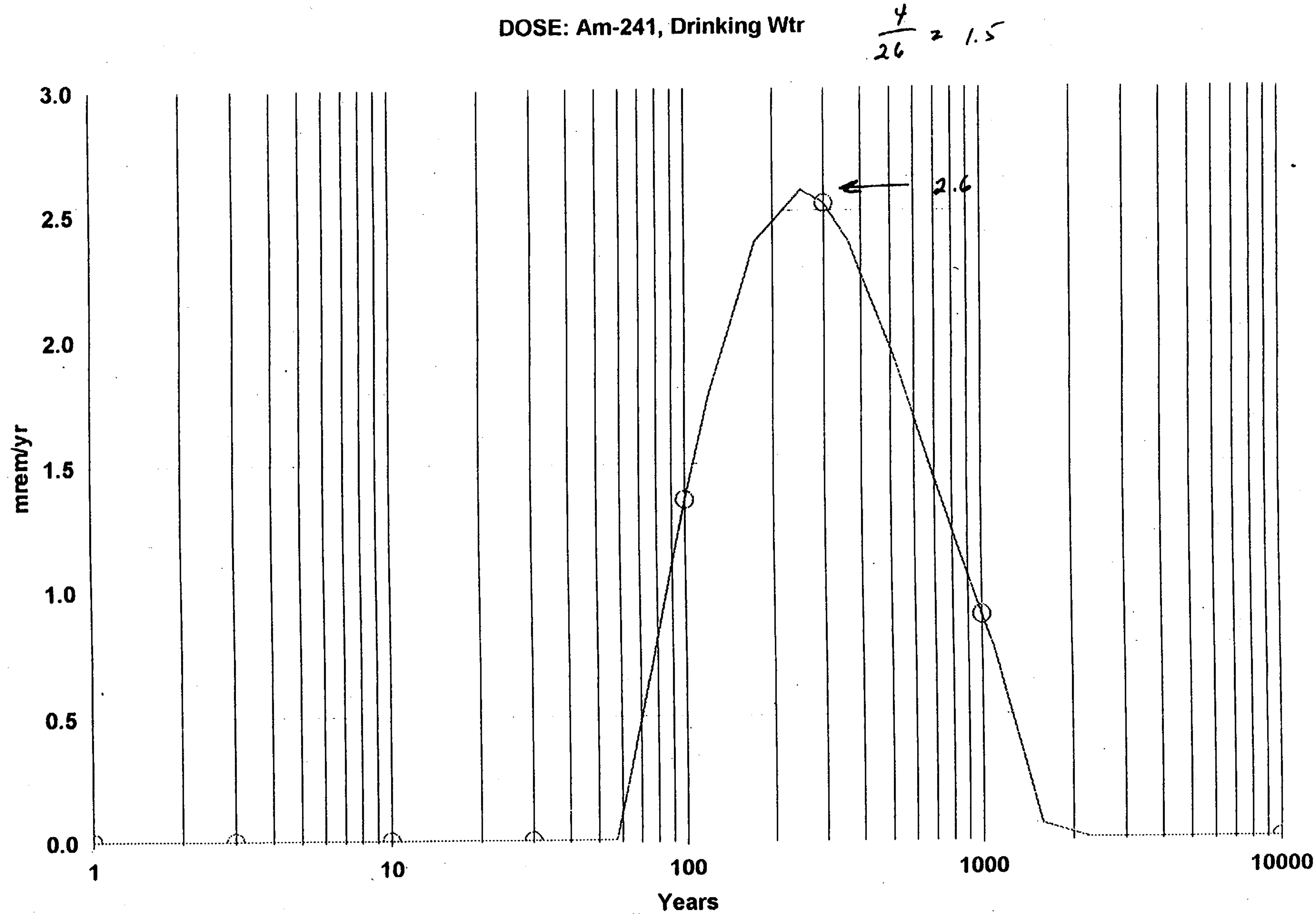
DOSE: U-238, Drinking Wtr



SADCGL2.RAD 12/14/99 15:25

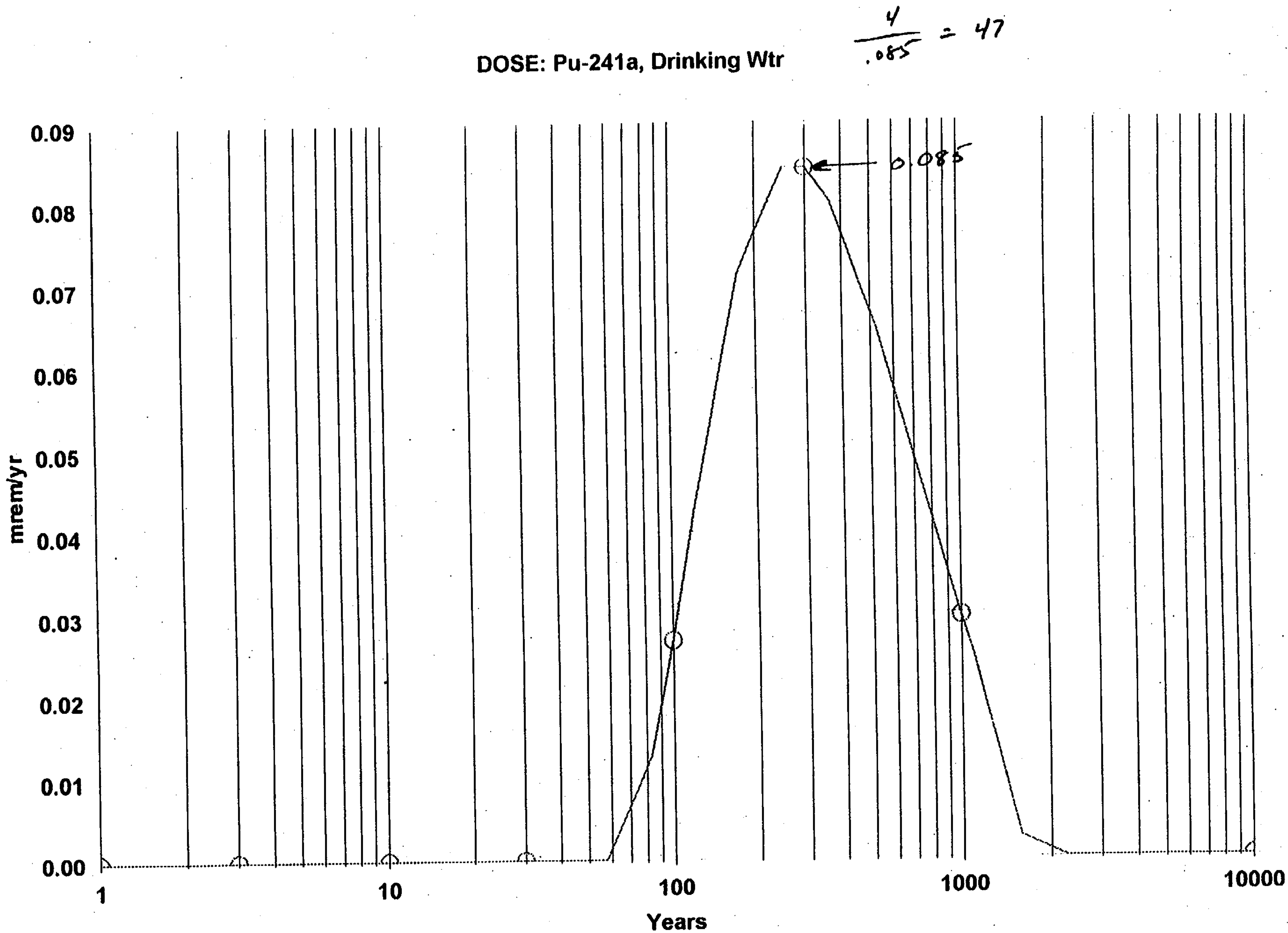
Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)	Drinking H_2O DCGLs (pCi/g)
Am-241	1.000E+00	243.1 ± 0.5	2.813E+00	8.889E+00	5.008E-01	4.992E+01	1.5
C-14	1.000E+00	0.000E+00	4.933E-01	5.068E+01	4.933E-01	5.068E+01	
Cm-243	1.000E+00	0.000E+00	6.422E-01	3.893E+01	6.422E-01	3.893E+01	
Cm-244	1.000E+00	0.000E+00	2.649E-01	9.438E+01	2.649E-01	9.438E+01	
Co-60	1.000E+00	0.000E+00	8.663E+00	2.886E+00	8.663E+00	2.886E+00	
Cs-134	1.000E+00	0.000E+00	5.257E+00	4.755E+00	5.257E+00	4.755E+00	
Cs-137	1.000E+00	0.000E+00	2.012E+00	1.243E+01	2.012E+00	1.243E+01	
Eu-152	1.000E+00	0.000E+00	3.637E+00	6.874E+00	3.637E+00	6.874E+00	
Eu-154	1.000E+00	0.000E+00	3.993E+00	6.261E+00	3.993E+00	6.261E+00	
Eu-155	1.000E+00	0.000E+00	9.854E-02	2.537E+02	9.854E-02	2.537E+02	
Fe-55	1.000E+00	0.000E+00	9.345E-05	2.675E+05	9.345E-05	2.675E+05	
H-3	1.000E+00	0.000E+00	3.286E-02	7.608E+02	3.286E-02	7.608E+02	
Nb-94	1.000E+00	0.000E+00	5.005E+00	4.995E+00	5.005E+00	4.995E+00	
Ni-59	1.000E+00	0.000E+00	1.322E-03	1.890E+04	1.322E-03	1.890E+04	
Ni-63	1.000E+00	0.000E+00	3.633E-03	6.880E+03	3.633E-03	6.880E+03	
Pu-238	1.000E+00	0.000E+00	4.199E-01	5.954E+01	4.199E-01	5.954E+01	
Pu-239	1.000E+00	0.000E+00	4.644E-01	5.383E+01	4.644E-01	5.383E+01	
Pu-240	1.000E+00	0.000E+00	4.643E-01	5.384E+01	4.643E-01	5.384E+01	
Pu-241	1.000E+00	268.1 ± 0.5	9.240E-02	2.706E+02	8.993E-03	2.780E+03	47
Pu-242	1.000E+00	0.000E+00	4.408E-01	5.671E+01	4.408E-01	5.671E+01	
Sb-125	1.000E+00	0.000E+00	1.281E+00	1.951E+01	1.281E+00	1.951E+01	
Sr-90	1.000E+00	0.000E+00	5.466E+00	4.574E+00	5.466E+00	4.574E+00	
Tc-99	1.000E+00	0.000E+00	8.553E-01	2.923E+01	8.553E-01	2.923E+01	
U-234	1.000E+00	3766 ± 8	1.755E-01	1.424E+02	9.028E-02	2.769E+02	25
U-235	1.000E+00	3627 ± 7	1.859E+00	1.345E+01	4.916E-01	5.086E+01	2.5
U-238	1.000E+00	0.000E+00	1.570E-01	1.592E+02	1.570E-01	1.592E+02	31



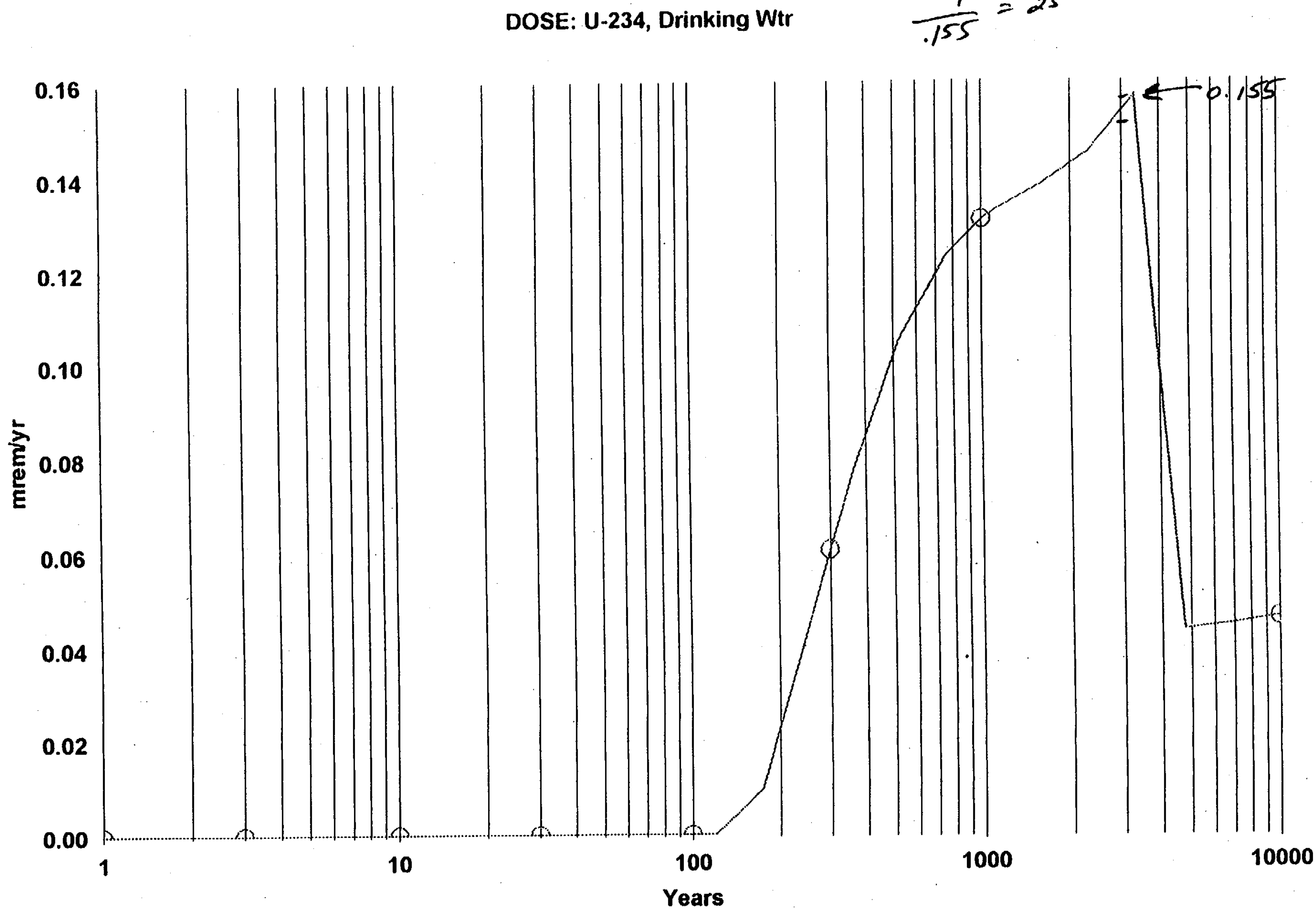
SADCGL3.RAD 12/14/99 14:29

DOSE: Pu-241a, Drinking Wtr

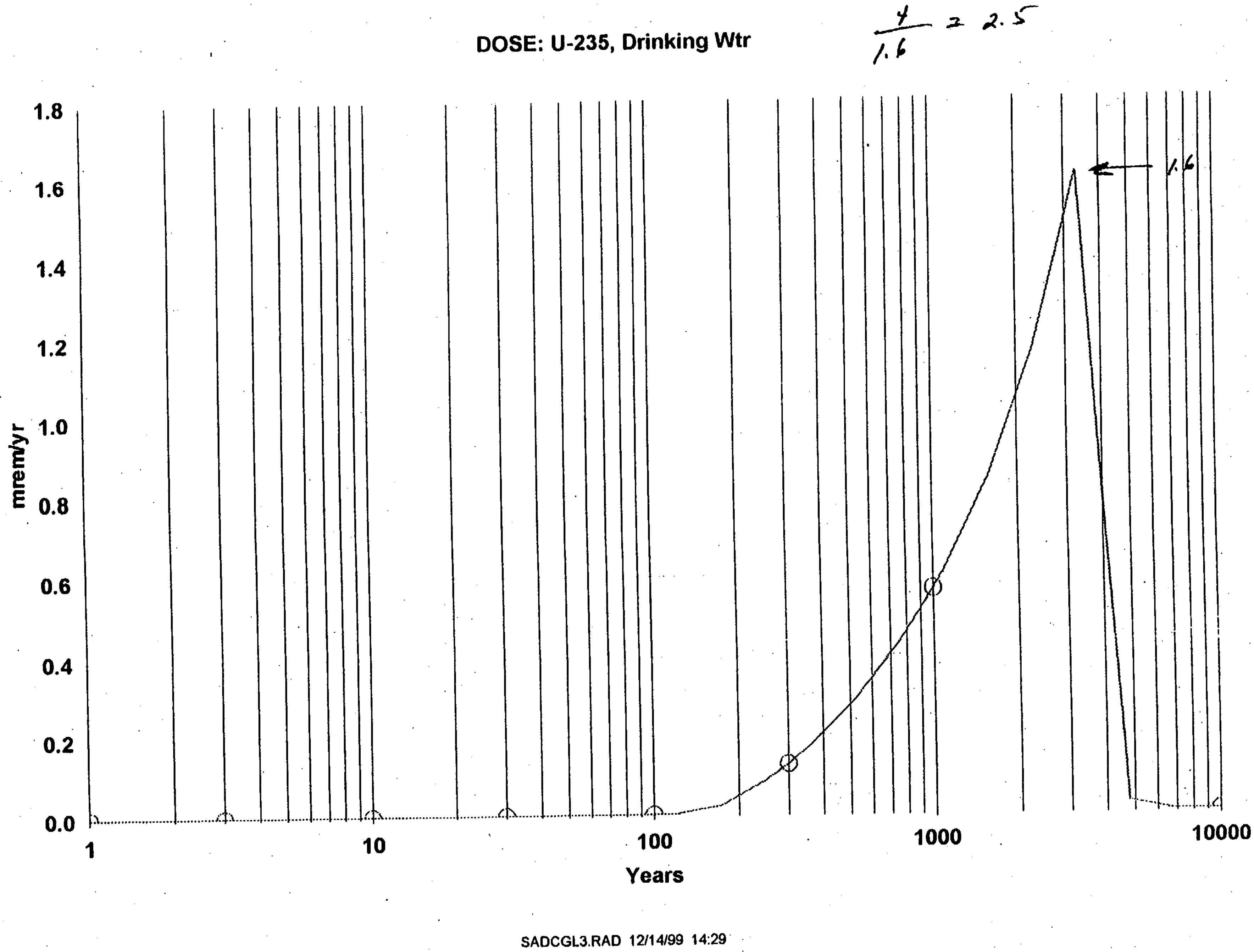


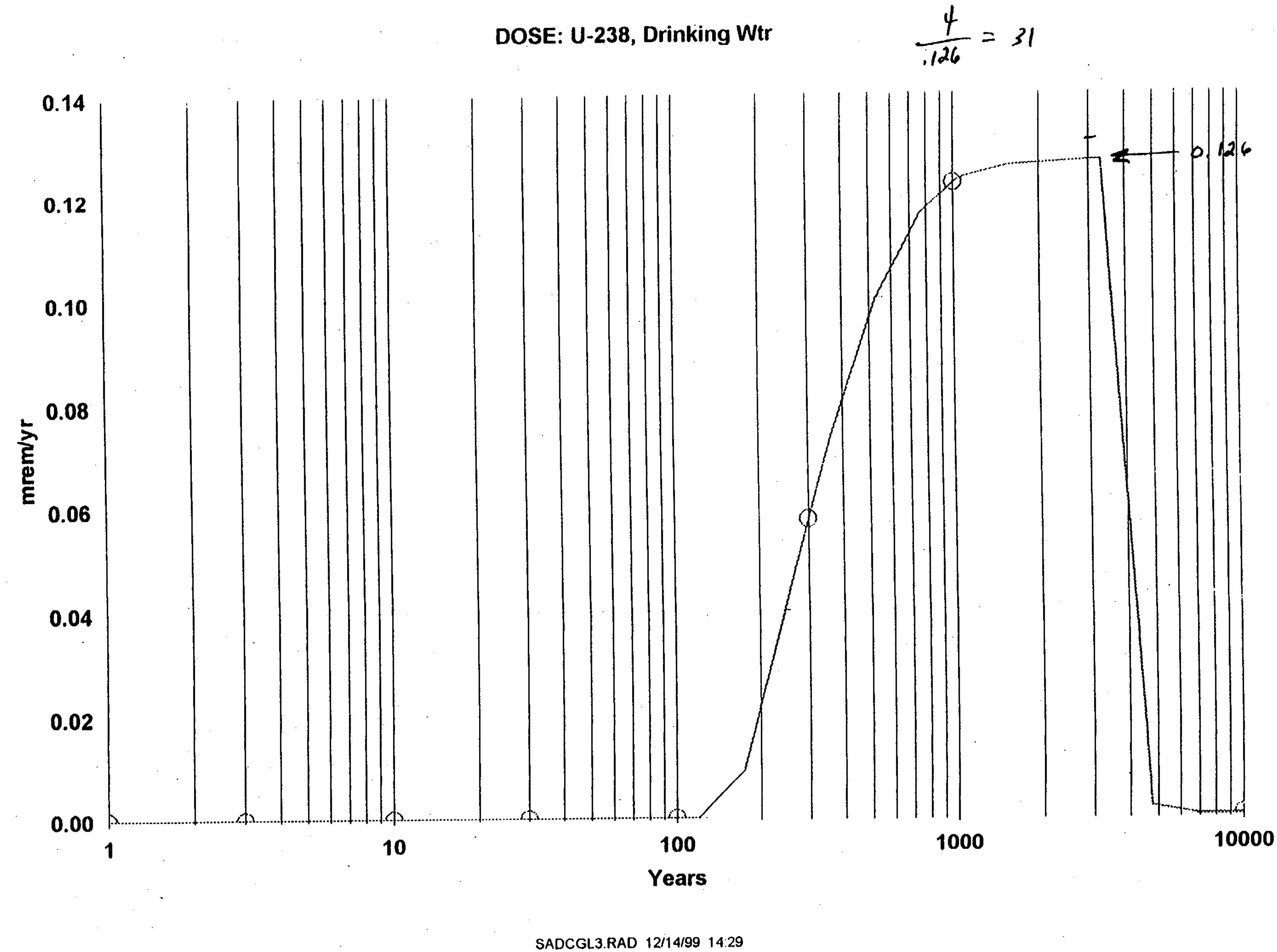
SADCGL3.RAD 12/14/99 14:29

$\frac{4}{.155} = 25$



SADCGL3.RAD 12/14/99 14:29


DOSE: U-235, Drinking Wtr
4 / 1.6 = 2.5
1.6
mrem/yr
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
10
100
1000
10000
Years
SADCGL3.RAD 12/14/99 14:29



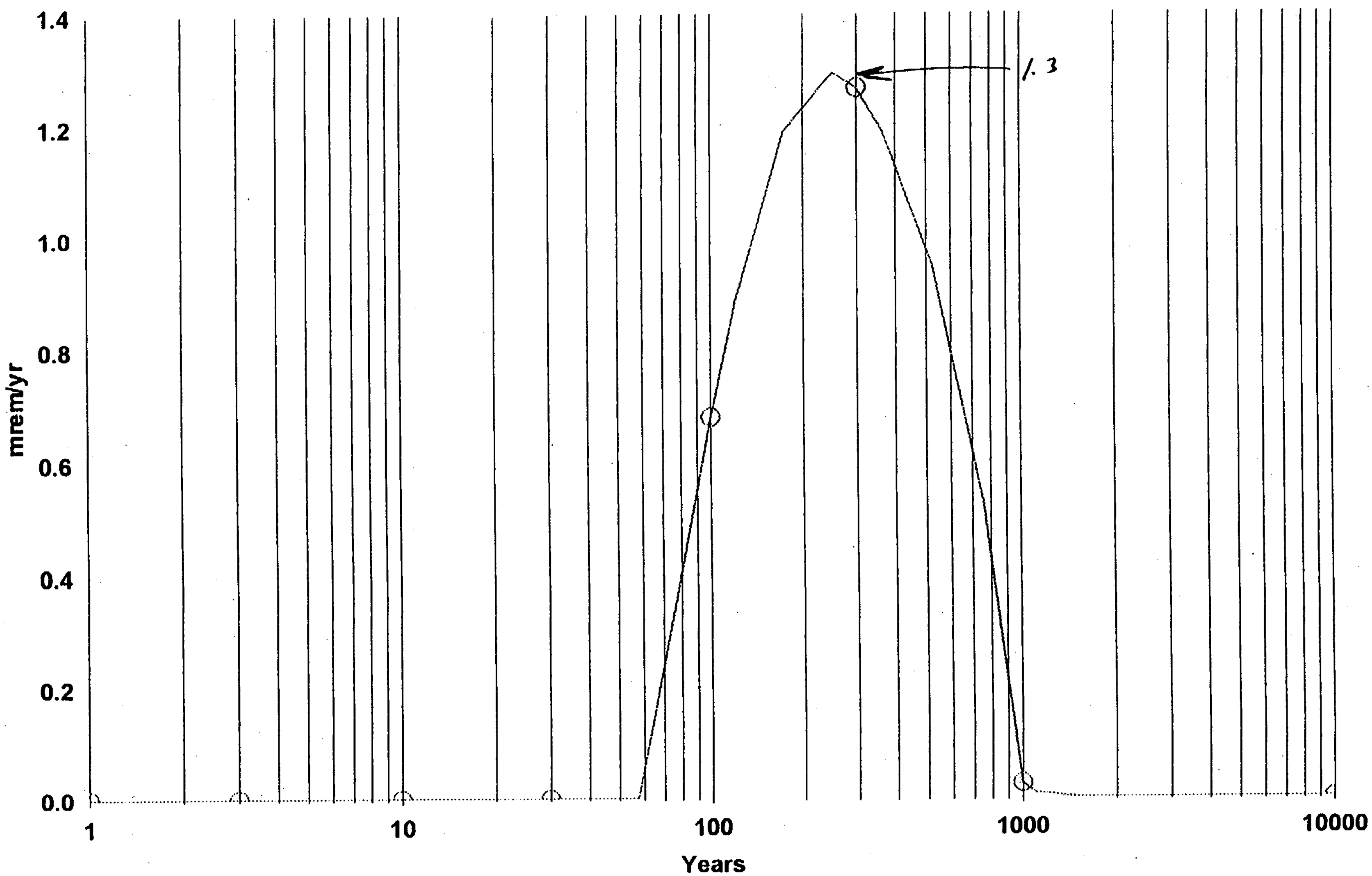
DOSE: U-238, Drinking Wtr
4 / .126 = 31
0.126
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
mrem/yr
1
10
100
1000
10000
Years
SADCGL3.RAD 12/14/99 14:29

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)	Drinking H_2O DCGLs (pCi/g)
Am-241	1.000E+00	245.1 ± 0.5	1.326E+00	1.886E+01	1.483E-01	1.686E+02	3.0
C-14	1.000E+00	8.12 ± 0.02	1.268E-01	1.972E+02	6.933E-02	3.606E+02	
Cm-243	1.000E+00	0.000E+00	3.758E-01	6.652E+01	3.758E-01	6.652E+01	
Cm-244	1.000E+00	0.000E+00	7.028E-02	3.557E+02	7.028E-02	3.557E+02	
Co-60	1.000E+00	0.000E+00	7.724E+00	3.236E+00	7.724E+00	3.236E+00	
Cs-134	1.000E+00	0.000E+00	4.558E+00	5.485E+00	4.558E+00	5.485E+00	
Cs-137	1.000E+00	0.000E+00	1.671E+00	1.496E+01	1.671E+00	1.496E+01	
Eu-152	1.000E+00	0.000E+00	3.313E+00	7.546E+00	3.313E+00	7.546E+00	
Eu-154	1.000E+00	0.000E+00	3.639E+00	6.869E+00	3.639E+00	6.869E+00	
Eu-155	1.000E+00	0.000E+00	9.097E-02	2.748E+02	9.097E-02	2.748E+02	
Fe-55	1.000E+00	0.000E+00	2.341E-05	1.068E+06	2.341E-05	1.068E+06	
H-3	1.000E+00	0.000E+00	8.238E-03	3.035E+03	8.238E-03	3.035E+03	
Nb-94	1.000E+00	0.000E+00	4.567E+00	5.474E+00	4.567E+00	5.474E+00	
Ni-59	1.000E+00	0.000E+00	3.306E-04	7.561E+04	3.306E-04	7.561E+04	
Ni-63	1.000E+00	0.000E+00	9.085E-04	2.752E+04	9.085E-04	2.752E+04	
Pu-238	1.000E+00	0.000E+00	1.114E-01	2.245E+02	1.114E-01	2.245E+02	
Pu-239	1.000E+00	0.000E+00	1.231E-01	2.030E+02	1.231E-01	2.030E+02	
Pu-240	1.000E+00	0.000E+00	1.231E-01	2.031E+02	1.231E-01	2.031E+02	
Pu-241	1.000E+00	270.1 ± 0.5	4.355E-02	5.741E+02	2.388E-03	1.047E+04	94
Pu-242	1.000E+00	0.000E+00	1.169E-01	2.139E+02	1.169E-01	2.139E+02	
Sb-125	1.000E+00	0.000E+00	1.171E+00	2.134E+01	1.171E+00	2.134E+01	
Sr-90	1.000E+00	0.000E+00	1.377E+00	1.816E+01	1.377E+00	1.816E+01	
Tc-99	1.000E+00	0.000E+00	2.139E-01	1.169E+02	2.139E-01	1.169E+02	
U-234	1.000E+00	1961 ± 4	7.361E-02	3.396E+02	2.485E-02	1.006E+03	57
U-235	1.000E+00	1873 ± 4	4.835E-01	5.171E+01	3.980E-01	6.282E+01	9.5
U-238	1.000E+00	0.000E+00	8.865E-02	2.820E+02	8.865E-02	2.820E+02	63

DOSE: Am-241, Drinking Wtr

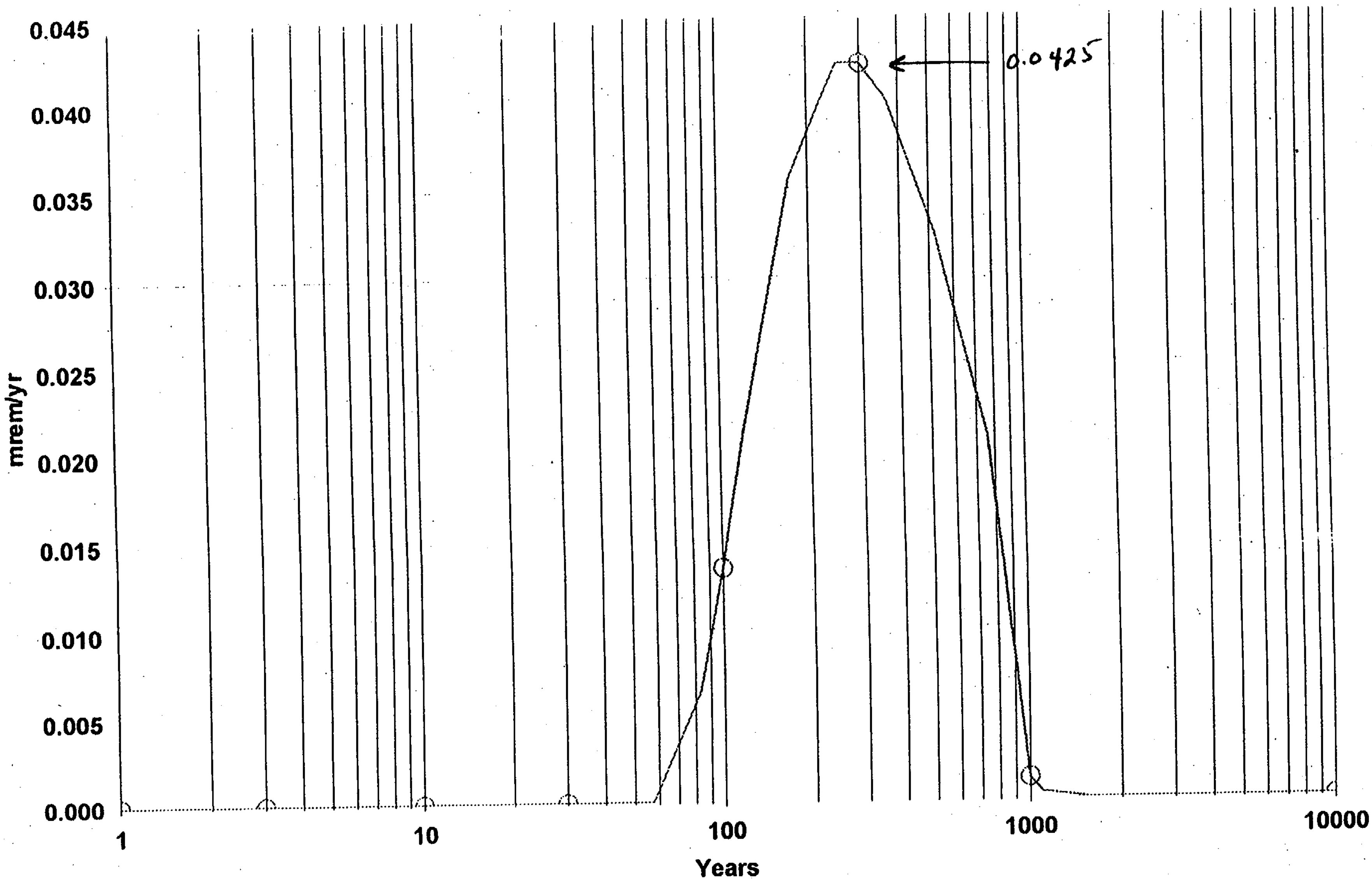
4 / 1.3 = 3.0



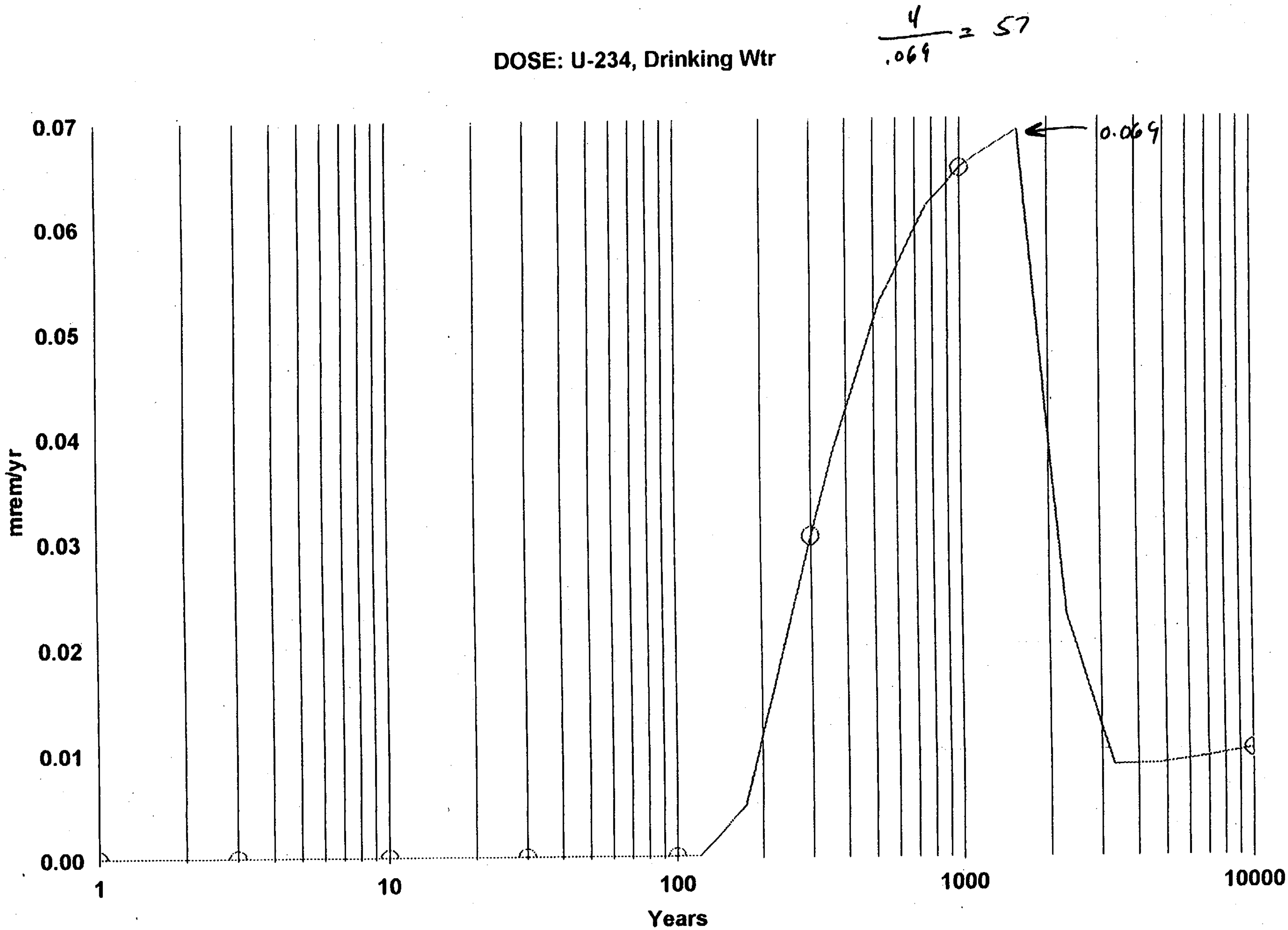
SADCGL4.RAD 12/14/99 14:36

DOSE: Pu-241a, Drinking Wtr

$\frac{4}{0.0425} = 94$

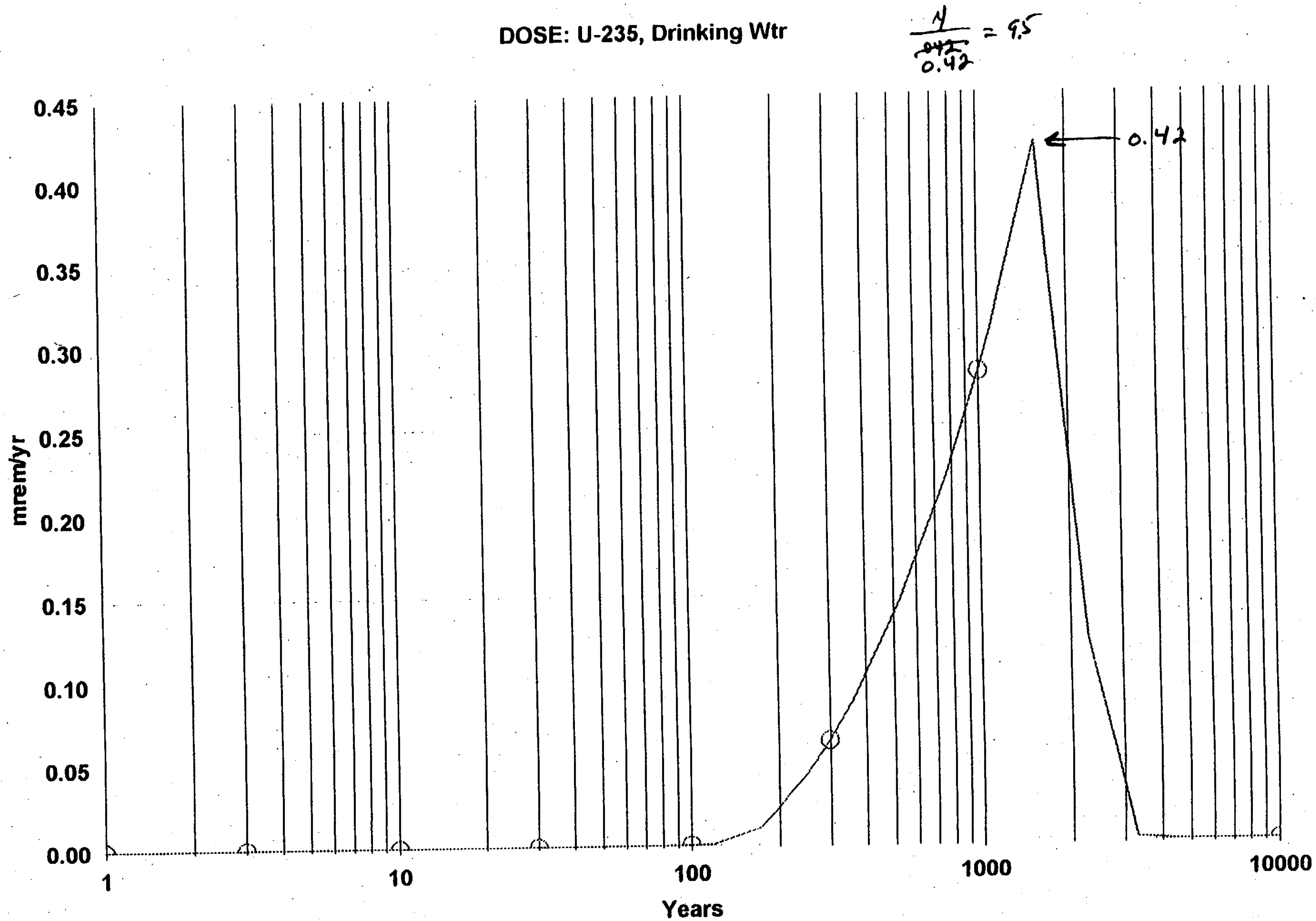


SADCGL4.RAD 12/14/99 14:36

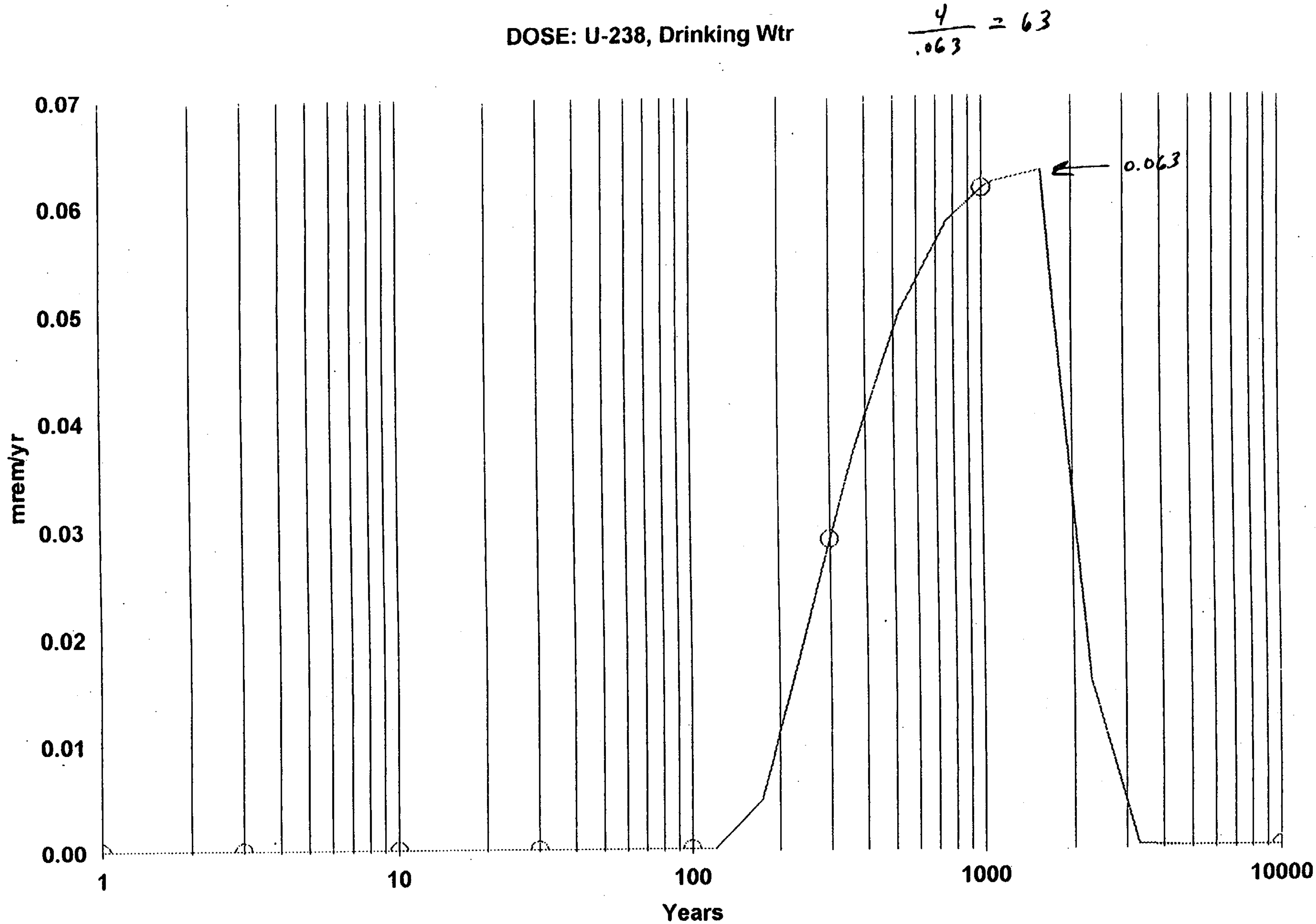


SADCGL4.RAD 12/14/99 14:36

DOSE: U-235, Drinking Wtr



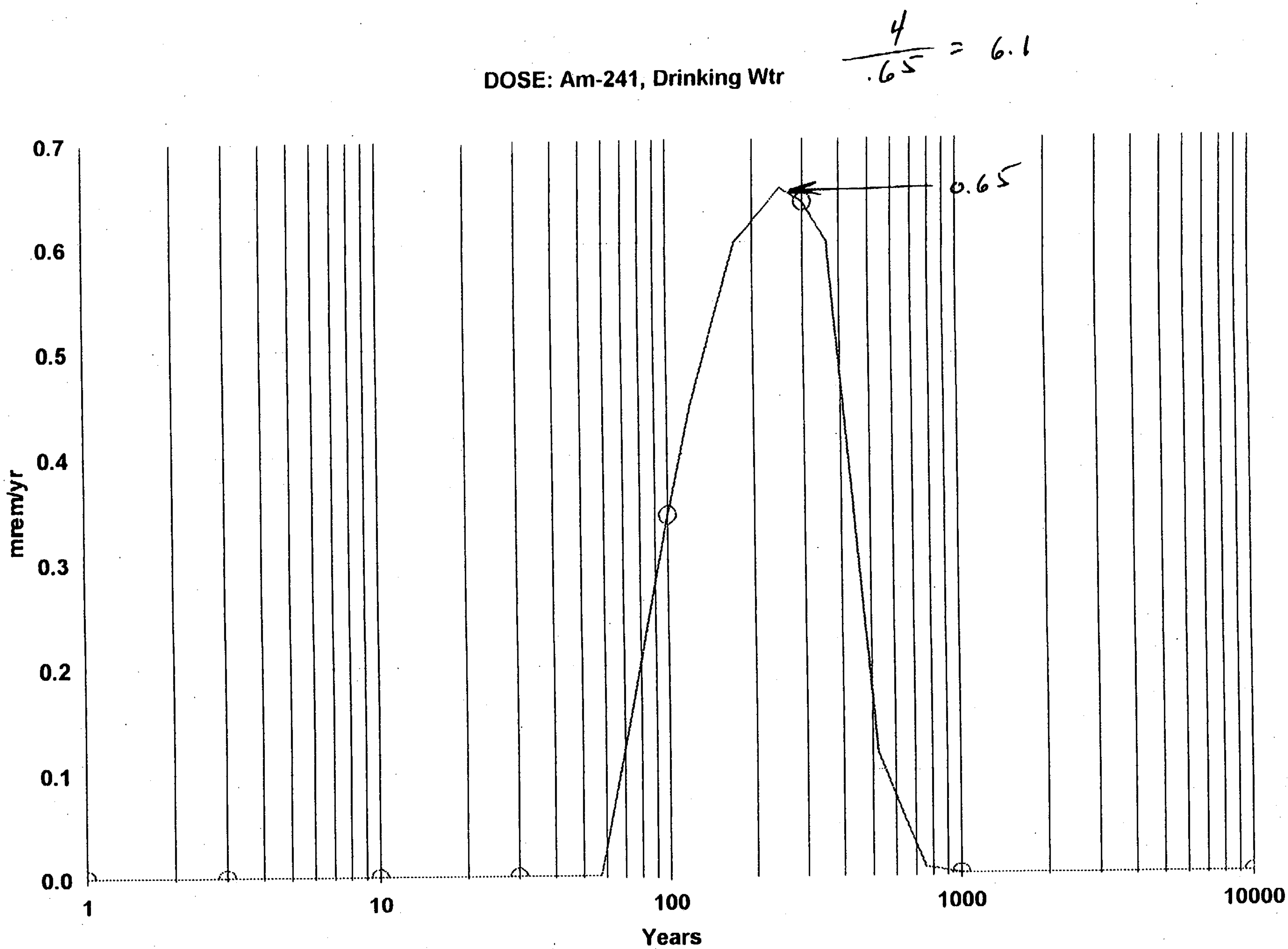
SADCGL4.RAD 12/14/99 14:36



SADCGL4.RAD 12/14/99 14:36

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

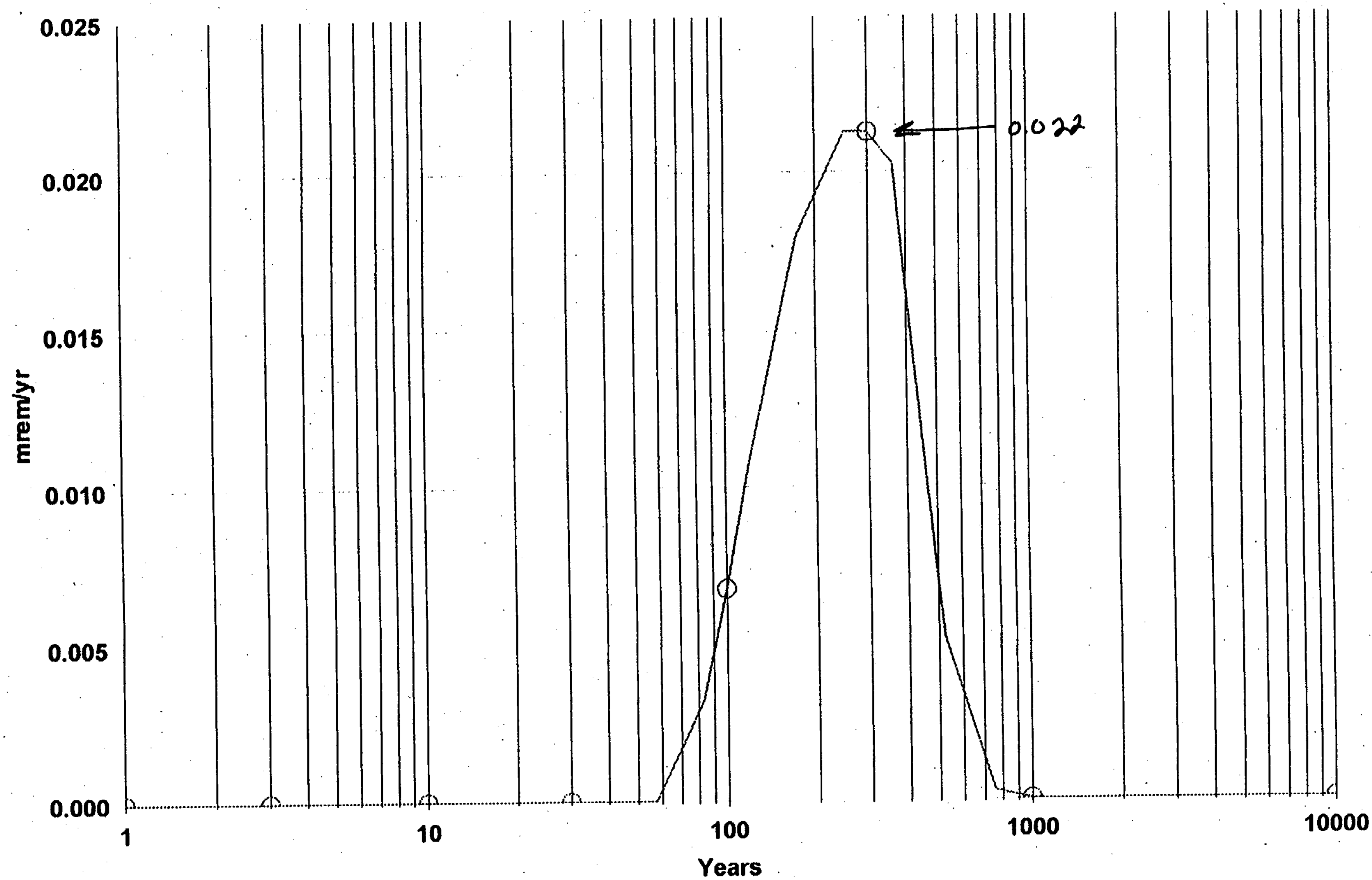
Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)	Drinking H_2O DCGL (pCi/g)
Am-241	1.000E+00	245.9 ± 0.5	6.582E-01	3.798E+01	5.524E-02	4.526E+02	6.1
C-14	1.000E+00	4.285 ± 0.009	6.282E-02	3.980E+02	1.059E-02	2.360E+03	
Cm-243	1.000E+00	0.000E+00	2.533E-01	9.868E+01	2.533E-01	9.868E+01	
Cm-244	1.000E+00	0.000E+00	2.105E-02	1.188E+03	2.105E-02	1.188E+03	
Co-60	1.000E+00	0.000E+00	5.973E+00	4.186E+00	5.973E+00	4.186E+00	
Cs-134	1.000E+00	0.000E+00	3.520E+00	7.103E+00	3.520E+00	7.103E+00	
Cs-137	1.000E+00	0.000E+00	1.275E+00	1.961E+01	1.275E+00	1.961E+01	
Eu-152	1.000E+00	0.000E+00	2.588E+00	9.660E+00	2.588E+00	9.660E+00	
Eu-154	1.000E+00	0.000E+00	2.832E+00	8.829E+00	2.832E+00	8.829E+00	
Eu-155	1.000E+00	0.000E+00	7.243E-02	3.452E+02	7.243E-02	3.452E+02	
Fe-55	1.000E+00	0.000E+00	5.888E-06	4.246E+06	5.888E-06	4.246E+06	
H-3	1.000E+00	0.000E+00	2.071E-03	1.207E+04	2.071E-03	1.207E+04	
Nb-94	1.000E+00	0.000E+00	3.575E+00	6.993E+00	3.575E+00	6.993E+00	
Ni-59	1.000E+00	0.000E+00	8.270E-05	3.023E+05	8.270E-05	3.023E+05	
Ni-63	1.000E+00	0.000E+00	2.272E-04	1.100E+05	2.272E-04	1.100E+05	
Pu-238	1.000E+00	0.000E+00	3.332E-02	7.502E+02	3.332E-02	7.502E+02	
Pu-239	1.000E+00	0.000E+00	3.682E-02	6.790E+02	3.682E-02	6.790E+02	
Pu-240	1.000E+00	0.000E+00	3.676E-02	6.800E+02	3.676E-02	6.800E+02	
Pu-241	1.000E+00	270.9 ± 0.5	2.162E-02	1.156E+03	7.165E-04	3.489E+04	181
Pu-242	1.000E+00	0.000E+00	3.496E-02	7.151E+02	3.496E-02	7.151E+02	
Sb-125	1.000E+00	0.000E+00	9.201E-01	2.717E+01	9.201E-01	2.717E+01	
Sr-90	1.000E+00	0.000E+00	3.527E-01	7.088E+01	3.527E-01	7.088E+01	
Tc-99	1.000E+00	0.000E+00	5.350E-02	4.673E+02	5.350E-02	4.673E+02	
U-234	1.000E+00	1051 ± 2	3.445E-02	7.256E+02	8.157E-03	3.065E+03	128
U-235	1.000E+00	0.000E+00	3.026E-01	8.261E+01	3.026E-01	8.261E+01	29
U-238	1.000E+00	0.000E+00	5.871E-02	4.258E+02	5.871E-02	4.258E+02	129



SADCGL5.RAD 12/14/99 14:43

DOSE: Pu-241a, Drinking Wtr

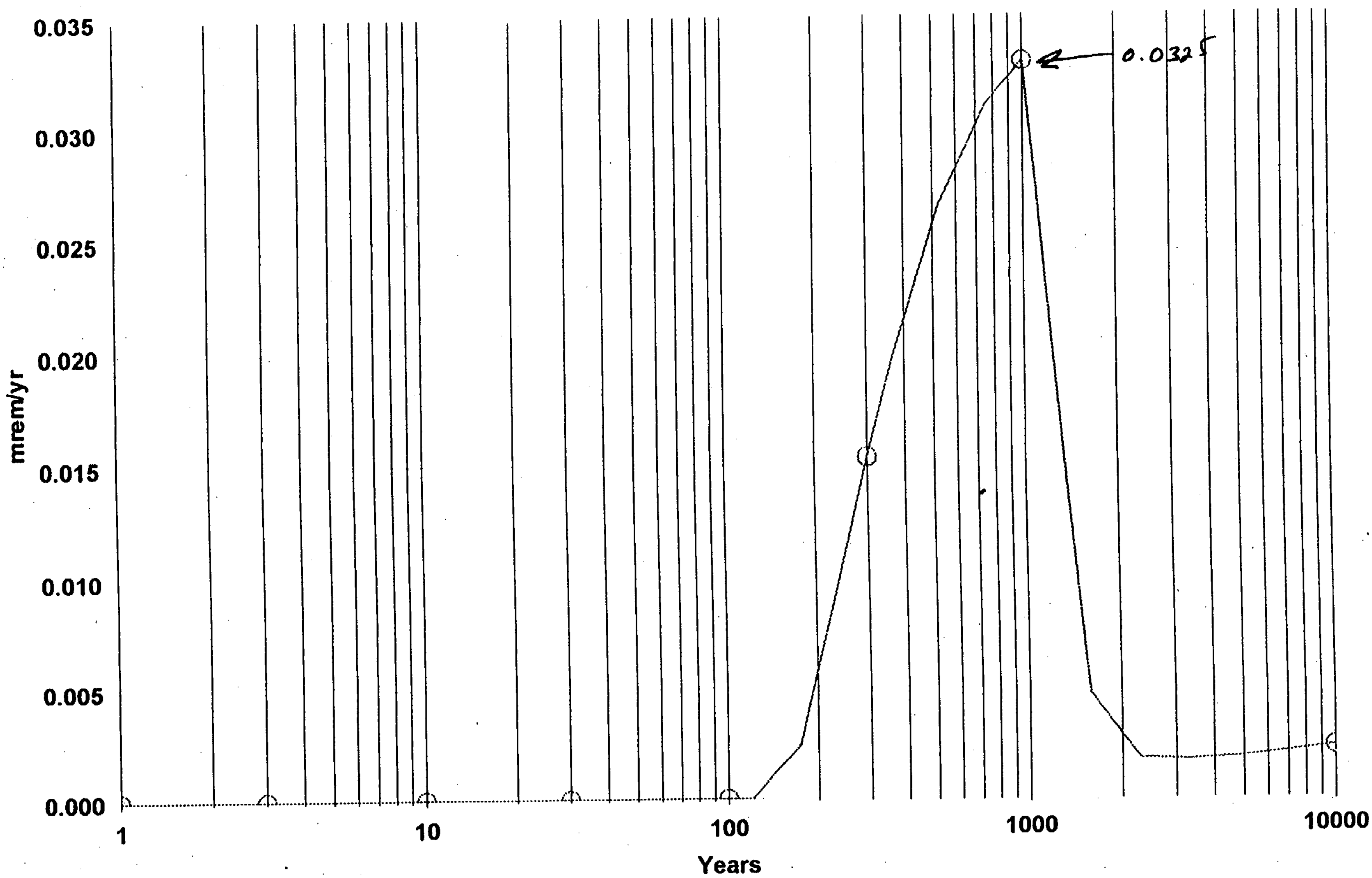
$\frac{4}{.022} = 181$



SADCGL5.RAD 12/14/99 14:43

DOSE: U-234, Drinking Wtr

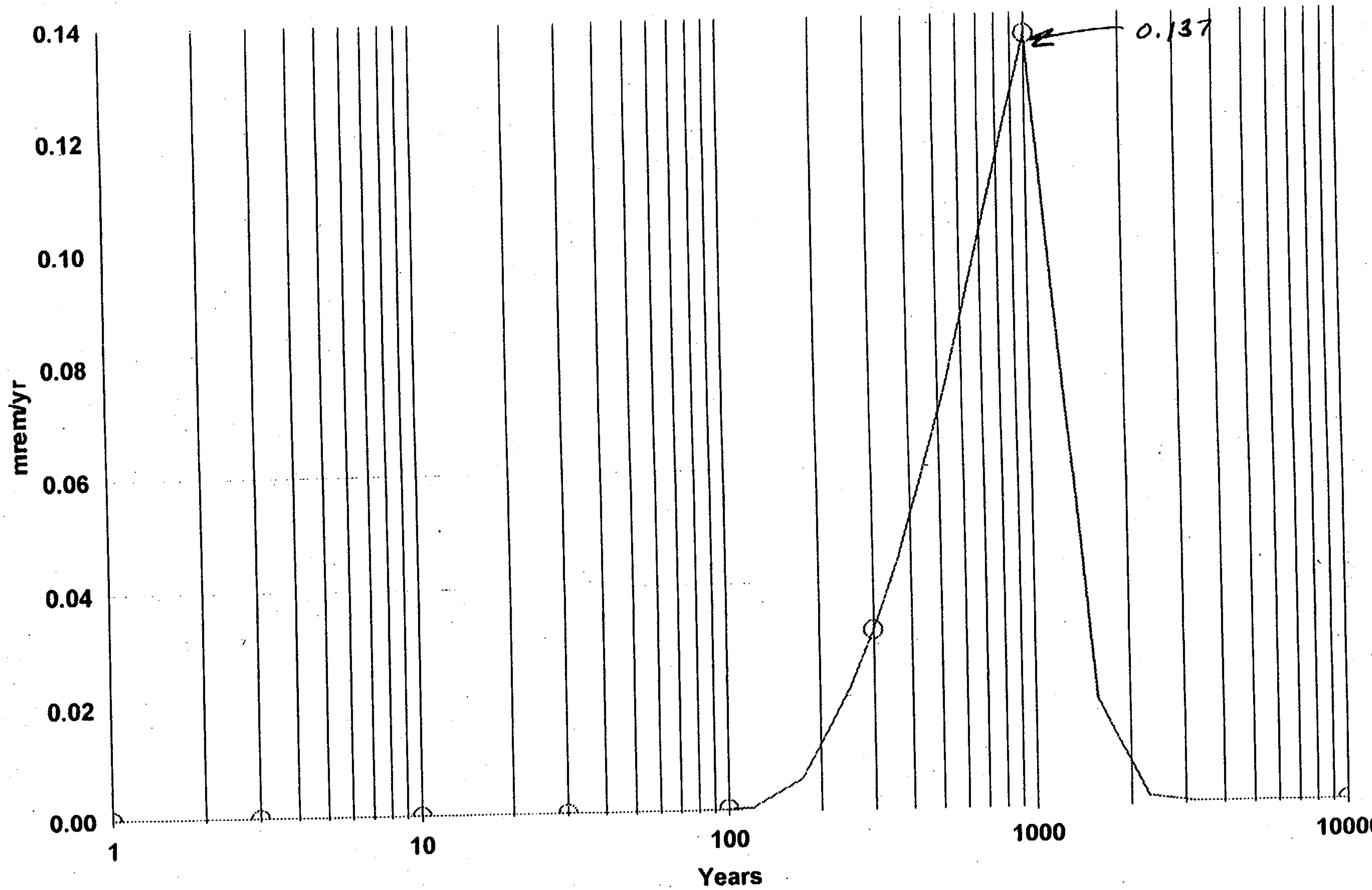
4 / 0.0325 = 123



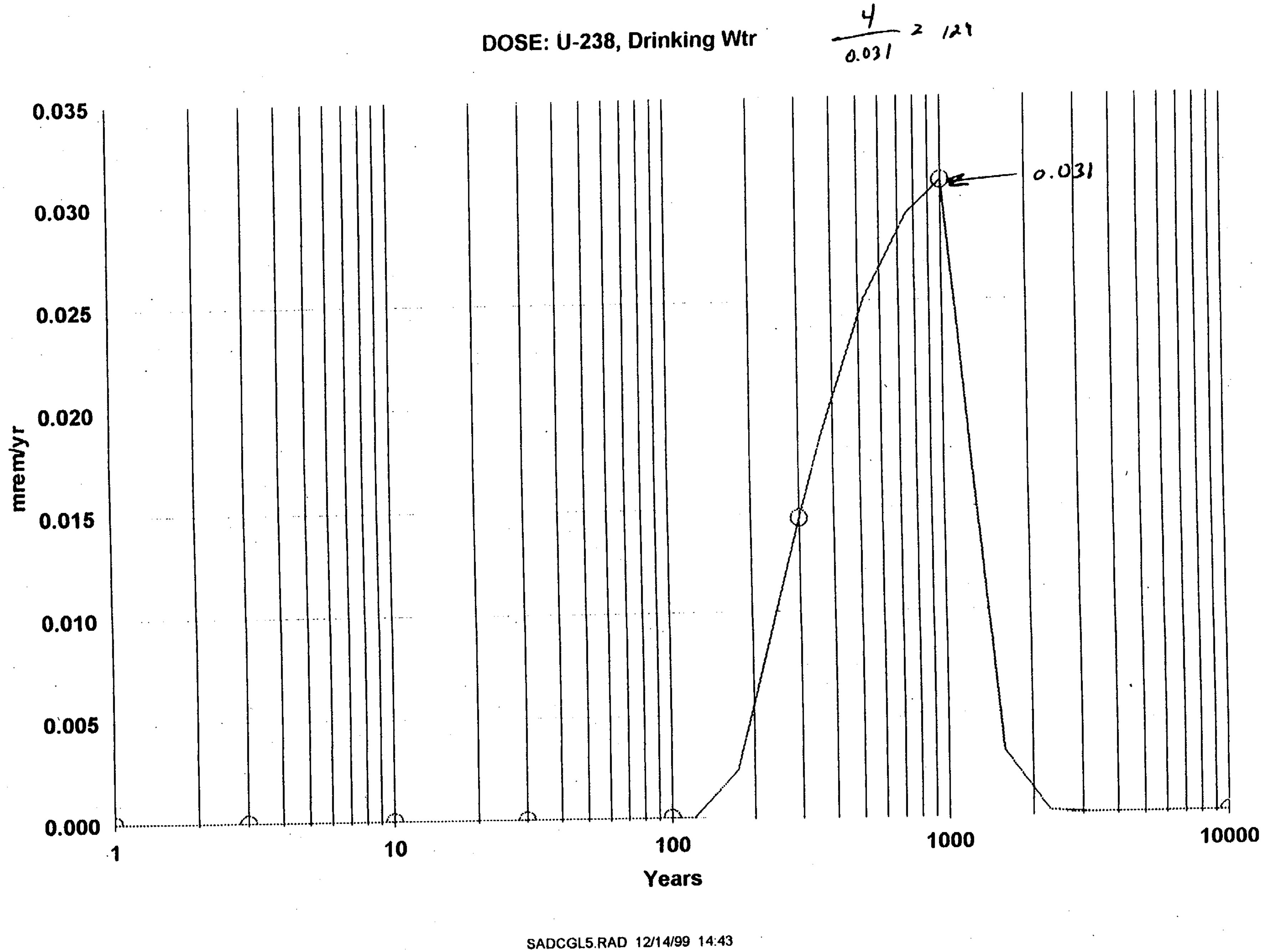
SADCGL5.RAD 12/14/99 14:43

DOSE: U-235, Drinking Wtr

4 / 0.137 = 29



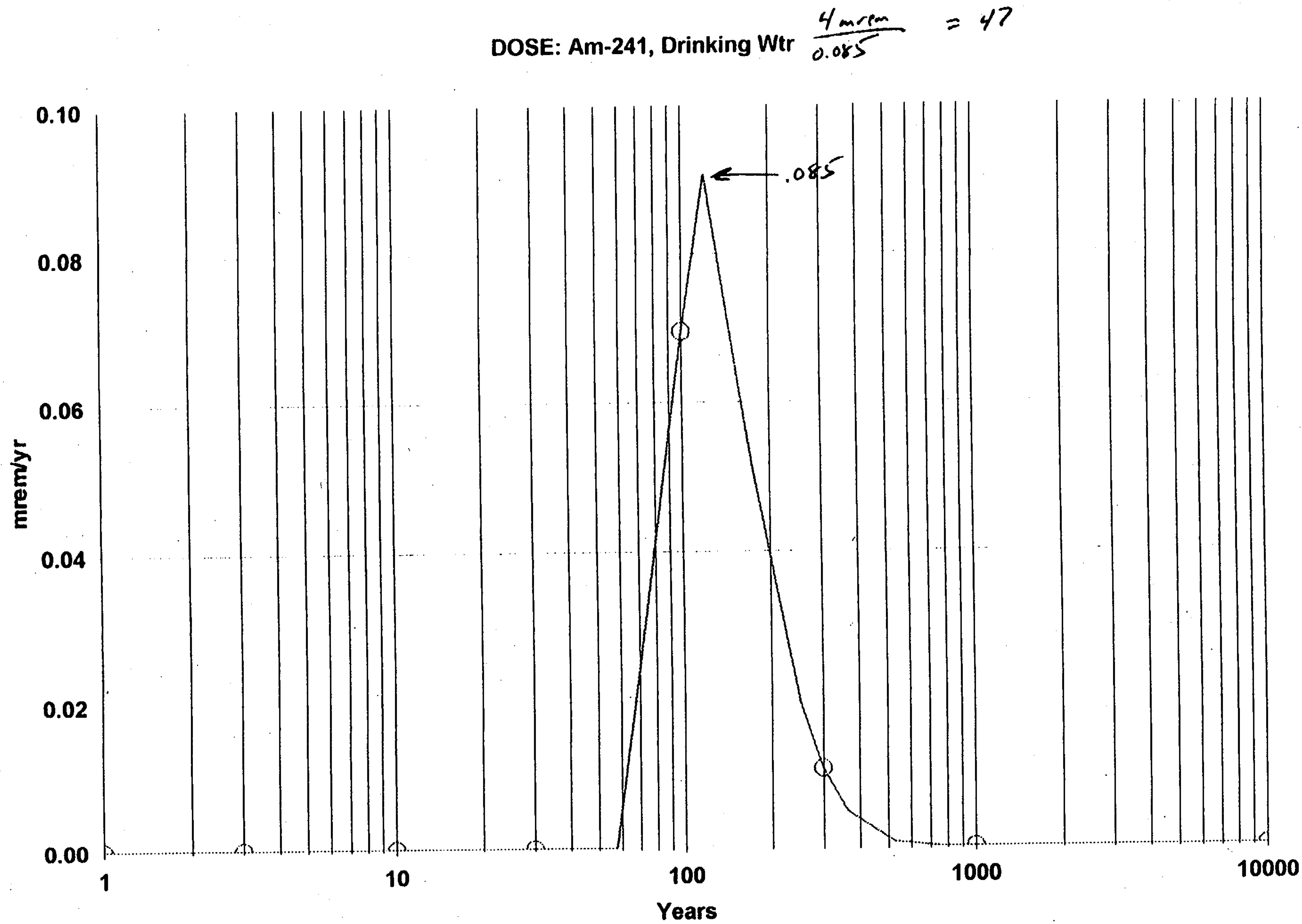
SADCGL5.RAD 12/14/99 14:43


DOSE: U-238, Drinking Wtr
4 / 0.031 = 129
0.031
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
mrem/yr
1
10
100
1000
10000
Years
SADCGL5.RAD 12/14/99 14:43

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

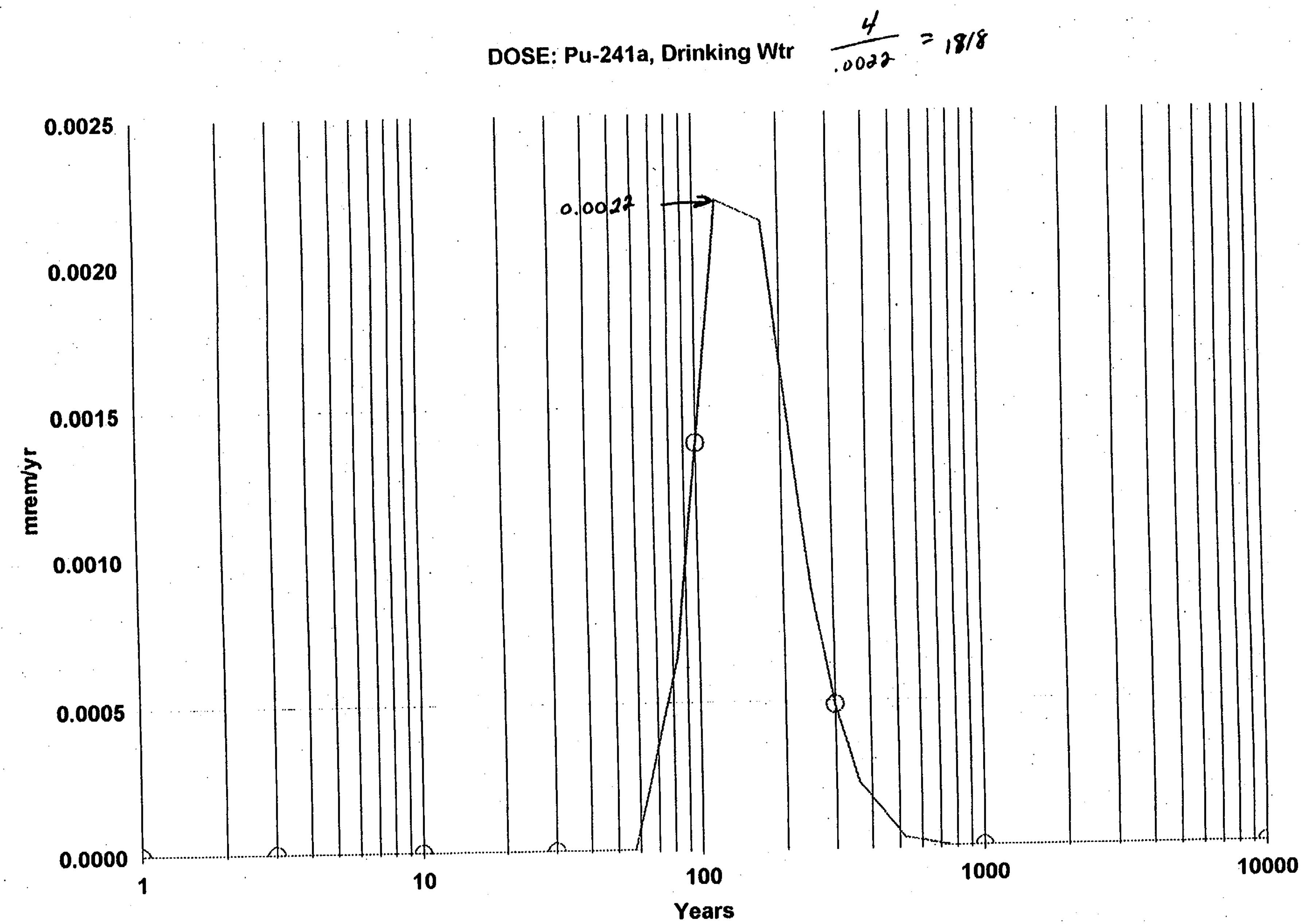
Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)	Drinking H_2O DCGL. (pCi/g)
Am-241	1.000E+00	124.7 ± 0.2	9.701E-02	2.577E+02	1.054E-02	2.371E+03	47
C-14	1.000E+00	1.257 ± 0.003	7.506E-03	3.331E+03	2.120E-04	1.179E+05	
Cm-243	1.000E+00	0.000E+00	4.387E-02	5.699E+02	4.387E-02	5.699E+02	
Cm-244	1.000E+00	0.000E+00	4.055E-03	6.165E+03	4.055E-03	6.165E+03	
Co-60	1.000E+00	0.000E+00	9.635E-01	2.595E+01	9.635E-01	2.595E+01	
Cs-134	1.000E+00	0.000E+00	5.808E-01	4.304E+01	5.808E-01	4.304E+01	
Cs-137	1.000E+00	0.000E+00	2.095E-01	1.194E+02	2.095E-01	1.194E+02	
Eu-152	1.000E+00	0.000E+00	4.263E-01	5.865E+01	4.263E-01	5.865E+01	
Eu-154	1.000E+00	0.000E+00	4.592E-01	5.444E+01	4.592E-01	5.444E+01	
Eu-155	1.000E+00	0.000E+00	1.333E-02	1.875E+03	1.333E-02	1.875E+03	
Fe-55	1.000E+00	0.000E+00	2.702E-07	9.251E+07	2.702E-07	9.251E+07	
H-3	1.000E+00	1.257 ± 0.003	1.935E-04	1.292E+05	8.649E-05	2.890E+05	
Nb-94	1.000E+00	0.000E+00	5.928E-01	4.217E+01	5.928E-01	4.217E+01	
Ni-59	1.000E+00	0.000E+00	3.343E-06	7.479E+06	3.343E-06	7.479E+06	
Ni-63	1.000E+00	0.000E+00	9.169E-06	2.726E+06	9.169E-06	2.726E+06	
Pu-238	1.000E+00	0.000E+00	6.406E-03	3.902E+03	6.406E-03	3.902E+03	
Pu-239	1.000E+00	0.000E+00	7.030E-03	3.556E+03	7.030E-03	3.556E+03	
Pu-240	1.000E+00	0.000E+00	7.021E-03	3.561E+03	7.021E-03	3.561E+03	
Pu-241	1.000E+00	139.1 ± 0.3	2.685E-03	9.311E+03	1.362E-04	1.836E+05	1818
Pu-242	1.000E+00	0.000E+00	6.715E-03	3.723E+03	6.715E-03	3.723E+03	
Sb-125	1.000E+00	0.000E+00	1.546E-01	1.617E+02	1.546E-01	1.617E+02	
Sr-90	1.000E+00	0.000E+00	1.623E-02	1.540E+03	1.623E-02	1.540E+03	
Tc-99	1.000E+00	0.000E+00	2.147E-03	1.164E+04	2.147E-03	1.164E+04	
U-234	1.000E+00	331.6 ± 0.7	4.120E-03	6.067E+03	2.055E-03	1.216E+04	1250
U-235	1.000E+00	0.000E+00	5.236E-02	4.775E+02	5.236E-02	4.775E+02	645
U-238	1.000E+00	0.000E+00	1.040E-02	2.404E+03	1.040E-02	2.404E+03	1379

DOSE: Am-241, Drinking Wtr

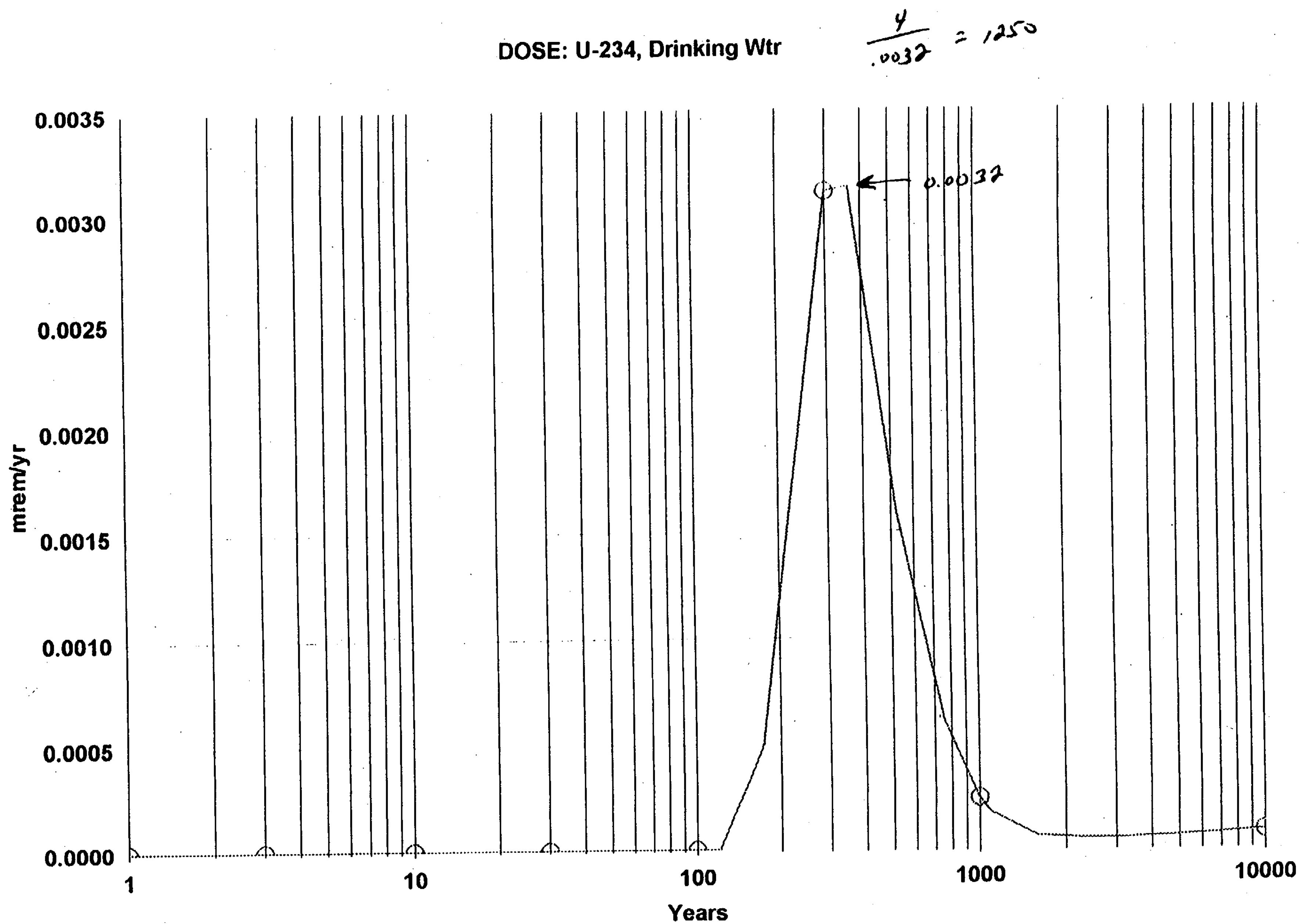


SADCGL6.RAD 12/14/99 14:51

DOSE: Pu-241a, Drinking Wtr



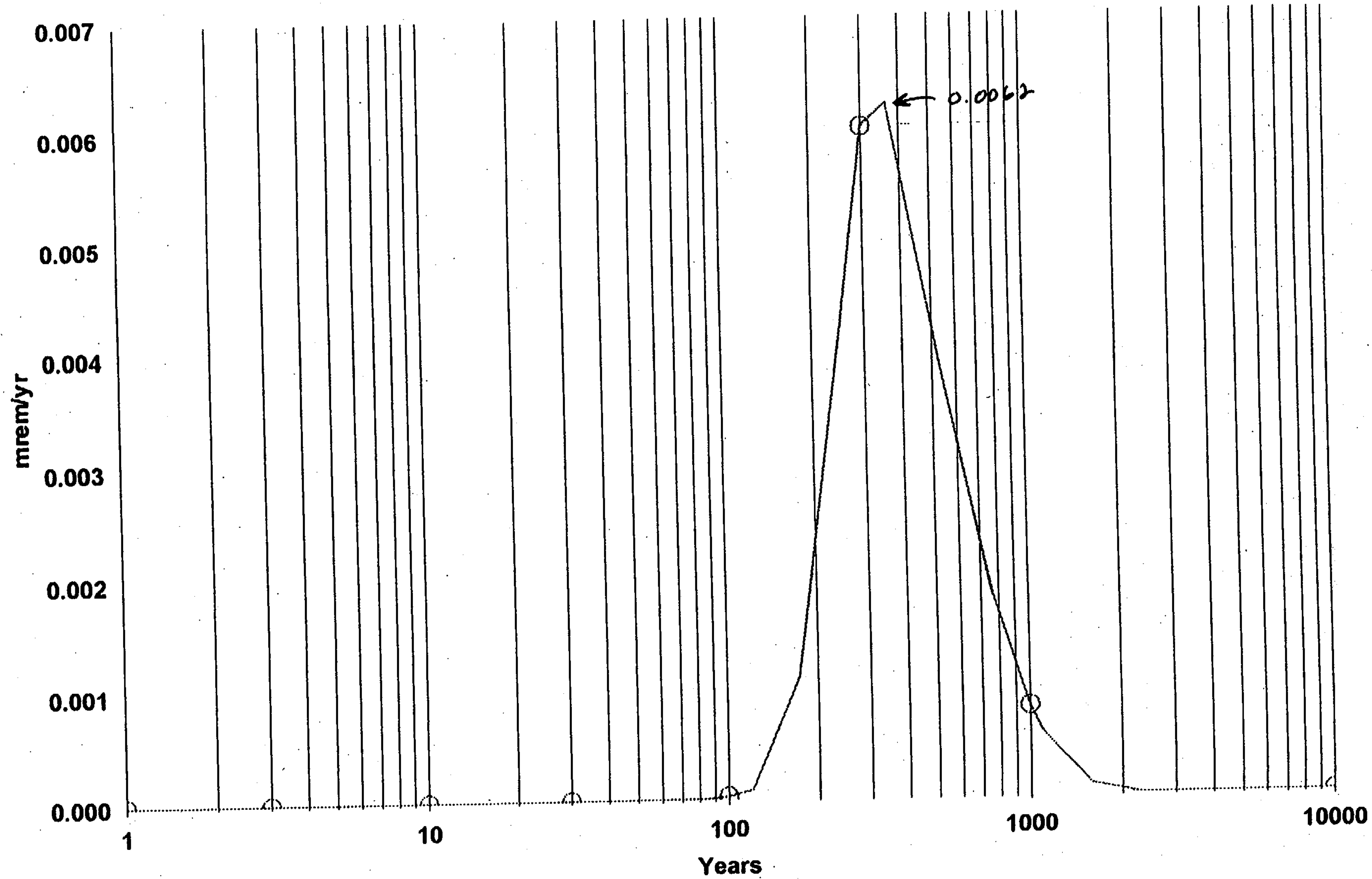
SADCGL6.RAD 12/14/99 14:51



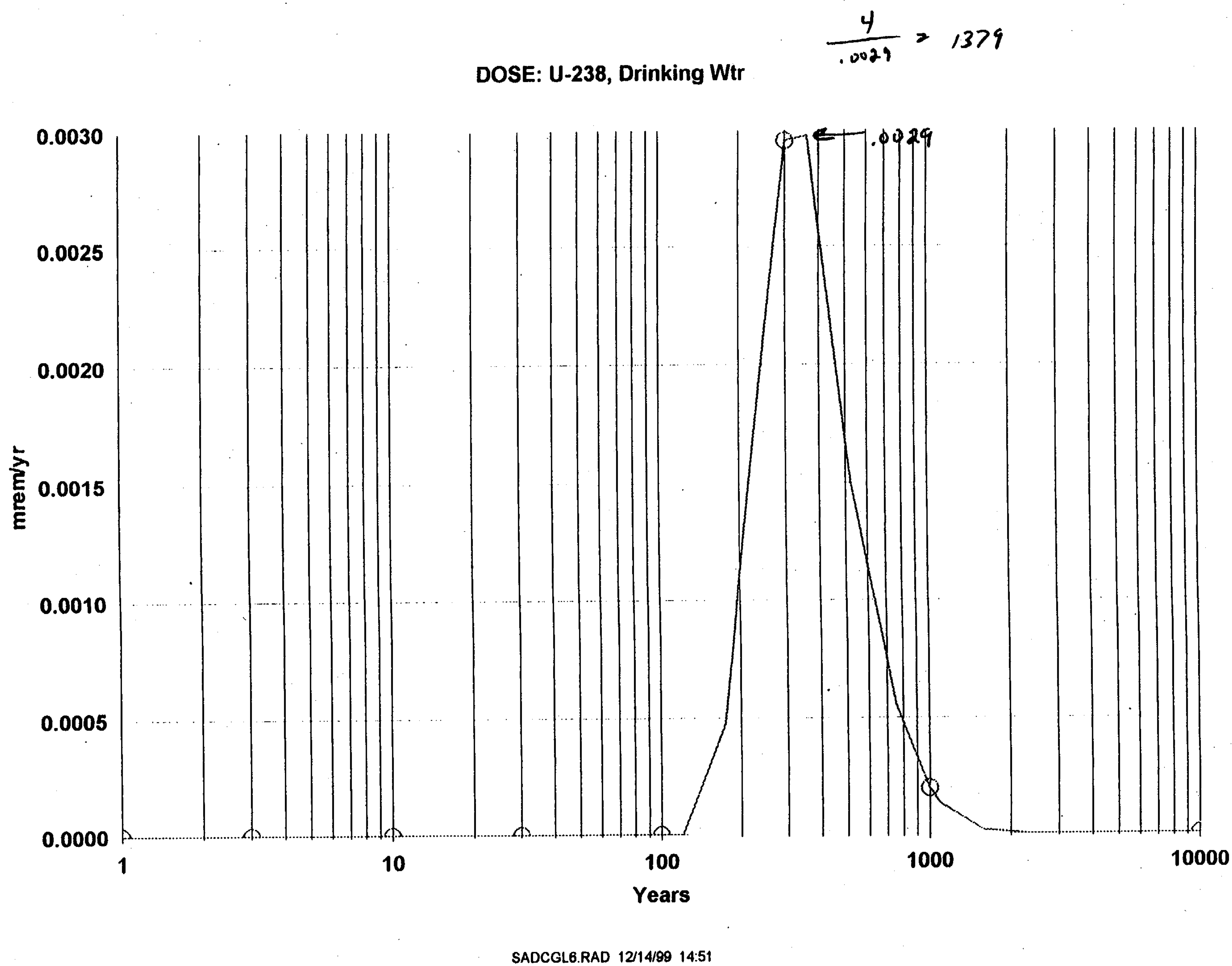
SADCGL6.RAD 12/14/99 14:51

DOSE: U-235, Drinking Wtr

$\frac{4}{.0062} = 645$



SADCGL6.RAD 12/14/99 14:51



4 / .0029 = 1379
DOSE: U-238, Drinking Wtr
.0029
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
mrem/yr
1
10
100
1000
10000
Years
SADCGL6.RAD 12/14/99 14:51

Appendix C

Haley & Aldrich Recommendations for RESRAD Hydrology Inputs

UNDERGROUND
ENGINEERING &
ENVIRONMENTAL
SOLUTIONS

Haley & Aldrich, Inc.
150 Mineral Spring Drive
Dover, NJ 07801-1635
Tel: 973.361.3600
Fax: 973.361.3800
E-mail: NEW@HaleyAldrich.co

HALEY & ALDRICH

31 March 1999
File No. 74582-000

J. Patrick Donnachie, Jr., CHP
Environmental Radioactivity Lab Mngr.
GPU Nuclear, Inc.
2574 Interstate Drive
Harrisburg, PA 17110

Subject: RESRAD Hydrological Input Summary
Saxton Nuclear Experimental Corporation

Dear Patrick:

This letter provides a summary of recommended ranges for the hydrologic input data for RESRAD. The attached Table I summarizes the hydrogeological input parameters and their respective recommended ranges, and Figure 1 provides a schematic indicating the conceptual model. The recommended ranges are based on published values as listed in the table, and are modified consistent with our experience in estimating values for hydrogeological properties of soil and aquifers. The recommended values are also based on our understanding of the conceptual site model, including relative depths to/thickness of the cover material, contaminated layer, and unsaturated zone as discussed in our 18 February 1999 and subsequent conference call.

Sincerely yours,
HALEY & ALDRICH, INC.

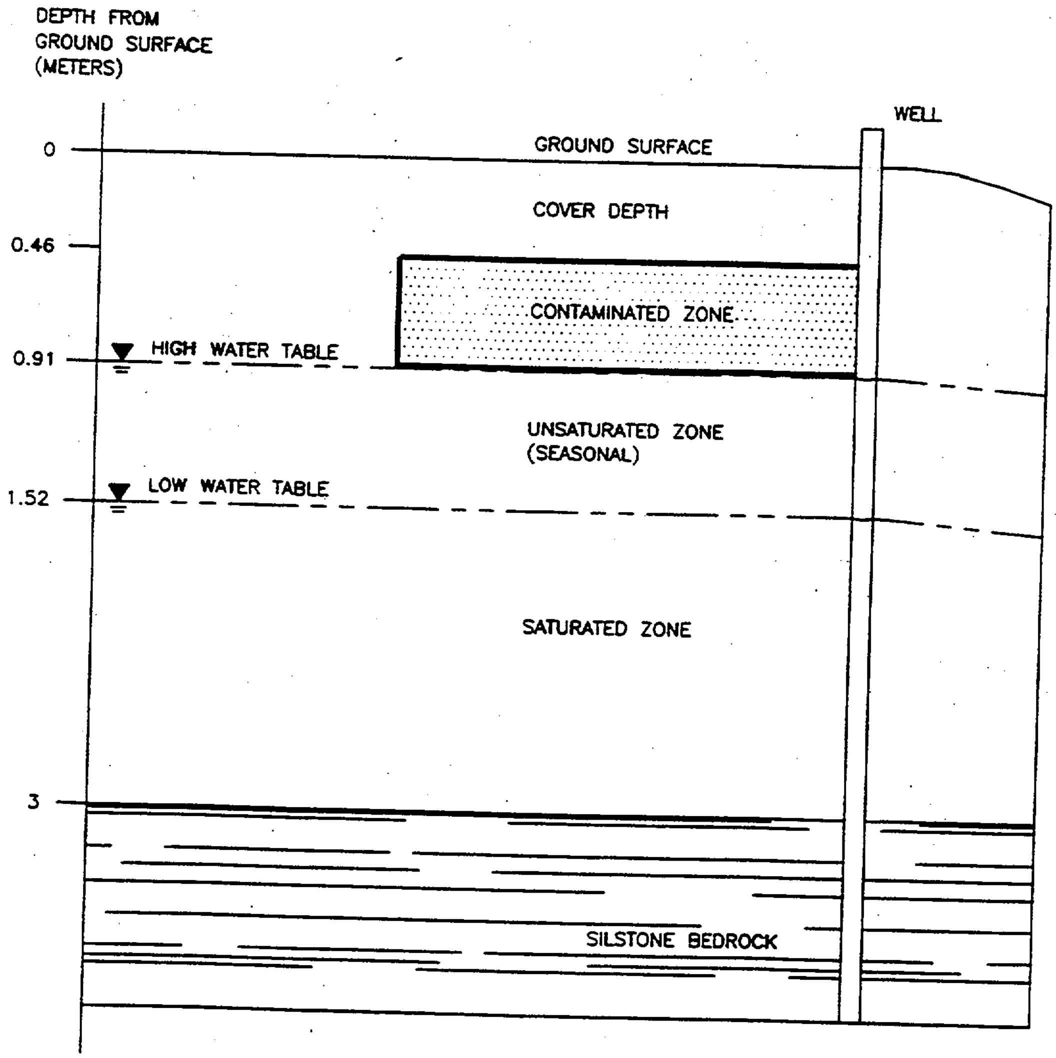
Anthony J. Bonasera
Senior Hydrogeologist

Charles R. Butts
Vice President

Attachments

\G:\documents\74\74582\74582a01a.doc

OFFICES
Boston, Massachusetts
Cleveland, Ohio
Denver, Colorado
Hartford, Connecticut
Los Angeles, California
Manchester, New Hampshire
Portland, Maine
Rochester, New York
San Diego, California
San Francisco, California
Washington, District of Columbia



NOTE

DRAWING IS CONCEPTUAL REPRESENTATION OF THE SITE, COINCIDING WITH RESRAD MODEL INPUT FORMAT AND IS BASED ON DISCUSSIONS WITH GPU PERSONNEL.

HALEY & ALDRICH
UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

SAXTON NUCLEAR EXPERIMENTAL FACILITY
SAXTON, PENNSYLVANIA

CROSS SECTION SCHEMATIC

NOT TO SCALE

FEBRUARY 1999

G:\74582\CONCEPTUAL.DWG

FIGURE 1

Table I
Summary of Model Parameters - Hydrogeologic Inputs
RESRAD, Version 5.82
Saxton Nuclear Experimental Corporation

Menu	Parameter	Recommended Range		Default*	References
R013	Cover depth (m)	3.000E-01	6.100E-01	1.000E+00	1
R013	Density of cover material (g/cm**3)	1.200E+00	1.600E+00	1.500E+00	11, 1
R013	Cover depth erosion rate (m/yr)	6.000E-04	9.000E-05	1.000E-03	12**
R013	Density of contaminated zone (g/cm**3)	1.280E+00	1.920E+00	1.500E+00	2, 11
R013	Contaminated zone erosion rate (m/yr)	6.000E-04	9.000E-05	1.000E-03	12**
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	4.000E-01	6
R013	Contaminated zone effective porosity	3.000E-01	4.000E-01	2.000E-01	6
R013	Contaminated zone hydraulic conductivity (m/yr)	3.150E+00	3.150E+01	1.000E+01	2, 3
R013	Contaminated zone b parameter	8.500E+00	1.250E+01	5.300E+00	12***
R013	Average annual wind speed (m/sec)	3.487E+00	4.247E+00	2.000E+00	8
R013	Humidity in air (g/m**3)	not used		8.000E+00	
R013	Evapotranspiration coefficient	5.500E-01	6.384E-01	5.000E-01	7, 12, 13, 15****
R013	Precipitation (m/yr)	9.563E-01	1.092E+00	1.000E+00	7
R013	Irrigation (m/yr)	2.000E-01		2.000E-01	12
R013	Irrigation mode	overhead		overhead	12
R013	Runoff coefficient	3.000E-01	4.000E-01	2.000E-01	12, 15
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	9.000E+06	1.000E+06	14
R013	Accuracy for water/soil computations	1.000E-03		1.000E-03	
R014	Density of saturated zone (g/cm**3)	1.280E+00	1.920E+00	1.500E+00	2, 11
R014	Saturated zone total porosity	3.000E-01	4.000E-01	4.000E-01	6
R014	Saturated zone effective porosity	3.000E-01	4.000E-01	2.000E-01	6
R014	Saturated zone hydraulic conductivity (m/yr)	3.150E+00	3.150E+01	1.000E+02	2, 3
R014	Saturated zone hydraulic gradient	2.000E-02	4.000E-02	2.000E-02	16
R014	Saturated zone b parameter	8.500E+00	1.250E+01	5.300E+00	12**
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	1.000E-03	
R014	Well pump intake depth (m below water table)	1.000E+01	5.000E+01	1.000E+01	2, 10
R014	Model: nondispersion (ND) or Mass-balance (MB)	ND	-	ND	
R014	Well pumping rate (m**3/yr)	2.073E+02	3.650E+02	2.500E+02	9
R015	Number of unsaturated zone strata	0	1	1	
R015	Unsat. zone 1, thickness (m)	-	6.100E-01	4.000E+00	1, 2
R015	Unsat. zone 1, soil density (g/cm**3)	1.280E+00	1.920E+00	1.500E+00	2, 11
R015	Unsat. zone 1, total porosity	3.000E-01	4.000E-01	4.000E-01	6
R015	Unsat. zone 1, effective porosity	3.000E-01	4.000E-01	2.000E-01	6
R015	Unsat. zone 1, soil-specific b parameter	8.500E+00	1.250E+01	5.300E+00	12**
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	3.150E+00	3.150E+01	1.000E+01	2, 3

* Default value as listed in the initial Site-Specific Parameter Summary provided by GPU Nuclear

** Assumes 2% slope + possible future use as row-crop agriculture

*** Estimated based on statistical regression of data (Clapp & Hornberger, 1978) to match recommended hydraulic conductivity

**** Range estimated through iterative solution with precipitation, runoff coefficient, and irrigation

References

1 Provided by GPU Nuclear

2 Preliminary Hydrogeological Investigation, Saxton Nuclear Experimental Station, Saxton, PA. Prepared by Ground/WaterTechnology, Inc. 1981.

3 Vokovic, Milan; Soro, Andjelko, Determination of Hydraulic Conductivity of Porous Media from Grain-Size Composition, Water Resources Publications. 1992.

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G:\DATA\74582\Recommended Range.XLS

Appendix D

RESRAD Summary Runs for Development of Area Factors

(Grid Areas = 2500 m^2, 400 m^2, 100 m^2, 25 m^2, and 1 m^2)

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Am-241
Description :
Single Run Am-241

Executed : 09/28/99 at 15:57:59

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
241Am	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
241Am	1.0000E+000
237Np	0.0000E+000
233Pa	0.0000E+000
233U	0.0000E+000
229Th	0.0000E+000
225Ra	0.0000E+000
225Ac	0.0000E+000
221Fr	0.0000E+000
217At	0.0000E+000
213Bi	0.0000E+000
213Po	0.0000E+000
209Tl	0.0000E+000
209Pb	0.0000E+000

Basic Parameters

Name	Value	Units	Default

===

'End Time' 25560.0000 days 365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 9.34E-001 TEDE (mrem) occurred 1.00 year(s) after
license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	3.85E-005	0.00
Inhalation	9.29E-001	99.54
Ingestion	4.26E-003	0.46
Total	9.34E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
241Am	9.34E-001	100.00
237Np	1.84E-007	0.00
233Pa	3.91E-011	0.00
233U	4.96E-014	0.00
229Th	1.71E-017	0.00
225Ra	5.02E-020	0.00
225Ac	5.64E-020	0.00
221Fr	1.03E-022	0.00
217At	1.05E-024	0.00

213Bi	5.49E-022	0.00
213Po	0.00E+000	0.00
209Tl	1.42E-022	0.00
209Pb	2.15E-024	0.00
Total	9.34E-001	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run C-14
Description :
     Single Run C-14

Executed     : 09/28/99 at 15:22:50
```

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
14C	1.0000

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
14C	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 6.83E-006 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of
Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	2.26E-008	0.33
Inhalation	4.37E-006	63.96
Ingestion	2.44E-006	35.71
Total	6.83E-006	100.00

Radionuclide Component of
Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
14C	6.83E-006	100.00
Total	6.83E-006	100.00

Program : DandD Version 1.0 Build 1.00.22
Session : Single Run Cm-243
Description :
Single Run Cm-243

Executed : 09/28/99 at 16:00:43

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
243Cm	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
243Cm	1.0000E+000
243Am	0.0000E+000
239Np	0.0000E+000
239Pu	0.0000E+000
235U	0.0000E+000
231Th	0.0000E+000
231Pa	0.0000E+000
227Ac	0.0000E+000
223Fr	0.0000E+000
227Th	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 6.39E-001 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.73E-004	0.03
Inhalation	6.36E-001	99.52
Ingestion	2.90E-003	0.45
Total	6.39E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
243Cm	6.39E-001	100.00
243Am	1.03E-007	0.00
239Np	2.61E-011	0.00
239Pu	1.29E-005	0.00
235U	1.21E-015	0.00
231Th	1.36E-019	0.00
231Pa	6.57E-020	0.00
227Ac	1.66E-021	0.00
223Fr	1.67E-028	0.00
227Th	1.85E-024	0.00
Total	6.39E-001	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run Cm-244
Description  :
     Single Run Cm-244

Executed     : 09/28/99 at 16:02:01
```

NRC Report

Occupancy Input Section

Execution Options

====================

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
244Cm	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
244Cm	1.0000E+000
240Pu	0.0000E+000
236U	0.0000E+000
232Th	0.0000E+000
228Ra	0.0000E+000
228Ac	0.0000E+000
228Th	0.0000E+000
224Ra	0.0000E+000
220Rn	0.0000E+000
216Po	0.0000E+000
212Pb	0.0000E+000
212Bi	0.0000E+000
212Po	0.0000E+000
208Tl	0.0000E+000

Basic Parameters

==

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 5.12E-001 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.21E-006	0.00
Inhalation	5.10E-001	99.55
Ingestion	2.31E-003	0.45
Total	5.12E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
244Cm	5.12E-001	99.99
240Pu	4.72E-005	0.01
236U	1.36E-013	0.00
232Th	2.25E-023	0.00
228Ra	1.93E-027	0.00
228Ac	3.21E-028	0.00
228Th	2.30E-025	0.00
224Ra	3.35E-027	0.00

220Rn	2.53E-031	0.00
216Po	1.10E-032	0.00
212Pb	1.77E-028	0.00
212Bi	8.67E-029	0.00
212Po	0.00E+000	0.00
208Tl	4.40E-028	0.00
Total	5.12E-001	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Co-60
Description :
Single Run Co-60

Executed : 09/28/99 at 15:27:54

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
60Co	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
60Co	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Co-60

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 3.55E-003 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	3.09E-003	87.07
Inhalation	4.29E-004	12.10
Ingestion	2.95E-005	0.83
Total	3.55E-003	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
60Co	3.55E-003	100.00
Total	3.55E-003	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Cs-134
Description :
Single Run Cs-134

Executed : 09/23/99 at 15:39:33

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
134Cs	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
134Cs	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Cs-134

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 1.96E-003 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.81E-003	92.10
Inhalation	8.23E-005	4.19
Ingestion	7.28E-005	3.71
Total	1.96E-003	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
134Cs	1.96E-003	100.00
Total	1.96E-003	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run Cs-137
Description :
     Single Run Cs-137

Executed     : 09/28/99 at 15:40:59
```

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
137Cs	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
137Cs	1.0000E+000
137mBa	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 8.93E-004 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	7.69E-004	86.13
Inhalation	6.61E-005	7.41
Ingestion	5.78E-005	6.47
Total	8.93E-004	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
137Cs	1.24E-004	13.92
137mBa	7.69E-004	86.08
Total	8.93E-004	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Eu-152
Description :
Single Run Eu-152

Executed : 09/28/99 at 15:42:47

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
152Eu	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
152Eu	1.0000E+000
152Gd	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 1.97E-003 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.51E-003	76.70
Inhalation	4.51E-004	22.93
Ingestion	7.38E-006	0.38
Total	1.97E-003	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
152Eu	1.97E-003	100.00
152Gd	7.07E-018	0.00
Total	1.97E-003	100.00

```
Program     : DandD Version 1.0 Build 1.00.02
Session     : Single Run Eu-155
Description :
     Single Run Eu-155

Executed    : 09/28/99 at 15:45:36
```

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
155Eu	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
155Eu	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 1.60E-004 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	7.73E-005	48.32
Inhalation	8.10E-005	50.64
Ingestion	1.67E-006	1.04
Total	1.60E-004	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
155Eu	1.60E-004	100.00
Total	1.60E-004	100.00

Program   : DandD Version 1.0 Build 1.00.02
Session   : Single Run Eu-154
Description :
     Single Run Eu-154

Executed   : 09/28/99 at 15:44:18

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
154Eu	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
154Eu	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 2.18E-003 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.59E-003	73.08
Inhalation	5.76E-004	26.43
Ingestion	1.07E-005	0.49
Total	2.18E-003	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
154Eu	2.18E-003	100.00
Total	2.18E-003	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run Fe-55
Description  :
     Single Run Fe-55

Executed     : 09/28/99 at 15:25:20
```

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
55Fe	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
55Fe	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 5.59E-006 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	0.00E+000	0.00
Inhalation	4.96E-006	88.80
Ingestion	6.26E-007	11.20
Total	5.59E-006	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
55Fe	5.59E-006	100.00
Total	5.59E-006	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run H-3
Description :
Single Run H-3

Executed : 09/28/99 at 15:19:52

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
3H	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
3H	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 2.03E-007 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	0.00E-000	0.00
Inhalation	1.30E-007	64.17
Ingestion	7.28E-008	35.83
Total	2.03E-007	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
3H	2.03E-007	100.00
Total	2.03E-007	100.00

```
Program      : DandD Version 1.0 Build 1.00.22
Session      : Single Run Nb-94
Description  :
      Single Run Nb-94

Executed     : 09/28/99 at 15:34:57
```

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
94Nb	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
94Nb	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Nb-94

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 3.02E-003 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	2.14E-003	70.98
Inhalation	8.68E-004	28.74
Ingestion	8.35E-006	0.28
Total	3.02E-003	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
94Nb	3.02E-003	100.00
Total	3.02E-003	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Ni-59
Description :
Single Run Ni-59

Executed : 09/28/99 at 15:29:39

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
59Ni	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
59Ni	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 5.91E-006 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	0.00E+000	0.00
Inhalation	5.67E-006	95.85
Ingestion	2.45E-007	4.15
Total	5.91E-006	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
59Ni	5.91E-006	100.00
Total	5.91E-006	100.00

Program : DandD Version 1.0 Build 1.00.22
Session : Single Run Ni-63
Description :
Single Run Ni-63

Executed : 09/28/99 at 15:31:04

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
63Ni	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
63Ni	1.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 1.38E-005 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	0.00E+000	0.00
Inhalation	1.31E-005	95.13
Ingestion	6.73E-007	4.87
Total	1.38E-005	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
63Ni	1.38E-005	100.00
Total	1.38E-005	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Pu-238
Description :
Single Run Pu-238

Executed : 09/28/99 at 16:03:46

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
238Pu	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
238Pu	1.0000E+000
234U	0.0000E+000
230Th	0.0000E+000
226Ra	0.0000E+000
222Rn	0.0000E+000
218Po	0.0000E+000
214Pb	0.0000E+000
218At	0.0000E+000
214Bi	0.0000E+000
214Po	0.0000E+000
210Pb	0.0000E+000
210Bi	0.0000E+000
210Po	0.0000E+000

Basic Parameters

Name	Value	Units	Default

==

'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 8.22E-001 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.17E-006	0.00
Inhalation	8.18E-001	99.55
Ingestion	3.73E-003	0.45
Total	8.22E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
238Pu	8.22E-001	100.00
234U	3.93E-007	0.00
230Th	2.90E-012	0.00
226Ra	9.00E-018	0.00
222Rn	2.40E-022	0.00
218Po	5.41E-024	0.00
214Pb	1.55E-019	0.00
218At	0.00E+000	0.00
214Bi	8.66E-019	0.00

214Po	4.95E-023	0.00
210Pb	8.85E-020	0.00
210Bi	9.56E-022	0.00
210Po	9.54E-021	0.00
Total	8.22E-001	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run Pu-239
Description  :
     Single Run Pu-239

Executed     : 09/28/99 at 15:52:17
```

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
239Pu	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
239Pu	1.0000E+000
235U	0.0000E+000
231Th	0.0000E+000
231Pa	0.0000E+000
227Ac	0.0000E+000
223Fr	0.0000E+000
227Th	0.0000E+000
223Ra	0.0000E+000
219Rn	0.0000E+000
215Po	0.0000E+000
211Pb	0.0000E+000
211Bi	0.0000E+000
211Po	0.0000E+000
207Tl	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 9.03E-001 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	5.15E-007	0.00
Inhalation	8.99E-001	99.54
Ingestion	4.14E-003	0.46
Total	9.03E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
239Pu	9.03E-001	100.00
235U	1.27E-010	0.00
231Th	1.44E-014	0.00
231Pa	9.24E-015	0.00
227Ac	3.78E-016	0.00
223Fr	3.80E-023	0.00
227Th	6.88E-019	0.00
223Ra	2.98E-019	0.00

219Rn	1.32E-021	0.00
215Po	4.20E-024	0.00
211Pb	1.54E-021	0.00
211Bi	1.10E-021	0.00
211Po	5.12E-025	0.00
207Tl	9.02E-023	0.00
Total	9.03E-001	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Pu-240
Description :
Single Run Pu-240

Executed : 09/28/99 at 15:53:40

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
240Pu	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
240Pu	1.0000E+000
236U	0.0000E+000
232Th	0.0000E+000
228Ra	0.0000E+000
228Ac	0.0000E+000
228Th	0.0000E+000
224Ra	0.0000E+000
220Rn	0.0000E+000
216Po	0.0000E+000
212Pb	0.0000E+000
212Bi	0.0000E+000
212Po	0.0000E+000
208Tl	0.0000E+000

Basic Parameters

Name	Value	Units	Default

'End Time' 25560.0000 days 365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 9.03E-001 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.13E-006	0.00
Inhalation	8.99E-001	99.54
Ingestion	4.14E-003	0.46
Total	9.03E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
240Pu	9.03E-001	100.00
236U	3.89E-009	0.00
232Th	8.37E-019	0.00
228Ra	8.34E-023	0.00
228Ac	1.39E-023	0.00
228Th	3.70E-022	0.00
224Ra	4.03E-024	0.00
220Rn	3.05E-028	0.00
216Po	1.33E-029	0.00

212Pb	2.72E-025	0.00
212Bi	1.33E-025	0.00
212Po	0.00E+000	0.00
208Tl	6.74E-025	0.00
Total	9.03E-001	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run Pu-241
Description :
     Single Run Pu-241

Executed     : 09/28/99 at 15:54:54
```

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
241Pu	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
241Pu	1.0000E+000
241Am	0.0000E+000
237U	0.0000E+000
237Np	0.0000E+000
233Pa	0.0000E+000
233U	0.0000E+000
229Th	0.0000E+000
225Ra	0.0000E+000
225Ac	0.0000E+000
221Fr	0.0000E+000
217At	0.0000E+000
213Bi	0.0000E+000
213Po	0.0000E+000
209Tl	0.0000E+000
209Pb	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 2.84E-002 TEDE (mrem) occurred 57.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.12E-006	0.00
Inhalation	2.83E-002	99.54
Ingestion	1.30E-004	0.46
Total	2.84E-002	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
241Pu	1.14E-003	4.03
241Am	2.73E-002	95.97
237U	3.27E-010	0.00
237Np	4.39E-007	0.00
233Pa	1.15E-010	0.00
233U	1.07E-011	0.00
229Th	2.52E-013	0.00

225Ra	9.34E-016	0.00
225Ac	1.27E-015	0.00
221Fr	2.32E-018	0.00
217At	2.36E-020	0.00
213Bi	1.23E-017	0.00
213Po	0.00E+000	0.00
209Tl	3.20E-018	0.00
209Pb	4.84E-020	0.00
Total	2.84E-002	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Pu-242
Description :
Single Run Pu-242

Executed : 09/28/99 at 15:56:33

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
242Pu	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
242Pu	1.0000E+000
238U	0.0000E+000
234Th	0.0000E+000
234mPa	0.0000E+000
234Pa	0.0000E+000
234U	0.0000E+000
230Th	0.0000E+000
226Ra	0.0000E+000
222Rn	0.0000E+000
218Po	0.0000E+000
214Pb	0.0000E+000
218At	0.0000E+000
214Bi	0.0000E+000
214Po	0.0000E+000
210Pb	0.0000E+000
210Bi	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 8.64E-001 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	9.36E-007	0.00
Inhalation	8.60E-001	99.55
Ingestion	3.93E-003	0.45
Total	8.64E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
242Pu	8.64E-001	100.00
238U	1.93E-011	0.00
234Th	6.49E-015	0.00
234mPa	1.38E-015	0.00
234Pa	3.33E-016	0.00
234U	1.56E-017	0.00

230Th	0.00E+000	0.00
226Ra	0.00E+000	0.00
222Rn	0.00E+000	0.00
218Po	0.00E+000	0.00
214Pb	0.00E+000	0.00
218At	0.00E+000	0.00
214Bi	0.00E+000	0.00
214Po	0.00E+000	0.00
210Pb	7.43E-022	0.00
210Bi	1.47E-023	0.00
Total	8.64E-001	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run Sb-125
Description :
Single Run Sb-125

Executed : 09/28/99 at 15:38:06

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
125Sb	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
125Sb	1.0000E+000
125mTe	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 5.64E-004 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	5.35E-004	94.92
Inhalation	2.51E-005	4.44
Ingestion	3.59E-006	0.64
Total	5.64E-004	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
125Sb	5.53E-004	98.02
125mTe	1.12E-005	1.98
Total	5.64E-004	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run Sr-90
Description  :
     Single Run Sr-90

Executed     : 09/28/99 at 15:32:48
```

NRC Report

Occupancy Input Section

Execution Options
====================
History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
90Sr	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
90Sr	1.0000E+000
90Y	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 2.89E-003 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	7.70E-006	0.27
Inhalation	2.71E-003	93.61
Ingestion	1.77E-004	6.12
Total	2.89E-003	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
90Sr	2.85E-003	98.72
90Y	3.69E-005	1.28
Total	2.89E-003	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run Tc-99
Description  :
     Single Run Tc-99

Executed     : 09/28/99 at 15:36:33
```

NRC Report

Occupancy Input Section

```
Execution Options
====================
History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities
========================================
Chain      dpm/100cm^2
========================================

99Tc              1.00

Code-Generated Radionuclide Activities
========================================
Chain      dpm/100cm^2
========================================

99Tc       1.0000E+000

Basic Parameters
======================================================================
Name                                  Value        Units      Default
======================================================================

'End Time'                         25560.0000      days      365.2500
```

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 1.93E-005 TEDE (mrem) occurred 1.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.09E-007	0.57
Inhalation	1.74E-005	90.56
Ingestion	1.71E-006	8.88
Total	1.93E-005	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
99Tc	1.93E-005	100.00
Total	1.93E-005	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run U-234
Description :
Single Run U-234

Executed : 09/28/99 at 15:47:24

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
234U	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
234U	1.0000E+000
230Th	0.0000E+000
226Ra	0.0000E+000
222Rn	0.0000E+000
218Po	0.0000E+000
214Pb	0.0000E+000
218At	0.0000E+000
214Bi	0.0000E+000
214Po	0.0000E+000
210Pb	0.0000E+000
210Bi	0.0000E+000
210Po	0.0000E+000

Basic Parameters

Name	Value	Units	Default

'End Time' 25560.0000 days 365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 2.78E-001 TEDE (mrem) occurred 70.00 year(s) after license termination.

Pathway Component of
Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	1.07E-006	0.00
Inhalation	2.78E-001	99.88
Ingestion	3.32E-004	0.12
Total	2.78E-001	100.00

Radionuclide Component of
Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
234U	2.78E-001	99.85
230Th	4.27E-004	0.15
226Ra	1.82E-007	0.00
222Rn	5.17E-012	0.00
218Po	1.16E-013	0.00
214Pb	3.34E-009	0.00
218At	0.00E+000	0.00
214Bi	1.86E-008	0.00
214Po	1.06E-012	0.00
210Pb	1.47E-007	0.00

210Bi	1.77E-009	0.00
210Po	9.08E-008	0.00
Total	2.78E-001	100.00

```
Program      : DandD Version 1.0 Build 1.00.02
Session      : Single Run U-235
Description :
     Single Run U-235

Executed     : 09/28/99 at 15:48:40
```

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
235U	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
235U	1.0000E+000
231Th	0.0000E+000
231Pa	0.0000E+000
227Ac	0.0000E+000
223Fr	0.0000E+000
227Th	0.0000E+000
223Ra	0.0000E+000
219Rn	0.0000E+000
215Po	0.0000E+000
211Pb	0.0000E+000
211Bi	0.0000E+000
211Po	0.0000E+000
207Tl	0.0000E+000

Basic Parameters

Name	Value	Units	Default

===

'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 69.98 year(s).

The peak dose of 2.74E-001 TEDE (mrem) occurred 70.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	2.34E-004	0.09
Inhalation	2.74E-001	99.79
Ingestion	3.46E-004	0.13
Total	2.74E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
235U	2.58E-001	94.05
231Th	2.94E-005	0.01
231Pa	3.96E-003	1.44
227Ac	1.23E-002	4.48
223Fr	1.24E-009	0.00
227Th	2.94E-005	0.01
223Ra	1.52E-005	0.01
219Rn	6.72E-008	0.00
215Po	2.14E-010	0.00

211Pb	7.85E-008	0.00
211Bi	5.62E-008	0.00
211Po	2.61E-011	0.00
207Tl	4.60E-009	0.00
Total	2.74E-001	100.00

Program : DandD Version 1.0 Build 1.00.02
Session : Single Run U-238
Description :
Single Run U-238

Executed : 09/28/99 at 15:49:47

NRC Report

Occupancy Input Section

Execution Options

History file will be generated.
Implicit progeny doses will not be included with explicit parent.
Concentration data will be calculated.

Initial Radionuclide Activities

Chain	dpm/100cm^2
238U	1.00

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
238U	1.0000E+000
234Th	0.0000E+000
234mPa	0.0000E+000
234Pa	0.0000E+000
234U	0.0000E+000
230Th	0.0000E+000
226Ra	0.0000E+000
222Rn	0.0000E+000
218Po	0.0000E+000
214Pb	0.0000E+000
218At	0.0000E+000
214Bi	0.0000E+000
214Po	0.0000E+000
210Pb	0.0000E+000
210Bi	0.0000E+000
210Po	0.0000E+000

Basic Parameters

Name	Value	Units	Default
'End Time'	25560.0000	days	365.2500

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 69.98 year(s).

The peak dose of 2.49E-001 TEDE (mrem) occurred 70.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	3.90E-005	0.02
Inhalation	2.48E-001	99.86
Ingestion	3.14E-004	0.13
Total	2.49E-001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
238U	2.48E-001	99.93
234Th	1.01E-004	0.04
234mPa	2.14E-005	0.01
234Pa	5.17E-006	0.00
234U	5.46E-005	0.02
230Th	4.20E-008	0.00

226Ra	1.20E-011	0.00
222Rn	3.39E-016	0.00
218Po	7.62E-018	0.00
214Pb	2.19E-013	0.00
218At	0.00E+000	0.00
214Bi	1.22E-012	0.00
214Po	6.97E-017	0.00
210Pb	7.86E-012	0.00
210Bi	9.47E-014	0.00
210Po	4.82E-012	0.00
Total	2.49E-001	100.00

7.0 UPDATE OF THE SITE-SPECIFIC DECOMMISSIONING COSTS

7.1 INTRODUCTION

GPU Nuclear contracted with TLG Services Inc. to perform a cost estimate for the completion of decommissioning activities at the Saxton Nuclear Experimental Corporation Facility. This estimate was completed in December 1998 and is included as Appendix 7.1 of the License Termination Plan.

This estimate, when combined with earlier expenditures at the SNEC Facility, for example decontamination and removal of support buildings from 1987 to 1992 and the soil removal project of 1993 and 1994, result in a total decommissioning cost estimate of $35.5 million.

7.2 ADDITIONAL COSTS

During 1999, additional areas not included in the cost study were identified that required remediation, most notably the Saxton Steam Generating Station Discharge Tunnel. Additionally, an evaluation has been performed on the added cost to accelerate the current project schedule in order to maintain the completion date in early 2001. These factors add approximately $4 million to the cost of the project.

The major factor influencing this increase in cost are the additional personnel, equipment, and time required to complete the remediation effort and the additional low level radioactive waste requiring disposal.

7.3 DECOMMISSIONING TRUST FUND STATUS

As indicated in GPU Nuclear Letter 1920-99-20304 dated June 3, 1999, there is a decommissioning trust fund shortfall. At the time of this letter, the shortfall was $6.1 million which, based on the additional costs described above, minus additional payments, would increase to $8.3 million or less than 0.3% of the total 1998 annual revenue of the Saxton owners. As committed in GPU Nuclear letter 1920-99-20304, this shortfall will be covered by the general funds of the owners.

APPENDIX 7.1

SAXTON NUCLEAR EXPERIMENTAL CORPORATION FACILITY

DECOMMISSIONING COST ESTIMATE

DECOMMISSIONING COST STUDY UPDATE

for the

SAXTON NUCLEAR EXPERIMENTAL FACILITY

prepared for

GPU Nuclear Corporation

December, 1998

prepared by

TLG Services, Inc.

Bridgewater, Connecticut

APPROVALS

Project Manager	**Albert A. Koehl**	12.30.98 **Date**
Technical Manager	**Geoffrey M. Griffiths**	12.30.98 **Date**
Quality Assurance Manager	**Carolyn A. Palmer**	12/30/98 **Date**

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REVISION LOG

Rev. No.	CRA No.	Date	Item Revised	Reason for Revision
0		12-30-98		Original Issue

SUMMARY

This document presents the cost, schedule, and radiation exposure estimates developed for completing the decommissioning of the Saxton Facility, owned and operated by the Saxton Nuclear Experimental Corporation and maintained by GPU Nuclear Corporation. The estimates herein include provisions for removing all radiological and hazardous contaminants to levels which will allow the facility and adjacent areas to be released for unrestrictive use. The project will allow Saxton Nuclear Experimental Corporation to terminate its nuclear license with the Nuclear Regulatory Commission.

The updated cost estimate for completing the Decommissioning of the Saxton facility is an update to the previous estimate prepared by TLG Services, Inc. This estimate is based upon remaining inventories of equipment, building structures, and decommissioning tasks as of June 1, 1998.

The proposed schedule to complete the decommissioning effort covers the period from June 1, 1998 into the year 2001. Preliminary activities, such as preparing a Decommissioning Plan, characterizing the facility, obtaining Certificates of Compliance for Waste Packages, and design and installation of support facilities were accomplished during the preparation phase of the decommissioning project. The physical decontamination effort of the plant buildings (operations phase) started in 1997 and is estimated to continue until through the end of 1999. Upon successful decontamination of the facility, a complete final survey will be completed (survey phase) to support GPU Nuclear Corporation's request for license termination. After NRC review and independent verification of the results, the last (restoration) phase concludes the decommissioning project with the demolition of the containment building and support facilities, backfill of below grade voids, and release of the site for unrestricted use.

The Updated Cost Estimate to complete the decommissioning of Saxton facility is estimated to be $18.3 Million (1998 dollars).

1.0 INTRODUCTION

This document provides the conclusions and basis of the cost estimates developed for decommissioning the remaining Saxton Nuclear Experimental Facility located in Saxton, PA. The facility is owned by the Saxton Nuclear Experimental Corporation (SNEC) and maintained by GPU Nuclear Corporation (GPUN).

This document was prepared by TLG Services, Inc., (TLG) as directed by Change Notice #6 issued to Contract #0685911, dated 6/23/98. GPUN authorized the previous estimate in accordance with Contract No. PC-0504936, dated Oct. 20, 1994, Section 1.3. TLG has developed this updated estimate, and based it on the key premise that GPUN is acting as its own Decommissioning Operations Contractor (DOC), to both manage and provide many of the essential support services associated with decommissioning the Saxton facility. The principal sources of site information used in preparing the cost estimate included the following:

- Saxton Nuclear Facility System Descriptions Manual, prepared by Westinghouse Atomic Power Department.
- Facility drawings, including structural, mechanical, and electrical (provided by GPUN).
- Site-specific information such as plant inventory and radiological surveys (provided by GPUN) to be used in the estimate.
- Selected information such as radioactive material, recycle/disposal costs, and labor costs (provided by GPUN).

This cost estimate is divided into six sections. Section 1.0, Introduction, provides an overview of what is included in this document. Section 2.0, Background, provides an explanation of what the Saxton facility is, why it was built, and why it will be decommissioned. Section 3.0, Decommissioning Activities, describes the activities expected to occur during the decommissioning of the Saxton facility. Included in this section are a description of work activities and the general sequence of decommissioning the facility. Section 4.0, Cost Estimate, presents the cost estimate for the decommissioning of the Saxton facility. This section includes the methodology used to estimate both cost and schedule, and a detailed description of the basis of the estimate. Section 5.0, Schedule Estimate, presents a summary of the proposed schedule for the decommissioning of the Saxton facility and includes a discussion of the four phases of the decommissioning schedule. Section 6.0, Occupational Radiation Exposure Estimate, summarizes the estimated man-rem exposures.

2.0 BACKGROUND

This section provides the background material describing the Saxton facility, including a brief facility description, its location, and setting. In addition, a brief description of facility operations is provided.

2.1 SITE DESCRIPTION

The Saxton facility is a deactivated 23.5 megawatt thermal (23.5 MWt) pressurized water reactor (PWR). It is owned by SNEC and maintained by GPUN. The Saxton reactor facility is maintained under a Title 10 Part 50 License and Technical Specifications. The license was amended to possess but not operate the Saxton reactor. The license expires on February 11, 2000 or upon expiration of the SNEC corporate charter, whichever occurs first.

The facility was built from 1960 to 1962 and operated from 1962 to 1972, primarily as a research and training reactor. The fuel was removed from the Containment Vessel (CV) in 1972 and shipped to the Atomic Energy Commission (AEC) facility at Savannah River, S.C. Following fuel removal, equipment, tanks, and piping located outside the CV were removed. The buildings and structures that supported reactor operations were partially decontaminated in 1972 through 1974. The radiological condition of the facility following shutdown was documented in a report titled "Decommissioned Status of the Saxton Reactor Facility" forwarded to the United States Nuclear Regulatory Commission (NRC) on February 20, 1975.

Decontamination/removal of reactor support structures/buildings was performed in 1987, 1988, and 1989, in preparation for demolition of these structures. This included the decontamination of the Control and Auxiliary Building, the Radioactive Waste Disposal Facility, Yard Pipe Tunnel, and the Filled Drum Storage Bunker, and the removal of the Refueling Water Storage Tank. A comprehensive final release survey was conducted from October, 1988 to June, 1989, to verify that residual contamination was within NRC guidelines for unrestricted use. Details of the decontamination activities and final survey are provided in the "Final Release Survey Report of the Control and Auxiliary Building, Radioactive Waste Disposal Facility, Refueling Water Storage Tank, Yard Pipe Tunnel, and Filled Drum Storage Bunker for the Saxton facility." Upon acceptance of the final release survey by the NRC, the buildings were demolished in 1992. Details of the demolition are available in a report titled, "SNEC Reactor Support Buildings Demolition Report."

2.1.1 Site Layout

The site is located about 100 miles east of Pittsburgh and 90 miles west of Harrisburg in the Allegheny Mountains, three fourths of a mile north of the Borough of Saxton in Liberty Township, Bedford County, Pennsylvania. The site is on the north side of Pennsylvania Route 913, 17 miles south of U.S. Route 22, and about 15 miles north of the Breezewood Interchange of the Pennsylvania Turnpike. Figure 2.1 identifies the location of the site relative to the landmarks of the local area.

Saxton facility was built on the east side of and adjacent to the Saxton Steam Generating Station of Pennsylvania Electric Company. This station was located on the east bank of the Raystown Branch of the Juniata River, as shown on the property map, Figure 2.2. The property comprises approximately 150 acres.

The SNEC site comprises 1.1 acres containing the yard and buildings from the nuclear plant. An additional 9.6 acre area is fenced in around electrical switchyard and buildings still in use by Penelec (Pennsylvania Electric Company, a subsidiary of GPU). This area adjoins the Raystown Branch of the Juniata River. The SNEC site as well as a portion of the Penelec area and the surrounding uncontrolled lands are in the 100-year floodplain of the Raystown Branch and Shoup Run. Additional large areas of lowlands and scrub tree growth surround the site.

2.1.2 Station Structures

The only remaining SNEC buildings and structures are the 50-foot diameter steel Containment Vessel (CV), the concrete shield wall located around the NW and NE quadrant of the CV, the tunnel sections that are immediately adjacent to the outer circumference of the CV, and portions of the septic system, weirs, and associated underground discharge piping. Concrete barrier walls have been installed to isolate the open ends of the tunnel that were connected to the Control & Auxiliary Building, the Radioactive Waste Disposal Facility, and the Steam Plant.

FIGURE 2.1

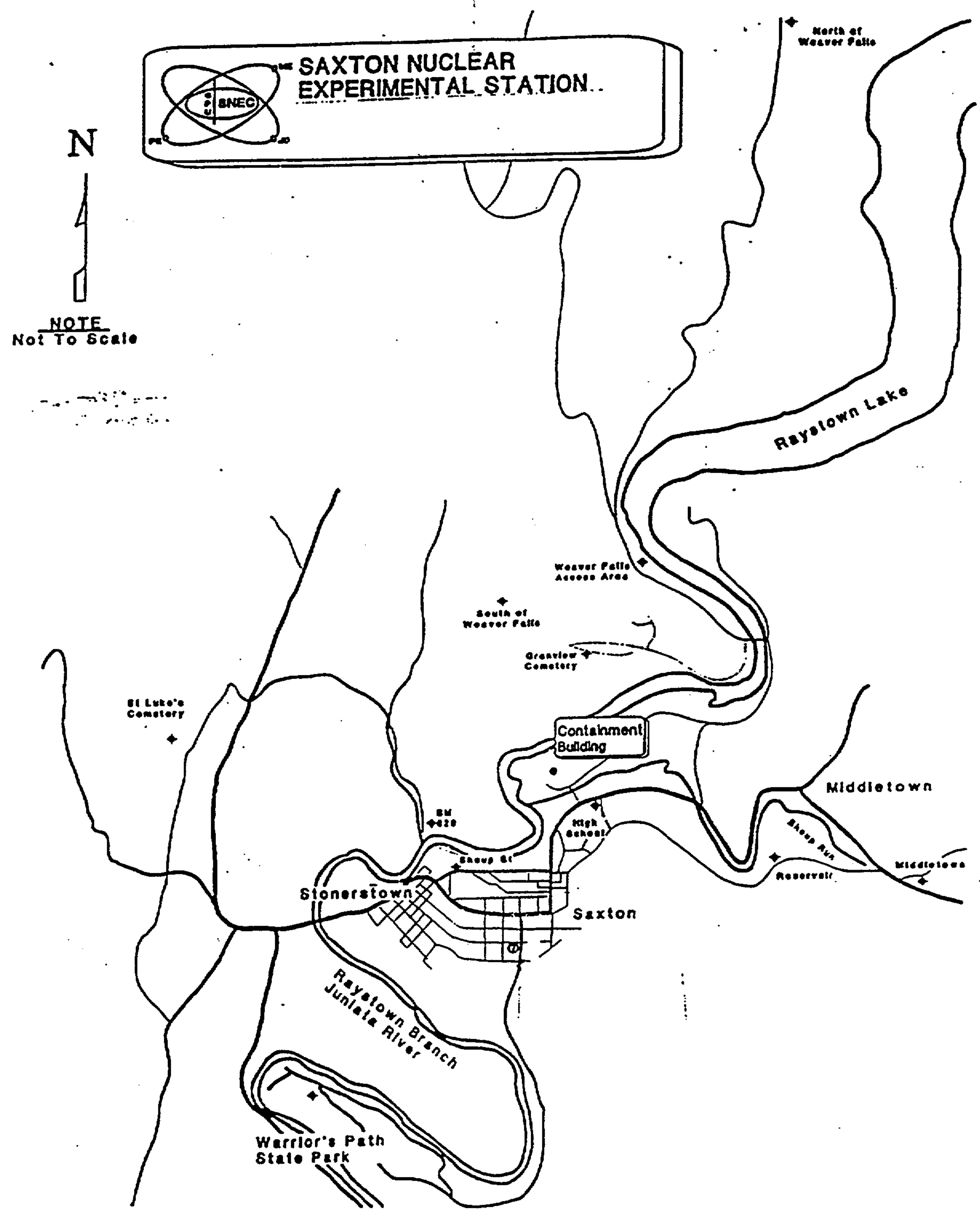
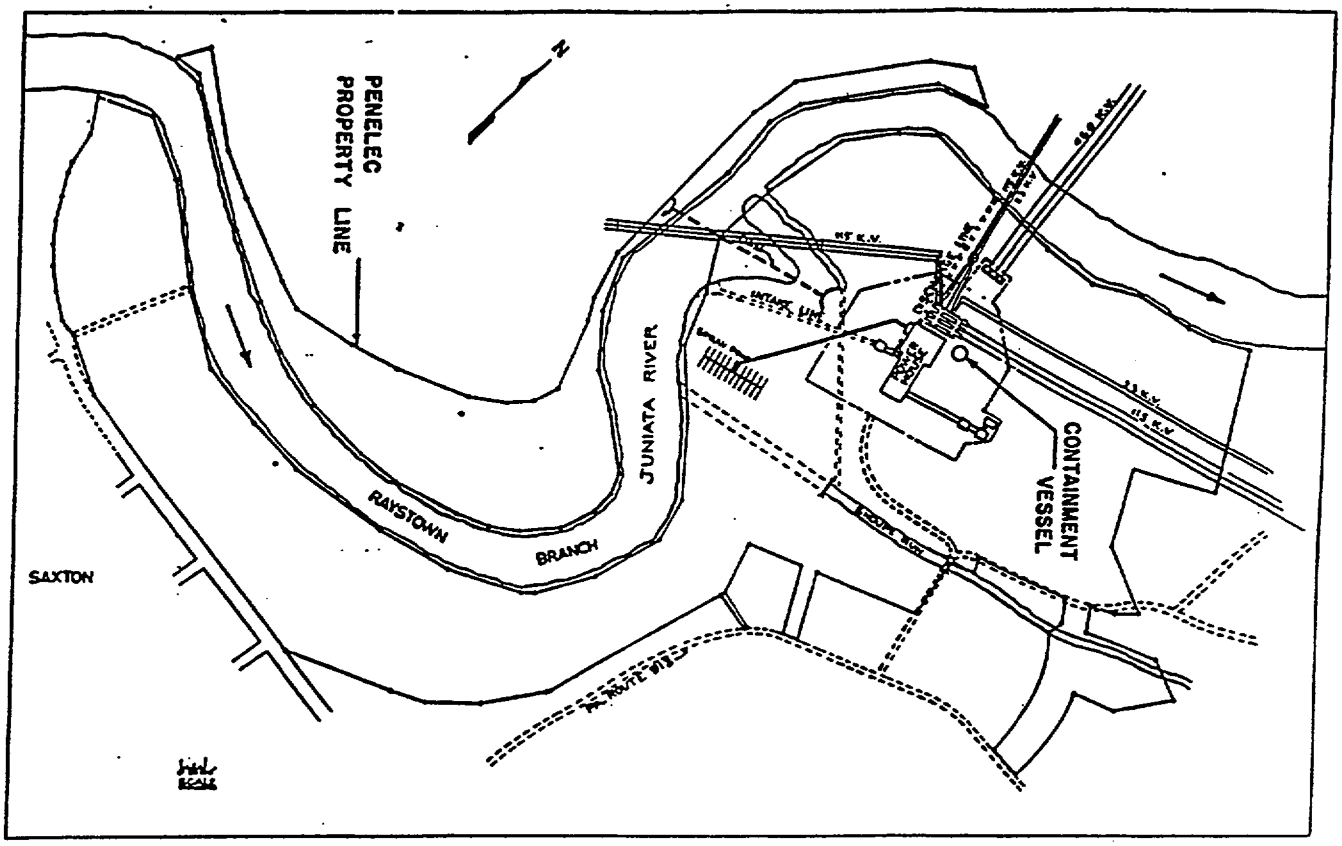

SAXTON NUCLEAR
EXPERIMENTAL STATION
SNEC
N
NOTE
Not To Scale
North of
Weaver Falls
Raystown Lake
Weaver Falls
Access Area
South of
Weaver Falls
Grandview
Cemetery
St Luke's
Cemetery
Containment
Building
Middletown
High
School
Shoup St
Stonerstown
Saxton
Reservoir
Middletown
Raystown Branch
Juniata River
Warrior's Path
State Park

FIGURE 2.2



PROPERTY MAP - SAXTON STEAM GENERATING STATION

2.1.3 Facility Operational History

The following is a chronology of major operational events at the Saxton facility since start of operation in 1962.

Event	Date
Construction authorization	February 11, 1960
Initial criticality	April 13, 1962
Experiments with mixed oxides fuel, with fuel cladding intentionally "failed"	Last fuel cycle
Final shutdown	May 1, 1972
Nuclear fuel and other removable special nuclear materials shipped off site	July - November, 1972
By-product material removed from site (with exception of material in exclusion areas)	November, 1972 - Early 1974
Facility is in a mothball condition	February, 1975
Groundwater removed from RWDF and Yard Pipe Tunnel	Late 1986 - Early 1987
Decontamination of C&A building RWDF, RWST, and Yard Pipe Tunnel	1987 & 1988
EG&G Measurements aerial survey	July, 1989
Pennsylvania State University Soil Characterization	December, 1988 & January, 1989
Final release survey of C&A building, RWDF, RWST, and Yard Pipe Tunnel	October, 1988 - June, 1989
Comprehensive Radiological Survey of CV (Scoping Survey)	1991

Event	Date
Demolition of C&A building, RWDF, RWST and Yard Pipe Tunnel	1992
Characterization of the remaining structures including the Containment Vessel and Exterior Tunnels	1995
Start of decommissioning activities	1996

3.0 DECOMMISSIONING ACTIVITIES

The following sections describe the decommissioning activities expected to occur to complete the decommissioning of the Saxton facility. It provides the background of what areas are included and the planned approach to remediating these areas. Included in this section is a brief description of the facility, the general sequence of decommissioning the facility, and the bases for estimating the duration and costs to perform the work.

3.1 FACILITY DESCRIPTION

The Saxton facility is owned by SNEC and maintained by GPUN. The only remaining structures are the CV, the concrete shield wall located around the NW and NE quadrant of the CV, the tunnel sections that are immediately adjacent to the outer circumference of the CV, and portions of the septic system, weirs, and associated underground discharge piping. Concrete barrier walls have been installed to isolate the open ends of the tunnel that were connected to the Control & Auxiliary Building, the Radioactive Waste Disposal Facility, and the Steam Plant.

The Saxton CV is a vertical steel cylinder with a hemispherical head at the top and an elliptical head at the bottom. The vessel is 50 feet in diameter and 109 feet 6 inches in overall height. The bottom of the vessel is embedded in concrete 50 feet 4 inches below grade.

The portion of the CV wall that is below grade level has a 1 foot 6 inch thick inner wall of reinforced concrete. This inner wall reinforces the below grade cylindrical shell against ground water and backfill pressures, and contributes to the supporting of the concrete operating deck. Premolded, one-half inch thick expansion material is installed between the steel shell and the inner concrete wall to a depth of 6 feet below grade level. This provides for differential expansion between the steel shell and the inner concrete wall.

That portion of the CV which is above ground is not insulated. A refined coal tar enamel (Bitumastic) has been applied to the outside surface of the below grade portions of the vessel where not protected by embedment in concrete.

During the preparation phase of this project a Decommissioning Support Building (DSB) was constructed. This provides controlled access to the interior of the CV through a hole cut in the CV wall at grade. Previous access to the interior of the CV had been through two personnel double-door assemblies and one flanged and bolted equipment hatch. The personnel doors are 2 feet 6 inches by 6 feet 8 inches, and the circular emergency exit doors are 2 feet 6 inches in diameter. The equipment hatch opening is 6 feet in diameter. In addition there are various piping, ventilation, and electrical penetrations in the steel shell.

For the purpose of this estimate the CV has been divided into the following five general areas:

Lower Level (SW, SE, & NW Quadrant) - This is the area at the bottom of the CV at elevation 765'- 8", except for the NE quadrant. The major components in this area are the control rod drives, shutdown cooling heat exchanger and pumps, and discharge tank and pumps.

Middle Level (SW Quadrant) - This is the area between elevation 779'-8"and 814'-6" in the SW quadrant; it contains the steam generator, pressurizer, primary coolant pump, and regenerative and non-regenerative heat exchangers.

Middle Level (SE Quadrant) - This is the area between elevation 781'-4"and 810'-0" in the SE quadrant; it contains the storage well heat exchanger and pumps, and the component cooling heat exchangers and pumps.

Operating Floor - This is the area from the operating floor at elevation 812'-0" to the top of the CV dome and includes the polar crane, equipment hatch, and personnel hatches.

Reactor Compartment and Storage Well - This area includes the NW and NE quadrants from elevation 765'-8" to 807'-0" and includes the reactor vessel, spent fuel racks, and three demineralizers.

3.2 DECOMMISSIONING APPROACH

The approach to the decommissioning of the Saxton facility is one of complete dismantling, disposal, and restoration of the site.

3.2.1 General Approach to the Saxton Facility Decommissioning

All accessible asbestos insulation was removed from piping and components and disposed of as radiological waste. This will permit other decommissioning activities to take place without the restrictions associated with handling asbestos.

Contaminated equipment will be dismantled, packaged, and transported to a volume reduction/recycle facility or disposed of as radiological waste.

Surface contaminated concrete will be decontaminated by scabbling or other surface removal techniques. Volumetrically contaminated concrete will be removed by chipping or cutting. Structural steel will be removed and if easily decontaminated to free release criteria, it will be disposed of as clean scrap. The steel shell of the CV will be dismantled and as with the structural steel, the material that can be readily free released will be disposed of as clean scrap. Contaminated concrete will be disposed of as radioactively contaminated waste. The remaining concrete that meets free release criteria will be used on site as clean fill. Contaminated steel and other metals will be shipped to a licensed processor for reprocessing, recycling, or disposal.

The remaining structures, including the CV and support structures, will be radiologically surveyed to verify that the Decommissioning Plan release criteria has been fulfilled. This activity includes an independent verification of the survey results by the NRC (or its subcontractor). Successful completion of this activity is expected to result in the termination of the SNEC radioactive material license.

Upon license termination, the CV and all support buildings will be dismantled, and the site will be backfilled, graded, seeded and/or replanted to release the area for unrestricted use.

3.2.2 Radiological Waste

Radioactively contaminated material will be disposed of in licensed low-level radioactive disposal facilities or recycled through licensed contractors. The material is expected to be handled as follows:

- Contaminated concrete will be transported and disposed of at Envirocare of Utah in Clive, Utah, or processed at an off-site recycling facility.

- The majority of contaminated metals will be transported to a commercial recycler for decontamination and/or volume reduction.

- Contaminated metals exceeding the recyclers capabilities will be transported and disposed of directly at the Barnwell disposal facility, located in Barnwell, SC.

- Contaminated asbestos will be volume reduced and disposed of at a licensed low-level radioactive waste disposal facility.

- Secondary waste, such as plastic, cloth, paper, etc. will be transported to a recycler for volume reduction and disposal.

- Contaminated metals removed as part of the demolition which are below the site release criteria, but which may contain detectable contamination, will be transported to a commercial recycler for decontamination/disposal.

- All radioactive material will be transported and packaged in accordance with NRC and United States Department of Transportation (US DOT) regulations.

3.2.3 Project Organization

GPU Nuclear Corporation will be the responsible project management and technical support organization for the Saxton facility Decommissioning Project. This organization is frequently referred to as the Decommissioning Operations Contractor (DOC). The DOC provides the management and labor necessary to conduct decommissioning activities, including decontamination and removal activities, health physics services, occupational safety, quality assurance, laboratory and dosimetry services, engineering analysis, work plans and procedures, and similar related activities.

GPUN with extensive in-house nuclear capabilities and experienced staff, is in an excellent position to minimize the costs associated with providing these services. For instance, since GPU provides radiation health and occupational safety training to its nuclear staff on a routine basis, only the incremental training costs associated with site-specific criteria will be incurred. Similarly, GPU's capability to provide in-house laboratory analysis services, whole body counts, instrument calibration services, dosimetry services, radiation detection instrumentation and air sampling equipment, etc., should reduce the overall project cost.

3.3 DECOMMISSIONING ACTIVITIES

The Saxton facility decommissioning estimate has been organized in a Work Breakdown Structure (WBS) numbering system. The highest level of the WBS system contains four key segments as listed below:

WBS No.	Description
1.1	Preparation Phase (completed)
1.2	Operations Phase (in progress)
1.3	Survey Phase
1.4	Site Restoration Phase

These key segments are described in the following sub-sections.

3.3.1 Preparation Phase (WBS No. 1.1)

This phase has been completed.

3.3.2 Operations Phase (WBS No. 1.2)

The project Operations Phase principally includes the complete removal, transportation, and disposal of all contaminated equipment (including the polar crane) and the decontamination or removal of all contaminated concrete and metal inside the CV. The principal focus of the project staff during this phase is to ensure that removal and decontamination activities are performed safely and efficiently.

3.3.3 Survey Phase (WBS No. 1.3)

The Final Survey Phase includes detailed, comprehensive, and formal radiological surveys of the CV and the surrounding area, consistent with the requirements of the Post Shutdown Decommissioning Activity Report and NRC requirements. A frequently cited document used as a basis in performing this radiological survey is, "Multi-Agency Radiation Survey and Site Investigation Manual", NUREG-1575, December 1996 (Draft). As a result of performing this survey, evidence will be provided to confirm that the facility and adjacent areas meet NRC site release criteria in order to support termination of the license. The NRC will review the survey results and independently verify the conclusions.

3.3.4 Site Restoration Phase (WBS No. 1.4)

The site restoration phase is started after the facility has been released from the requirements of an NRC license. This phase includes the removal, disposition and disposal of the CV steel shell (including the polar crane and the three hatches) to three feet below grade, the demolition of all remaining concrete to three feet below grade, backfilling with additional structural fill, placement of topsoil and landscaping of the site.

All clean concrete is used for fill. Steel which is below the site release criteria, but may contain detectable levels of radioactivity will be sent to a licensed radioactive material recycler for processing and disposal. Upon completion of the dismantling program, the DOC staff and its subcontractors demobilize from the site.

4.0 COST ESTIMATE

A site-specific cost estimate was prepared for the Saxton facility to account for the unique features of the plant and the dismantling of the CV. The basis for the estimate, including the source of information, methodology, assumptions and total costs, is described in this section.

The total estimated cost to decommission the Saxton facility is summarized below. The details are provided in Appendix C, Saxton Decommissioning Cost Summary.

Cost Summary	Estimated Cost (1998 Dollars)[1]
Labor Related Costs (excluding specialty contractors)	7,591,871
Radwaste Disposal/Processing/Transportation[2]	1,570,317
Specialty Contractor Services	4,902,120
Demolition of CSB	19,806
Purchased Materials and Equipment	2,205,640
Subtotal	16,289,753
Contingency	2,057,122
Total Estimated Remaining Cost (with contingency)	18,346,875
Actual expenses through May 31, 1998	7,499,491
Total Estimated Cost	**25,846,366**

Note 1: Columns may not add due to rounding
Note 2: Does not include the cost of removing, transporting, and burying the steam generator, pressurizer and reactor vessel. These costs are included under Specialty Contractor Services.

4.1 METHODOLOGY

This study was performed in accordance with the published study from the Atomic Industrial Forum/National Environmental Studies Project report AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates." The contents of these AIF Guidelines were prepared under the review of a task force consisting of representatives form utilities, state regulatory commissions, architect/engineering firms, the Federal Energy Regulatory Commission, the Nuclear Regulatory Commission, and the National Association of Regulatory Utility Commissioners.

These categories are identified in this estimate: activity-dependent costs, period-dependent costs and collateral costs. Activity-dependent costs are those associated with physical decommissioning tasks, such as decontamination, removal, packaging, shipping and burial. Period-dependent costs are defined as cost for project management, technical support, etc., and are a function of the duration of the project.

The methodology used to develop the cost estimates follows the basic approach presented in the aforementioned AIF Guidelines, and the U.S. DOE "Decommissioning Handbook". These references describe a unit cost factor method for estimating decommissioning activity costs to simplify the estimating calculations. Unit cost factors for items such as concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/in) were developed from the productivity information compiled by TLG. The costs for conventional demolition of nonradioactive structures, materials, backfill, landscaping and equipment rental were obtained from the "Building Construction Cost Data" published by R.S. Means, and TLG experience. Examples of unit cost factor development are presented in the AIF Guidelines study with the item quantity (cubic yards, tons, inches, etc.) developed from plant drawings and inventory documents, the activity-dependent costs are estimated.

The activity duration critical path is used to determine the total decommissioning program schedule. The program schedule is used to determine the period-dependent costs for program management, administration, field engineering, equipment rental, quality assurance and security. TLG used the salary information provided by GPUN for personnel associated with period-dependent costs.

The activity-dependent, period-dependent, and associated collateral costs are summed to develop the total decommissioning costs. A contingency is then applied, defined in the American Association of Cost Engineers Cost Engineers' Notebook:

> *A specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur.*

The cost elements in this estimate are based upon ideal conditions; therefore, a contingency factor has been applied. As with any major project, elements which could occur that have not been accounted for in this estimate are changes in the regulatory requirements, the effects of craft labor strikes, bad weather halting or slowing down waste shipments to the burial ground, equipment/tool breakage, changes in the anticipated plant conditions, etc.

The unit cost factor method provides a demonstrable basis for establishing reliable cost estimates. The detail of activities provided in the unit cost factors for activity time labor costs (by craft) provide assurance that cost elements have not been omitted. These detailed unit cost factors, coupled with the plant-specific inventory of piping, components, and structures, provide a high degree of confidence in the reliability of the cost estimates.

4.1.1 Unit Cost Factors

The unit cost factor approach to cost estimating has been widely adopted by cost estimators because of the ease in estimating and the flexibility it provides to account for individual differences in site conditions on a component or item basis. TLG adopted this technique for decommissioning cost estimating for these same reasons.

A unit cost factor (UCF) consists of the labor required to complete an activity. Each UCF is based on the work to be performed, the individual steps required, and the estimate duration of each step. The base time to perform each step is estimated for ideal working conditions: work performed at waist height, on non-contaminated materials, without protective clothing or respirators, and without work breaks. A summary of the principal UCFs used in the decommissioning of the Saxton facility are listed in Table 4.1. Starting with the base estimate, allowances for work difficulty factors to account for the non-ideal conditions are added. The range of percentages for these Work Difficulty Factors (WDF) are provided in the AIF Guidelines. The specific factors used for the Saxton facility decommissioning estimates are based on the site characterization data, and are applied for each contaminated component removal UCF. Noncontaminated component UCFs include only the Height/Accessibility and Work Break factors. The selected values for working in radiologically controlled areas are as follows:

TABLE -.1 (1)

SAXTON DECOMMISSIONING PROJECT
UNIT COST FACTORS

TITLE	STD QUANTITY	UNIT	STD DURATION (cHRS / UNIT)	CREW COMPOSITION Laborer	Craftsmen	Foreman	Area Sr. RT
INSTRUMENT TUBING CONTAMINATED	100	FT	0.583	1.00	0.00	0.00	0.00
.25-2 IN PIPE CONTAMINATED	5	FT	0.417	2.00	0.00	0.00	0.00
>2-4 IN PIPE CONTAMINATED	5	FT	0.700	2.00	0.00	0.00	0.00
>4-8 IN PIPE CONTAMINATED	5	FT	0.750	2.00	1.00	0.00	0.00
>8-14 IN PIPE CONTAMINATED	5	FT	1.250	3.00	1.00	0.00	0.00
>2-4 IN VALVES CONTAMINATED	1	EA	0.650	2.00	0.00	0.00	0.00
>4-8 IN VALVES CONTAMINATED	1	EA	0.700	2.00	1.00	0.00	0.00
<300 LBS PUMPS CONTAMINATED	1	EA	1.417	2.00	1.00	0.00	0.00
1000-10,000 LBS PUMPS CONTAMINATED	1	EA	5.000	4.00	3.00	0.00	0.00
1000-10,000 LBS PUMP MOTOR	1	EA	2.000	4.00	3.00	0.00	0.00
<3000 LBS HEAT EXCHANGER	1	EA	4.250	3.00	2.00	0.00	0.00
>3000 LBS HEAT EXCHANGER	1	EA	12.167	3.00	2.00	0.00	0.00
<300 GAL TANKS CONTAMINATED	1	EA	2.333	2.00	1.00	0.00	0.00
>300 GAL TANKS CONTAMINATED	26.25	SF	0.917	2.00	2.00	0.00	0.00
<300 LBS ELECT EQUIP CONT.	1	EA	1.000	2.00	1.00	0.00	0.00
300-1000 LBS ELECT EQUIP CONT.	1	EA	1.917	2.00	2.00	0.00	0.00
ELECTRICAL CONDUIT	5	FT	0.167	2.00	1.00	0.00	0.00
<300 LBS MECH EQUIP CONT.	1	EA	1.000	2.00	1.00	0.00	0.00
300-1000 LBS MECH EQUIP CONT.	1	EA	1.917	2.00	2.00	0.00	0.00
1000-10000 LBS MECH EQUIP CONT.	1	EA	3.667	2.00	2.00	0.00	0.00
>10000 LBS MECH EQUIP CONT.	1	EA	6.750	2.00	2.00	0.00	0.00
<300 LBS HVAC EQUIPMENT CONT.	1	EA	1.000	2.00	1.00	0.00	0.00
300-1000 LBS HVAC EQUIPMENT CONT.	1	EA	1.917	2.00	2.00	0.00	0.00
HVAC DUCTWORK CONTAMINATED	1000	LBS	8.000	1.00	1.00	0.00	0.00
SURFACE DECONTAMINATION	60	SF	1.000	2.00	0.00	0.00	0.00
ASBESTOS REMOVAL CONTAMINATED	60	SF	1.000	2.00	0.00	0.00	0.00
CONCRETE FLOOR SCABBLING	110	SF	3.917	2.00	0.00	0.00	0.00
CONCRETE WALL SCABBLING	31	SF	3.917	2.00	0.00	0.00	0.00
CONCRETE CEILING SCABBLING	6.2	SF	3.917	2.00	0.00	0.00	0.00
> 50 TON POLAR CRANE	1	EA	10.500	2.00	4.00	0.00	0.00
STRUCTURAL STEEL REMOVAL CONT.	9633	LBS	8.000	5.00	1.00	0.00	0.00
STEEL FLOOR GRATING REMOVAL CONT.	460	SF	8.000	2.00	1.00	0.00	0.00
HANDRAILS, REMOVAL	160	LF	8.000	2.00	1.00	0.00	0.00
STEEL LINER, FREE STANDING	26.25	EA	1.000	2.00	2.00	0.00	0.00
CONCRETE REMOVAL (TUNNEL)	1	DY	8.000	2.00	1.00	0.00	0.00
CONST. DECON CHAMBER (PERSONNEL)	1	SF	0.029	0.00	2.00	0.00	0.00

TABLE -.

SAXTON DECOMMISSIONING PROJECT
UNIT COST FACTORS

TITLE	STD QUANTITY	UNIT	STD DURATION (cHRS / UNIT)	CREW COMPOSITION Laborer	Craftsmen	Foreman	Area Sr. RT
CONST. DECON CHAMBER (WASTE)	1	SF	0.022	0.00	2.00	0.00	0.00
COLLECT AND BAG ASBESTOS	1	BG	0.080	0.00	2.00	0.00	0.00
DOUBLE BAG AND DECON ASBESTOS	1	BG	0.034	0.00	2.00	0.00	0.00
FINAL SURVEY <2M (CONCRETE)	100	SF	1.590	2.00	0.00	0.00	2.00
FINAL SURVEY <2M (STEEL)	100	SF	1.590	2.00	0.00	0.00	2.00
FINAL SURVEY >2M (CONCRETE)	100	SF	2.260	2.00	0.00	0.00	2.00
FINAL SURVEY >2M (STEEL)	100	SF	2.260	2.00	0.00	0.00	2.00
FINAL SURVEY OF STEEL DOME	100	SF	4.150	2.00	0.00	0.00	2.00
BACKFILL OF BELOW GRADE VOIDS	800	CY	8.000	3.50	1.00	0.00	0.00
LANDSCAPING WITH TOPSOIL	1	AC	29.733	1.50	1.00	0.00	0.00
REMOVAL OF REINFORCED CONCRETE	24	CY	8.000	1.00	1.00	0.00	0.00
REMOVAL OF CLEAN CONCRETE FLOORS	25	CY	6.000	4.00	2.00	0.00	0.00
FINAL SURVEY OF OUTSIDE STEEL WALL<2	100	SF	1.590	2.00	0.00	0.00	2.00
FINAL SURVEY OF OUTSIDE STEEL WALL >	100	SF	2.260	2.00	0.00	0.00	2.00
FINAL SURVEY OF OUTSIDE STEEL DOME	100	SF	4.150	2.00	0.00	0.00	2.00
FINAL SURVEY OF SOIL	6450	SF	8.000	2.00	0.00	0.00	2.00
FINAL SURVEY <2M	100	SF	1.590	2.00	0.00	0.00	2.00
FINAL SURVEY >2M	100	SF	2.260	2.00	0.00	0.00	2.00
SEPTIC REMOVAL	1	EA	8.000	1.00	1.00	0.00	0.00
CONCRETE WALL CUTTING	1	SF	0.039	0.00	1.00	0.00	0.00
VACUBLASTING	1	SF	0.010	3.00	0.00	1.00	0.00

Duration Adjustments	Percent
Height/Accessibility[1]	20-40
Respiratory Protection[2]	50
Radiation/ALARA	40
Protective Clothing	30
Work Breaks	8

Note 1: Applied to a limited number of activities
Note 2: Only applied to airborne contamination creating operations such as scabbling concrete

The total time to perform the removal activity including WDFs is then multiplied by the number of workers by craft needed for the activity. The craft labor rate is applied per worker hour to obtain the total direct labor cost.

This UCF is then multiplied by the inventory of material in this category to obtain the total labor cost of removal for that item. The sum of all such UCF/inventory calculations represents the total activity-dependent labor costs.

4.1.2 Schedule

The schedule for the project was developed using a PERT network critical path methodology to determine the overall duration. The sequence of activities is developed from the logical succession of events based on considerations of the need for decontamination, removal, packaging, shipping, and processing/burial of specific components and/or structures. Information provided by GPUN on the projected overall duration of project phases and tasks performed by contractors were also incorporated into the schedule. The inter-relationship of these activities is developed in a network of predecessor and successor events until all activities have been accomplished. TLG used the "Microsoft Project for Windows" computer code to develop this network. Figure 5.1 contains a detailed Gantt chart schedule of principal decommissioning activities.

4.1.3 Management Staff Organization

The DOC, in this case GPUN, will have overall responsibility for managing the Saxton project. The positions and level of personnel staffing are not fixed for the length of the project, but are adjusted depending on the type of expertise needed to support the activities being performed during each period. A summary of the total number of management and support staff for each of four distinct phases of the decommissioning project is presented below.

Phase	DOC Staff Level
Preparation	Completed
Operations	32
Final Survey	20
Restoration	12

Organization charts representing the three remaining project phases are provided in Appendix A of this report.

4.1.4 Collateral Costs

Collateral costs constitute a considerable percentage of the total decommissioning cost. Collateral costs are generally not correlated to a specific unit cost factor because of the difficulty of allocating these costs on a rational basis. For example, it is difficult to assign the cost of Heavy Equipment Rental to a specific crew task because the equipment will be used for many tasks. Accordingly, equipment costs are expensed as a line-item cost entry.

The estimate for the collateral costs are based on a detailed analysis of the financial records from a decommissioning project with a similarly sized workforce. Collateral costs defined as activity-dependent are calculated as a unit cost per craft labor man-hour. Collateral costs defined as period-dependent are calculated as a unit cost per man-year for all on site project members.

4.1.5 Radwaste Packaging, Transportation, and Disposal/Recycling

An estimate of the volume and/or weight of radioactive waste was developed using systems and building inventory information. Based on these estimated quantities, the costs for packaging, transporting and decontaminating (recycling at an off-site facility) or direct disposal at a licensed disposal facility were calculated. The costs were based on information provided by GPUN for shipments of concrete, metal, and DAW already made from the site.

4.1.6 Installation of Support Facilities and Systems

The Saxton facility (containment vessel) is essentially a stand alone building. With the exception of a few trailers, the infrastructure to support decommissioning activities was not in place. This includes services such as potable water and sanitary waste systems or support facilities such as a Radioactive Waste handling/loading area, office/change facilities, and temporary storage/warehouse facilities. The design and construction of temporary support facilities were completed during the preparation phase.

4.1.7 Specialty Contractor Services

There are two significant activities that have been awarded to specialty contractors. First is the removal of the Reactor Pressure Vessel, Steam Generator, and Pressurizer from the containment vessel. The contract for this work includes the removal of these components from the CV, preparing the vessels for shipment, grouting the vessels, preparing and submitting the required exemption request to the DOT, designing and supplying necessary shipping containers and facilities, transporting the vessels via rail to the Barnwell disposal facility, and disposing of the vessels at the facility.

The second is the removal of activated and contaminated concrete by concrete cutting, scabbling, or other appropriate techniques. The scope of the contract for this work includes providing the concrete cutting equipment and the equipment supervisors for cutting and removing activated concrete.

Other activities which have been included in this cost category include:

- An estimate of the NRC costs associated with supporting the Saxton facility decommissioning effort (review of plans, site visits, independent verification of survey results, etc.)

- Outside decommissioning services, including independent reviews, engineering support and similar services.

- Specialty contractor services, such as trucking companies, railroads, building design/construction, waste recycling, etc., are not included under this general category, but are included within the specific activity cost (e.g., transportation of radioactive material or installation of temporary facilities).

4.1.8 Contingency

The estimating approach used by TLG assumed all decommissioning activities would be performed without any field-related problems. The WDF's account for the site-related accessibility limitations (height factor), radiological factors (respirators, protective clothing, and ALARA planning) and associated work break factors. However, experience has shown that even under the best management, engineering, and planning conditions, problems beyond management's control often add to the costs of completing a project. This form of contingency estimate is not scope related; such scope-related problems would be dealt with by field change orders. These field problems include inclement weather, equipment or process breakdown, late shipments from suppliers, damaged equipment/supplies in transit to the site, and regulatory changes in the extent of review needed or revisions needed to approve plans, procedures, or licensing documents. Accordingly, TLG has applied contingency percentage to account for these problems. Appendix C identifies specific labor, equipment/material, and waste management costs, including allocated contingency.

4.2 BASIS OF ESTIMATE

The site-specific cost estimate was developed using available Saxton drawings and documents, piping and component inventory, radiological survey data, labor rates and the radwaste processing/disposal fees provided by GPUN. This information was used to develop the general arrangement of the facility and to determine estimates of building steel and concrete volumes, numbers and size of components, and restoration requirements. Where information was not available, TLG relied upon photographs, visual inspection of the site, and professional judgment to determine the plant inventory.

4.2.1 Equipment and Building Inventory

The equipment and building inventories were taken directly from the lists provided by GPUN. This list was updated by GPU to show those items removed before June 1, 1998. These inventories were used without modification, and applied to TLG's Equipment Removal and Building Decontamination and Demolition Unit Cost Factors. The values used in TLG's cost estimate are identified in Appendix B of this report, "Saxton Project Task Data".

4.2.2 Labor and Staff Cost Data

The decommissioning effort is a labor-intensive program. The labor rates for both the DOC staff and the activity-dependent craft labor were those provided by GPUN, marked up by 63.5% for GPUN overhead. A 10 hour day, 4 day week was used in this estimate. All craft labor was categorized as one of the following three labor categories: 1) Laborer; 2) Craftsman (composite of various trades); and 3) Foreman (composite of various trades). Appendix D provides a summary of the labor costs.

Engineering services for such items as preparing Project Plans, writing procedures, structural analysis, etc., are assumed to be provided by the DOC.

Staff labor costs broken out by major work breakdown structure elements are provided in Appendix D, Schedule and Labor Cost Estimate.

4.2.3 Radioactive Waste Disposal and Transportation

The radioactive waste disposal and transportation cost are based on actual costs provided by GPU for shipments of concrete, metal, and DAW from the site prior to June 1,1998.

A breakdown of the disposal/processing costs for the wastes are provided in Appendix C, Saxton Decommissioning Cost Summary.

4.2.4 Specialty Contractor Services

Activities performed by specialty contractors included:

- Removal, packaging, and disposal of the Reactor Pressure Vessel, Steam Generator, and Pressurizer
- Activated concrete cutting
- NRC Fees
- Decommissioning Consulting

Removal of the Reactor Pressure Vessel, Steam Generator, and Pressurizer is based on a competitively bid, fixed price contract award of $4,250,000 by GPUN for this work.

NRC fees were based on an estimate of the number of man-hours the NRC may use to actively review and oversee the Saxton facility decommissioning activities. The estimate of the remaining NRC fees is $199,120.

An allowance for consulting costs, which include the use of outside contractors for preparation or review of specific activities or tasks, was based on TLG's experience. The estimated remaining cost, without contingency, is $250,000.

4.2.5 Purchased Materials and Equipment

The estimate of the collateral (non-labor) costs were determined by performing a financial analysis of an ongoing decommissioning project that employs a workforce similar to the staff size identified in this estimate. The collateral costs have been broken down into two major categories, including:

Activity-Dependent Collateral Costs - Non-labor costs associated with the performance of a specific decontamination or demolition activity. These costs are calculated based on an hourly rate for all craft labor assigned to the decommissioning activities.

Period-Dependent Collateral Costs - Costs associated with maintaining the facility in a safe and usable condition and cost associated with supporting the project staff. These costs are calculated based on an annual rate for all personnel assigned to the facility, regardless of their role in the decommissioning activities.

Details on the unit rates used, and examples of items included within each category is provided in Appendix E, Period-Dependent and Activity-Dependent Collateral Costs.

4.2.6 Removal of Support Facilities/Systems

Included in the estimate for this project is the removal of the decommissioning support building constructed during the preparation.

Also included is an estimated cost of $275,000 for capital equipment over the remaining life of the project. This estimate is based on an analysis of actual capital equipment costs of a similar decommissioning project.

4.2.7 Other Principal Assumptions

Following are some additional assumptions used in the course of preparing this estimate:

- The Appalachian compact disposal site will not be in operation during any phase of this decommissioning project.
- Minimal on-site decontamination of removed components will be performed -- only that required to support packaging and shipment.
- Asbestos has been removed during the beginning of the operations phase; therefore, the remainder of the decommissioning project will proceed asbestos free.
- All dry active waste is assumed to be less than 200 mr/hr and, therefore, there are no radiation surcharges.
- All metal sent to an off-site radwaste decontamination and/or recycle facility is assumed to be 25 - 200 mr/hr.
- The CV steel will be dismantled to 3 ft below grade. The steel from the shell, the three hatches, and the polar crane that can be easily decontaminated on site will be scrapped locally as clean material with no transportation cost and no scrap value. Material that cannot be readily decontaminated to free release limits will be decontaminated to the extent needed to support handling and sent to a processor for disposition.
- The polar crane will be used for all lifting and handling within the CV, except for the reactor vessel, steam generator, and pressurizer.

5.0 SCHEDULE ESTIMATE

TLG has prepared a schedule for completing the decommissioning of the Saxton facility. The schedule follows the concepts and general sequence presented in the AIF Guidelines, with appropriate changes to reflect the differences for the Saxton facility. This schedule reflects schedule input provided by GPUN. The schedule, shown in Figure 5.1, identifies the key activities by WBS number, the sequence of these key activities, and the schedule duration for each WBS item. The significance of the schedule can not be understated. Since a major percentage of the decommissioning costs are directly associated with project management, and radiological support, the schedule for the activity-dependent tasks is a principal driver in project costs. The schedule is 100% integrated with the cost estimate and was prepared using the computer code "Microsoft Project for Window."

5.1 SCHEDULE ESTIMATE ASSUMPTIONS

The schedule shown in Figure 5.1 reflects the results of precedence networks developed for the Saxton facility decommissioning activities. The durations used in the precedence network reflect the actual man-hour and crew size estimates provided in Appendices B. The following assumptions were made in the development of the schedule for the Saxton facility.

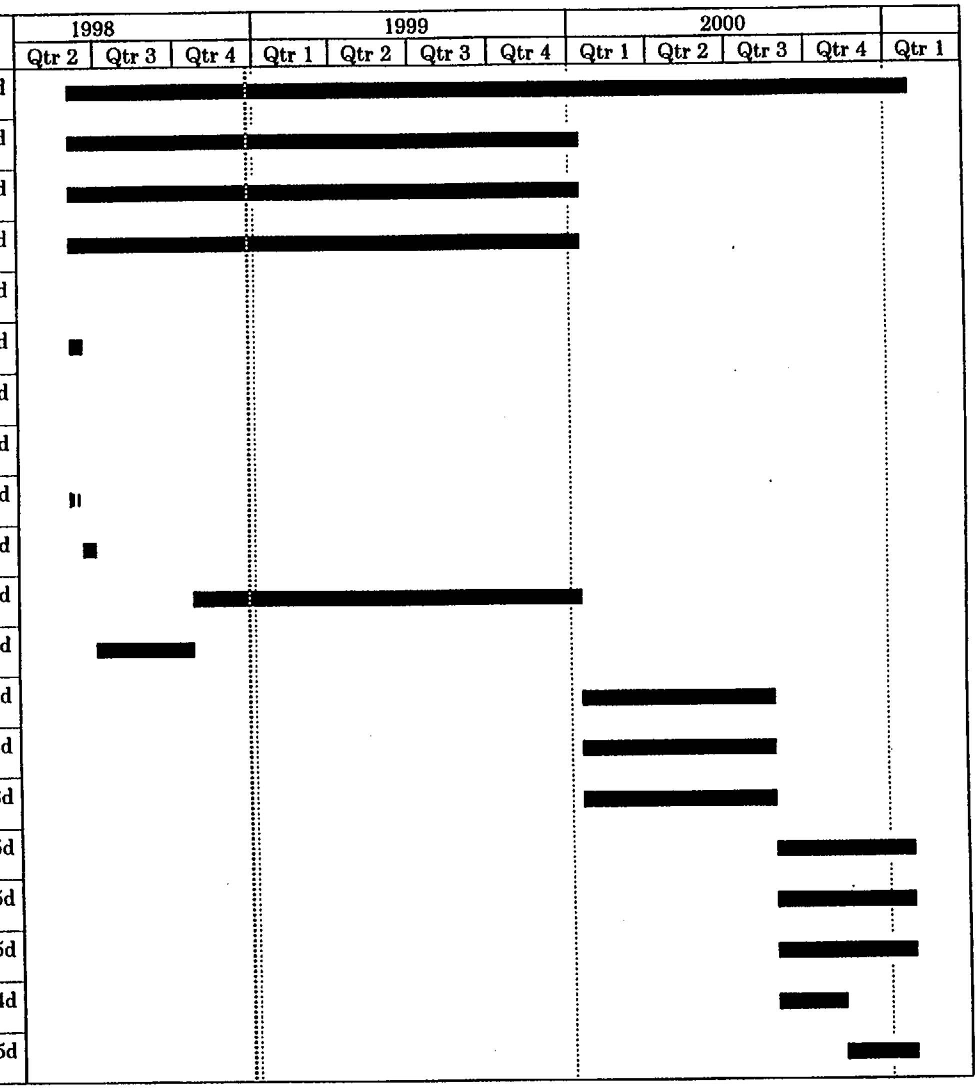
1. All work is performed during an 10-hour workday, 4 days per week with no overtime.

2. Where appropriate, the man-hour estimates reflect adjustments for working in a radiologically controlled environment, including productivity adjustments for ALARA programs, the use of protective clothing, the use of respiratory equipment, and appropriate work breaks.

3. Multiple crews work parallel activities to the maximum extent possible, consistent with optimum efficiency, adequate access for cutting, removal and laydown space, and with consideration for the stringent safety measures necessary during demolition of heavy components and structures.

FIGURE 5.1
SAXTON DECOMMISSIONING PROJECT SCHEDULE

WBS	Name	Duration
1	Saxton VC Decommissioning	530.54d
1.1	Operations Phase	323.89d
1.1.1	DOC Staff	323.89d
1.1.2	Operations Activities	323.89d
1.1.2.1	Asbestos Removal	0d
1.1.2.2	Lower Level (SW, SE, & NW Quadrant	9.01d
1.1.2.3	Middle Level (SW Quadrant)	0d
1.1.2.4	Middle Level (SE Quadrant)	0.16d
1.1.2.5	Operating Floor	0.59d
1.1.2.6	Reactor Compartment and Storage We	8.15d
1.1.2.7	CV Structures (Concrete and Steel)	242.14d
1.1.2.8	RPV, SG and PRZ Removal	64d
1.2	Survey Phase	124.3d
1.2.1	DOC Staff	124.3d
1.2.2	Final Survey	124.3d
1.3	Site Restoration Phase	82.35d
1.3.1	Doc Staff	82.35d
1.3.2	Restoration Activities	82.35d
1.3.2.1	NRC Review	44d
1.3.2.2	Restoration	38.35d



5.2 PROJECT SCHEDULE

The project schedule has been developed and presented in a WBS format, and divides the decommissioning activities into four distinct phases. These phases have been selected primarily based on the sequence of activities required to decommission the site in an orderly manner. As the project changes phases, the DOC staff is substantially adjusted. The following is a brief description of each of the phases. Appendix D presents the project start and finish dates for each phase.

5.2.1 Preparation Phase

The preparation phase of this project has been completed.

5.2.2 Operations Phase

The decommissioning Operations Phase principally includes the complete removal of all equipment and the decontamination of all concrete and steel inside the CV. The shipping and disposal of the equipment and contaminated and activated building material is also included.

5.2.3 Survey Phase

The Final Survey Phase includes detailed, comprehensive, and formal radiological surveys of the CV and the surrounding area, consistent with the requirements of the NRC's, "Multi-Agency Radiation Survey and Site Investigation Manual", NUREG-1575, December 1996 (Draft). As a result of performing this survey, evidence will be provided to confirm that all radiological and hazardous contaminants have been removed from the facility and adjacent areas.

5.2.4 Site Restoration Phase

The Site Restoration Phase is started after the facility has been released by the NRC from the requirements of an NRC license. This phase includes the removal and scrapping of the CV steel shell (including the three hatches) to three feet below grade, the demolition of all remaining concrete to three feet below grade, backfilling with additional structural fill, placement of topsoil and landscaping of the site. Also included is the removal of the existing septic tank. All concrete is used for fill and all steel is released as scrap. At this time the final report on the dismantling program is prepared and the utility and its subcontractors demobilize from the site.

6.0 OCCUPATIONAL RADIATION EXPOSURE ESTIMATE

TLG calculated an estimate of the radiation exposure to be received as a result of completing the Saxton facility decommissioning work.

Since the plant was shut down in 1972, the following are the principal assumptions in calculating radiation exposure as a result of completing the Saxton facility decommissioning project.

Co-60 and Cs-137 were the principal contributors to occupational radiation exposure (gamma emitters) shortly after time of shutdown.

Co-60 has decayed for approximately 25 years or 4.74 half-lives. The amount of Co-60 present in 1997 will be approximately 3.7% of the Co-60 present at time of shutdown (1972). Decay of Co-60 will be considered a negligible contributor to changes in total occupational dose if decommissioning is postponed.

Cs-137 has decayed for approximately 25 years or 0.83 half-lives. The amount of Cs-137 present in 1997 will be approximately 56.4% of the Cs-137 present at time of shutdown (1972).

Cs-137 will be considered the principal source of occupational radiation exposure. Occupational exposure reductions, based on performing the work in the future, will be adjusted based on the half-life of Cs-137.

The estimated radiation exposure to complete the work is 10.5 Rem. This estimate is based on occupational workers receiving radiation exposure from the dismantling, decontamination, waste handling, and radiological surveying of the Saxton facility. This estimate was prepared by applying both general area dose rates (inside the CV) and component dose rates (contact readings or 1 foot readings) to the estimated number of hours spent in each radiation field, respectively.

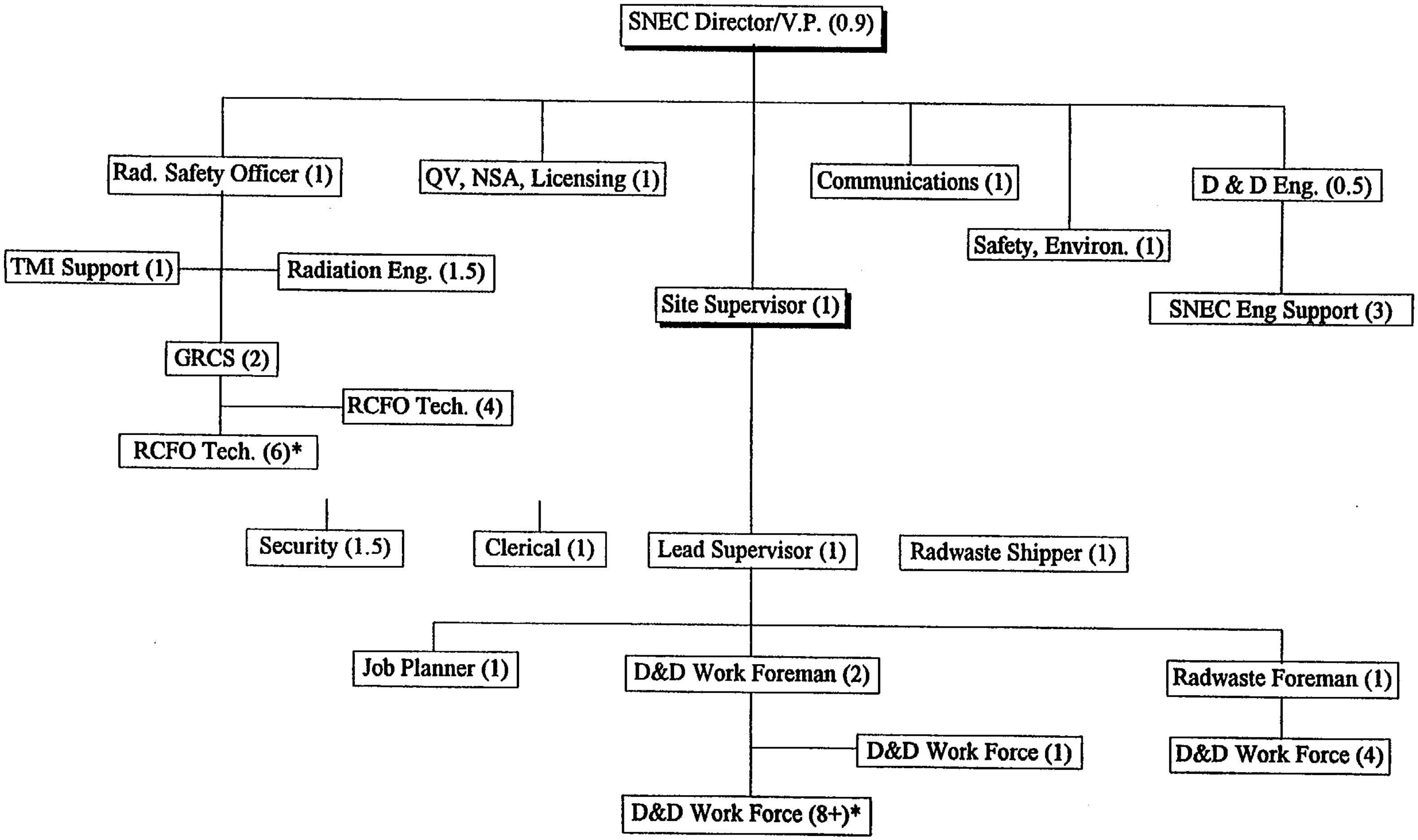
APPENDIX A

DECOMMISSIONING OPERATIONS CONTRACTOR ORGANIZATIONS

This Appendix contains the proposed organization charts for the three remaining phases of the decommissioning project. Each organization chart shows the staff positions and quantity, for the identified phase of the project. These organization charts are listed below:

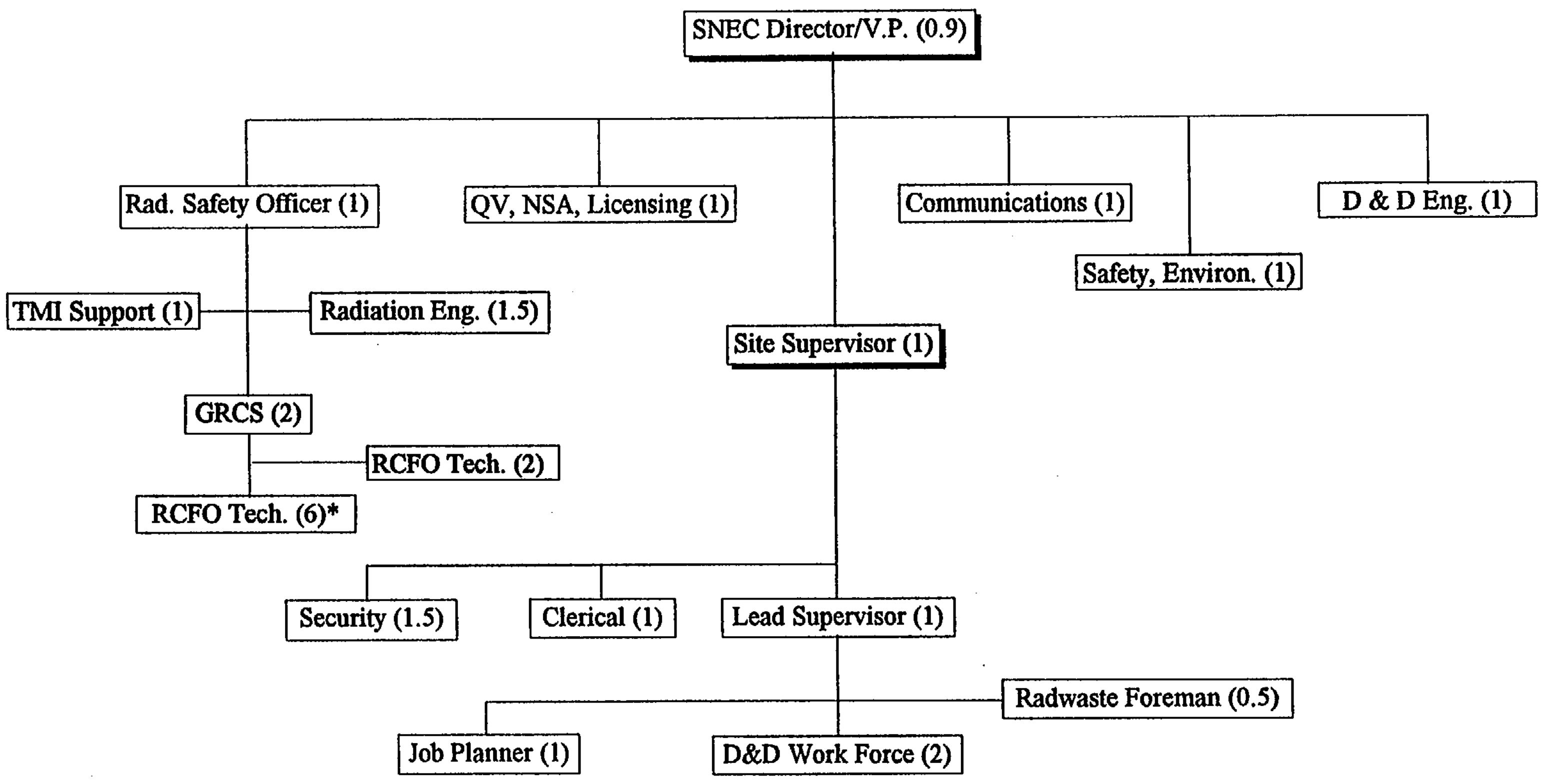
Phase	Chart No.
Operations	A - 1
Survey	A - 2
Restoration	A - 3

A-1
SAXTON DECOMMISSIONING PROJECT
OPERATIONS PHASE



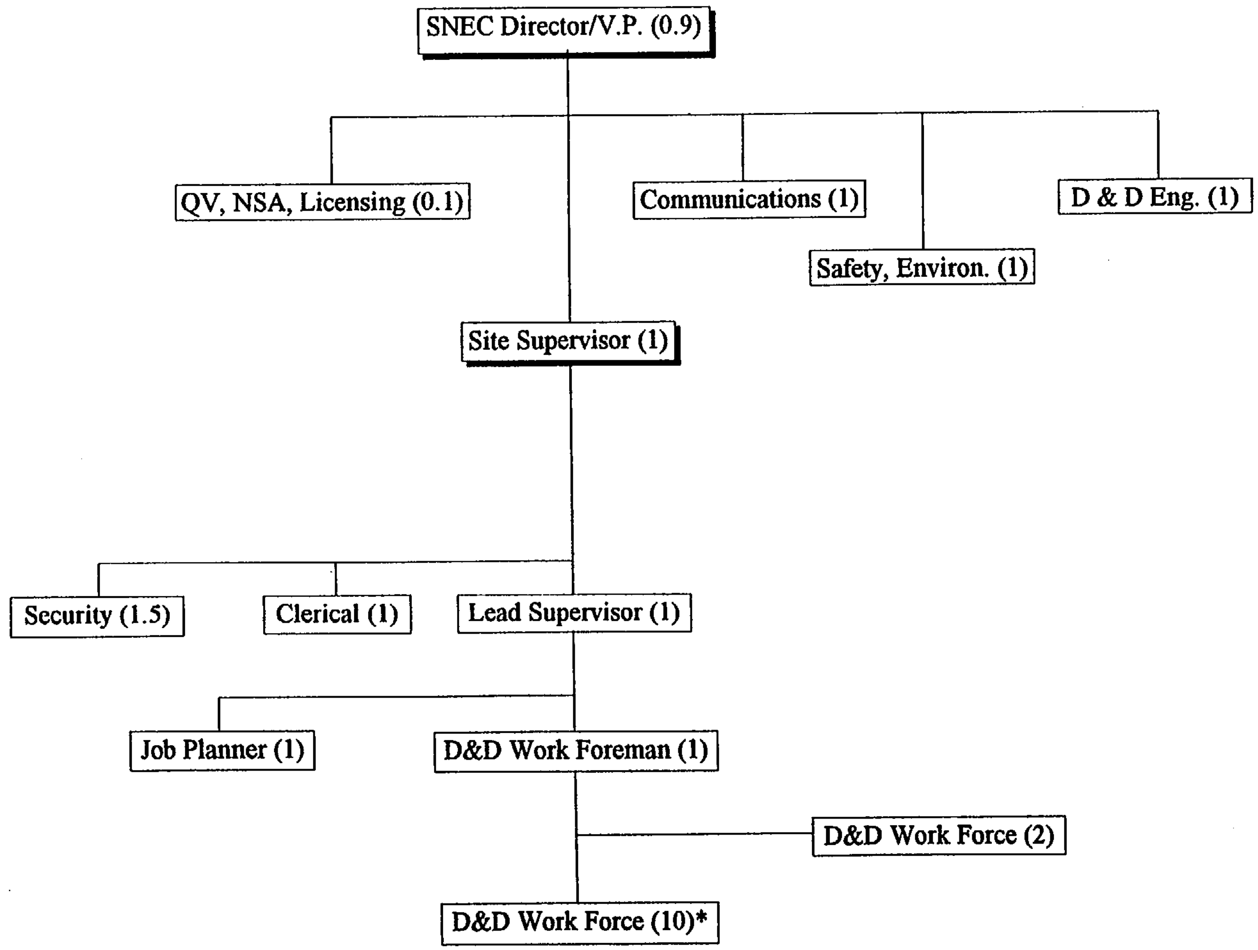
* The number of workers may vary and is determined by the activity dependent tasks.

A-2
SAXTON DECOMMISSIONING PROJECT
SURVEY PHASE



* The number of workers may vary and is determined by the activity dependent tasks.

A-3
SAXTON DECOMMISSIONING PROJECT
RESTORATION PHASE



* The number of workers may vary and is determined by the activity dependent tasks.

APPENDIX B

SAXTON PROJECT TASK DATA

This Appendix contains the detailed estimate data for each phase of the project. Listed under each work area are all the applicable tasks. For each task, the actual remaining quantity of work is shown, along with the number of work crews and crew composition. Additionally, the duration, which is a product of the task quantity and TLG Unit Cost Factor, is shown for each task. All activities listed in Appendix B of the 1995 cost estimate are listed in this appendix, even if the quantity remaining has been reduced to zero.

SAXTON DECOMMISSIONING PROJECT
TASK DATA
OPERATIONS PHASE

WORK AREA/ACTIVITY	ACT DUR (DAYS)	RESOURCES	NO. OF CREWS	ACTUAL QUANTITY	UNIT
Asbestos Removal	0.00	RCFO (Contractor)[2]	1		
SURFACE DECONTAMINATION	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	SF
ASBESTOS REMOVAL CONTAMINATED	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	SF
CONST. DECON CHAMBER (PERSONNEL)	0.00	Laborer[0],Craftsmen[2],Foreman[0]	1	0	SF
CONST. DECON CHAMBER (WASTE)	0.00	Laborer[0],Craftsmen[2],Foreman[0]	1	0	SF
COLLECT AND BAG ASBESTOS	0.00	Laborer[0],Craftsmen[2],Foreman[0]	1	0	BG
DOUBLE BAG AND DECON ASBESTOS	0.00	Laborer[0],Craftsmen[2],Foreman[0]	1	0	BG
Lower Level (SW, SE, & NW Quadrant)	9.01	RCFO (Contractor)[2]	1		
INSTRUMENT TUBING CONTAMINATED	0.03	Laborer[1],Craftsmen[0],Foreman[0]	1	20.9	FT
.25-2 IN PIPE CONTAMINATED	2.81	Laborer[2],Craftsmen[0],Foreman[0]	1	114.2	FT
>2-4 IN PIPE CONTAMINATED	1.24	Laborer[2],Craftsmen[0],Foreman[0]	1	29.9	FT
>4-8 IN PIPE CONTAMINATED	0.04	Laborer[2],Craftsmen[1],Foreman[0]	1	0.9	FT
>8-14 IN PIPE CONTAMINATED	0.16	Laborer[3],Craftsmen[1],Foreman[0]	1	2.1	FT
>2-4 IN VALVES CONTAMINATED	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	EA
<300 LBS PUMPS CONTAMINATED	1.68	Laborer[2],Craftsmen[1],Foreman[0]	1	4	EA
<3000 LBS HEAT EXCHANGER	1.14	Laborer[3],Craftsmen[2],Foreman[0]	1	1	EA
<300 GAL TANKS CONTAMINATED	1.87	Laborer[2],Craftsmen[1],Foreman[0]	1	3	EA
>300 GAL TANKS CONTAMINATED	1.83	Laborer[2],Craftsmen[2],Foreman[0]	1	177	SF
300-1000 LBS ELECT EQUIP CONT.	0.38	Laborer[2],Craftsmen[2],Foreman[0]	1	1	EA
ELECTRICAL CONDUIT	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	FT
300-1000 LBS MECH EQUIP CONT.	1.13	Laborer[2],Craftsmen[2],Foreman[0]	1	3	EA
<300 LBS HVAC EQUIPMENT CONT.	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	EA
300-1000 LBS HVAC EQUIPMENT CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
Middle Level (SW Quadrant)	0.00	RCFO (Contractor)[2]	1		
INSTRUMENT TUBING CONTAMINATED	0.00	Laborer[1],Craftsmen[0],Foreman[0]	1	0	FT
.25-2 IN PIPE CONTAMINATED	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	FT
>2-4 IN PIPE CONTAMINATED	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	FT
>4-8 IN PIPE CONTAMINATED	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	FT
>8-14 IN PIPE CONTAMINATED	0.00	Laborer[3],Craftsmen[1],Foreman[0]	1	0	FT
>2-4 IN VALVES CONTAMINATED	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	EA
1000-10,000 LBS PUMPS CONTAMINATED	0.00	Laborer[4],Craftsmen[3],Foreman[0]	1	0	EA
1000-10,000 LBS PUMP MOTOR	0.00	Laborer[4],Craftsmen[3],Foreman[0]	1	0	EA
<3000 LBS HEAT EXCHANGER	0.00	Laborer[3],Craftsmen[2],Foreman[0]	1	0	EA
>3000 LBS HEAT EXCHANGER	0.00	Laborer[3],Craftsmen[2],Foreman[0]	1	0	EA

SAXTON DECOMMISSIONING PROJECT
TASK DATA
OPERATIONS PHASE

WORK AREA/ACTIVITY	ACT DUR (DAYS)	RESOURCES	NO. OF CREWS	ACTUAL QUANTITY	UNIT
300-1000 LBS ELECT EQUIP CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
ELECTRICAL CONDUIT	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	FT
300-1000 LBS MECH EQUIP CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
300-1000 LBS HVAC EQUIPMENT CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
Middle Level (SE Quadrant)	0.16	RCFO (Contractor)[2]			
INSTRUMENT TUBING CONTAMINATED	0.00	Laborer[1],Craftsmen[0],Foreman[0]	1	0	FT
.25-2 IN PIPE CONTAMINATED	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	FT
>2-4 IN PIPE CONTAMINATED	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	FT
>4-8 IN PIPE CONTAMINATED	0.07	Laborer[2],Craftsmen[1],Foreman[0]	1	1.5	FT
>8-14 IN PIPE CONTAMINATED	0.09	Laborer[3],Craftsmen[1],Foreman[0]	1	1.2	FT
>2-4 IN VALVES CONTAMINATED	0.00	Laborer[2],Craftsmen[0],Foreman[0]	1	0	EA
>4-8 IN VALVES CONTAMINATED	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	EA
<300 LBS PUMPS CONTAMINATED	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	EA
<3000 LBS HEAT EXCHANGER	0.00	Laborer[3],Craftsmen[2],Foreman[0]	1	0	EA
<300 GAL TANKS CONTAMINATED	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	EA
ELECTRICAL CONDUIT	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	FT
300-1000 LBS MECH EQUIP CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
300-1000 LBS HVAC EQUIPMENT CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
Operating Floor	0.59	RCFO (Contractor)[2]			
<300 LBS ELECT EQUIP CONT.	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	EA
ELECTRICAL CONDUIT	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	FT
<300 LBS MECH EQUIP CONT.	0.59	Laborer[2],Craftsmen[1],Foreman[0]	1	3	EA
300-1000 LBS MECH EQUIP CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
1000-10000 LBS MECH EQUIP CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
>10000 LBS MECH EQUIP CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
300-1000 LBS HVAC EQUIPMENT CONT.	0.00	Laborer[2],Craftsmen[2],Foreman[0]	1	0	EA
HVAC DUCTWORK CONTAMINATED	0.00	Laborer[1],Craftsmen[1],Foreman[0]	1	0	LBS
Reactor Compartment and Storage Well	8.15	RCFO (Contractor)[2]			
INSTRUMENT TUBING CONTAMINATED	0.05	Laborer[1],Craftsmen[0],Foreman[0]	1	41.3	FT
.25-2 IN PIPE CONTAMINATED	10.41	Laborer[2],Craftsmen[0],Foreman[0]	1	422.5	FT
>2-4 IN PIPE CONTAMINATED	5.18	Laborer[2],Craftsmen[0],Foreman[0]	1	125.1	FT
>4-8 IN PIPE CONTAMINATED	0.00	Laborer[2],Craftsmen[1],Foreman[0]	1	0	FT
>8-14 IN PIPE CONTAMINATED	1.89	Laborer[3],Craftsmen[1],Foreman[0]	1	25.6	FT
>2-4 IN VALVES CONTAMINATED	0.70	Laborer[2],Craftsmen[0],Foreman[0]	1	4	EA

SAXTON DECOMMISSIONING PROJECT
TASK DATA
OPERATIONS PHASE

WORK AREA/ACTIVITY	ACT DUR (DAYS)	RESOURCES	NO. OF CREWS	ACTUAL QUANTITY	UNIT
<3000 LBS HEAT EXCHANGER	1.14	Laborer[3],Craftsmen[2],Foreman[0]	1	1	EA
>3000 LBS HEAT EXCHANGER	0.00	Laborer[3],Craftsmen[2],Foreman[0]	1	0	EA
<300 GAL TANKS CONTAMINATED	1.87	Laborer[2],Craftsmen[1],Foreman[0]	1	3	EA
300-1000 LBS MECH EQUIP CONT.	0.38	Laborer[2],Craftsmen[2],Foreman[0]	1	1	EA
1000-10000 LBS MECH EQUIP CONT.	2.17	Laborer[2],Craftsmen[2],Foreman[0]	1	3	EA
CV Structures (Concrete and Steel)	242.14	RCFO (Contractor)[2]	1		
1000-10000 LBS MECH EQUIP CONT.	0.80	Laborer[2],Craftsmen[2],Foreman[0]	1	1.1	EA
SURFACE DECONTAMINATION	3.62	Laborer[4],Craftsmen[0],Foreman[0]	2	1470.4	SF
CONCRETE FLOOR SCABBLING	10.71	Laborer[8],Craftsmen[0],Foreman[0]	4	3715.8	SF
CONCRETE WALL SCABBLING	135.88	Laborer[8],Craftsmen[0],Foreman[0]	4	12218.8	SF
CONCRETE CEILING SCABBLING	15.35	Laborer[8],Craftsmen[0],Foreman[0]	4	276	SF
STEEL FLOOR GRATING REMOVAL CONT.	5.30	Laborer[4],Craftsmen[2],Foreman[0]	2	2278.3	SF
HANDRAILS, REMOVAL	7.86	Laborer[2],Craftsmen[1],Foreman[0]	1	587.6	LF
CONCRETE WALL CUTTING	51.34	Laborer[0],Craftsmen1[1],Foreman[0]	1	4451	CF
VACUBLASTING	25.24	Laborer[3],Craftsmen1[0],Foreman[1]	1	8875	SF

SAXTON DECOMMISSIONING PROJECT
TASK DATA
SURVEY PHASE

WORK AREA/ACTIVITY	ACT DUR (DAYS)	RESOURCES	NO. OF CREWS	ACTUAL QUANTITY	UNIT
Final Survey					
FINAL SURVEY <2M (CONCRETE)	10.24	Laborer[4],Craftsmen[0],Foreman[0],RCFO (Contractor)[4]	2	12875	SF
FINAL SURVEY <2M (STEEL)	1.06	Laborer[2],Craftsmen[0],Foreman[0],RCFO (Contractor)[2]	1	666	SF
FINAL SURVEY >2M (CONCRETE)	10.80	Laborer[4],Craftsmen[0],Foreman[0],RCFO (Contractor)[4]	2	9558	SF
FINAL SURVEY >2M (STEEL)	7.65	Laborer[4],Craftsmen[0],Foreman[0],RCFO (Contractor)[4]	2	6771	SF
FINAL SURVEY OF STEEL DOME	16.30	Laborer[2],Craftsmen[0],Foreman[0],RCFO (Contractor)[2]	1	3927	SF
FINAL SURVEY OF OUTSIDE STEEL WALL<2M	1.50	Laborer[2],Craftsmen[0],Foreman[0],RCFO (Contractor)[2]	1	942	SF
FINAL SURVEY OF OUTSIDE STEEL WALL >2M	12.42	Laborer[2],Craftsmen[0],Foreman[0],RCFO (Contractor)[2]	1	5495	SF
FINAL SURVEY OF OUTSIDE STEEL DOME	16.29	Laborer[2],Craftsmen[0],Foreman[0],RCFO (Contractor)[2]	1	3925	SF
FINAL SURVEY OF SOIL	5.96	Laborer[4],Craftsmen[0],Foreman[0],RCFO (Contractor)[4]	2	96100	SF
FINAL SURVEY <2M (DSF & LCLA)	17.19	Laborer[4],Craftsmen[0],Foreman[0],RCFO (Contractor)[4]	2	21620	SF
FINAL SURVEY >2M (DSF & LCLA)	24.89	Laborer[4],Craftsmen[0],Foreman[0],RCFO (Contractor)[4]	2	22030	SF

SAXTON DECOMMISSIONING PROJECT
TASK DATA
RESTORATION PHASE

WORK AREA/ACTIVITY	ACT DUR (DAYS)	RESOURCES	NO. OF CREWS	ACTUAL QUANTITY	UNIT
Site Restoration			1		
1000-10000 LBS MECH EQUIP CONT.	0.62	Laborer[2],Craftsmen[2],Foreman[0]	1	1	EA
>10000 LBS MECH EQUIP CONT.	2.28	Laborer[2],Craftsmen[2],Foreman[0]	1	2	EA
> 50 TON POLAR CRANE	1.36	Laborer[2],Craftsmen[4],Foreman[0]	1	1	EA
STRUCTURAL STEEL REMOVAL CONT.	1.93	Laborer[5],Craftsmen[1],Foreman[0]	1	13760	LBS
STEEL LINER, FREE STANDING	23.82	Laborer[4],Craftsmen[4],Foreman[0]	2	9618.5	SF
CONCRETE REMOVAL (TUNNEL)	3.12	Laborer[2],Craftsmen[1],Foreman[0]	1	3	DY
BACKFILL OF BELOW GRADE VOIDS	2.80	Laborer[3.5],Craftsmen[1],Foreman[0]	1	2801	CY
LANDSCAPING WITH TOPSOIL	2.97	Laborer[1.5],Craftsmen[1],Foreman[0]	1	1	AC
REMOVAL OF REINFORCED CONCRETE	5.12	Laborer[2],Craftsmen[2],Foreman[0]	2	307	CY
REMOVAL OF CLEAN CONCRETE FLOORS	2.96	Laborer[4],Craftsmen[2],Foreman[0]	1	95	CY
SEPTIC REMOVAL	0.00	Laborer[1],Craftsmen[1],Foreman[0]	1	0	EA

APPENDIX C

SAXTON DECOMMISSIONING COST SUMMARY

This Appendix contains a summary of the Saxton facility decommissioning costs, including the contingency for each line item.

SAXTON DECOMMISSIONING PROJECT
COST SUMMARY (1998 DOLLARS)

Category	Cost	Contingency (%)	Contingency ($s)
Utility/DOC staff			
Operations Phase	5,512,245	15%	826,837
Survey Phase	1,052,668	15%	157,900
Restoration Phase	482,008	15%	72,301
Subtotal DOC	7,046,921		1,057,038
Activity Dependent staff			
Operations Phase	210,935	50%	105,468
Survey Phase	212,856	15%	31,928
Restoration Phase	121,158	15%	18,174
Subtotal Activity	544,950		155,570
Radwaste Disposal/Processing/Shipping			
Metal	513,836	25%	128,459
Dry Active Waste	6,565	25%	1,641
Lead	20,029	25%	5,007
Concrete	1,029,886	25%	257,472
Subtotal Radwaste	1,570,317		392,579
Specialty Contractor Services			
RPV/SG/PRES Removal (Contract)	4,250,000	0%	0
RPV/SG/PRES Removal (GPUN Additional Costs)	203,000	25%	50,750
NRC Review & Subcontractors	199,120	15%	29,868
Decommissioning Consulting	250,000	15%	37,500
Subtotal Specialty	4,902,120		118,118
Demolition of Support Facilities/Systems			
Demolition of Construction Support Bldg.	19,806	15%	2,971
Materials and Equipment			
Heavy Equipment Rental	467,894	15%	70,184
Capital Equipment Year 2	125,000	15%	18,750
Capital Equipment Year 3	75,000	15%	11,250
Capital Equipment Year 4	75,000	15%	11,250
Activity Dependent Collateral Costs	131,609	15%	19,741
Period Dependent Collateral Costs	1,331,137	15%	199,671
Subtotal Materials & Equipment	2,205,640		330,846
Subtotal Project	16,289,753		2,057,122
Average Contingency		13%	
Total Project	18,346,875		

APPENDIX D

SCHEDULE AND LABOR COST ESTIMATE

This Appendix contains the Saxton Decommissioning Schedule and Labor Estimate. This schedule and labor estimate provides the cost, duration, and scheduled start and finish dates for each element of the WBS.

SAXTON DECOMMISSIONING PROJECT
SCHEDULE AND LABOR COST ESTIMATE

WBS	Name	Labor Cost	Labor Hours	Duration	Start	Finish	Notes
1	Saxton VC Decommissioning	$7,591,870.73	183895.75h	530.54d	6/1/98	1/29/01	
1.1	Operations Phase	$5,723,180.52	137826.42h	323.89d	6/1/98	1/13/00	
1.1.1	DOC Staff	$5,512,245.24	131176.92h	323.89d	6/1/98	1/13/00	
1.1.2	Operations Activities	$210,935.28	6649.5h	323.89d	6/1/98	1/13/00	
1.1.2.1	Asbestos Removal	$0.00	0h	0d	6/1/98	6/1/98	
1.1.2.2	Lower Level (SW, SE, & NW Quadrant)	$19,817.16	668.7h	9.01d	6/1/98	6/16/98	
1.1.2.3	Middle Level (SW Quadrant)	$0.00	0h	0d	6/1/98	6/1/98	
1.1.2.4	Middle Level (SE Quadrant)	$265.09	8.9h	0.16d	6/1/98	6/1/98	
1.1.2.5	Operating Floor	$891.37	29.5h	0.59d	6/1/98	6/1/98	
1.1.2.6	Reactor Compartment and Storage Well	$17,837.86	603.5h	8.15d	6/16/98	6/30/98	
1.1.2.7	CV Structures (Concrete and Steel)	$172,123.80	5338.9h	242.14d	10/21/98	1/13/00	
1.1.2.8	RPV, SG and PRZ Removal	$0.00	0h	64d	6/30/98	10/21/98	Subcontracted Workscope
1.2	Survey Phase	$1,265,523.99	32422.3h	124.3d	1/13/00	8/23/00	
1.2.1	DOC Staff	$1,052,668.12	24735.7h	124.3d	1/13/00	8/23/00	
1.2.2	Final Survey	$212,855.87	7686.6h	124.3d	1/13/00	8/23/00	
1.3	Site Restoration Phase	$603,166.22	13647.03h	82.35d	8/23/00	1/29/01	
1.3.1	Doc Staff	$482,007.75	10293.75h	82.35d	8/23/00	1/29/01	
1.3.2	Restoration Activities	$121,158.47	3353.28h	82.35d	8/23/00	1/29/01	
1.3.2.1	NRC Review	$0.00	0h	44d	8/23/00	11/9/00	
1.3.2.2	Restoration	$121,158.47	3353.28h	38.35d	11/9/00	1/29/01	

APPENDIX E

PERIOD-DEPENDENT AND ACTIVITY-DEPENDENT COLLATERAL COSTS

This Appendix defines the items and costs for the anticipated period-dependent and activity-dependent collateral costs. The dollar values were determined from the financial records of a decommissioning project with a workforce similar in size to the staff planned for the Saxton facility Decommissioning Project. The definition of the costs are as follows:

<u>Activity-Dependent Costs</u>

Equipment Purchase/Rent - This line item reflects the costs of purchasing and renting equipment acquired specifically for the purpose of decommissioning the facility. The equipment must have sufficient service life and value that would ordinarily classify the item as a capital asset. Examples of items that may be classified in this category would include the following:

1. Laboratory Equipment
2. Material Handling Equipment
3. Radiological Monitoring equipment
4. Decontamination and Demolition Equipment
5. Health and Safety Equipment
6. Office Equipment
7. Ventilation Equipment
8. Water Treatment Equipment

The costs for these activities are budgeted as follows:

2nd year (1998)	$125,000
3rd and 4th year (1999 and 2000)	$ 75,000

Note: Expenses are larger early in the project due to the acquisition of one-time purchases of expensive equipment.

Collateral Costs - This line item reflects the costs for items or services purchased specifically for the purpose of decommissioning the facility and are generally of a consumable nature, or a one-time purchase of a subcontracted service to decontaminate or demolish a specific area within the facility. Examples of items that may be included in this category include:

1. Safety clothes and supplies
2. Physical examinations
3. Maintenance/repair of equipment
4. Consumables (e.g., gas for cutting torches)

The average activity-dependent collateral cost expenditure, based on a $ per man-hour for all D & D workers (i.e., laborers and foreman) is $7.44 per man-hour

Period-Dependent Costs

Collateral Costs - This line item reflects the accrual of costs generally related to the length of time an activity is performed, and cannot be assigned directly to a specific decommissioning work activity. Examples of items that may be included in this category include:

1. Health and Safety Training and Monitoring Equipment and Services (dosimetry, whole body counts, physical examinations, respirator testing, urinalysis, drug screening, specialized training courses, (i.e., asbestos, OSHA hazardous materials, etc.), H&S calibration services, etc.

2. Facility Maintenance (snow removal, security systems, lighting, heating, cooling, ventilation services, etc.)

3. Utility costs (gas, water, electric, sanitary sewer, garbage disposal, etc.)

4. Office supplies

5. Telephone expenses

6. Travel expenses

7. Environmental Sampling Supplies and Services (outside laboratory analyses, [both radiological and environmental], sampling equipment, well installation and maintenance, sampling consumables)

8. Operating supplies

The average period-dependent collateral cost expenditure, based on a $ per man-year for the entire on-site decommissioning workforce (i.e., project staff, technical staff, office staff, laborers and foreman) is $13,898 per man-year.

8.0 SUPPLEMENT TO THE ENVIRONMENTAL REPORT

The SNEC Facility Environmental Report was originally submitted in April 1996 to support SNEC Facility decommissioning. Three supplements to the report, in the form of responses to NRC requests for additional information, were provided on July 18, 1996, March 3, 1998 and March 31, 1998. In support of the SNEC Facility License Termination Plan, these documents were reviewed and minor revisions were made to reflect current information. The revised Environmental Report is being submitted under separate cover as GPU Letter 1920-00-20025.

The most significant changes in this document from are:

1. The site release criteria were revised to reflect the criteria of 10CFR20.1402 which became effective subsequent to Revision 0 of the Environmental Report,

2. An increase in the estimated occupational exposure from approximately 32 person-rem to 37 person-rem based on experience gained on the SNEC Facility Decommissioning Project. This occupational exposure is still well within the GEIS (NUREG 0586) estimate of 344 person-rem,

3. The Saxton Steam Generating Station (SSGS) Discharge Tunnel was added as a structure to be decontaminated and released, and

4. An increase in the estimated offsite population dose from routine decommissioning activities from approximately 13.7 person-mrem to 14.2 person-mrem due to the discovery of water with low levels of radioactive contamination in the Saxton Steam Generating Station discharge tunnel. This population dose is still well within the GEIS (NUREG 0586) estimate of <100 person-mrem.

Therefore, as these changes are minor and the impacts are still within the bounds of the GEIS, it can be concluded that there are no significant environmental changes at the SNEC Facility associated with License Termination.