DEPARTMENT OF THE ARMY

UNITED STATES ARMY TANK - AUTOMOTIVE AND ARMAMENTS COMMAND
ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
PICATINNY ARSENAL, NEW JERSEY 07806-5000

November 29, 1999

Docket No. 040-06377
Control No. 126958

License No. SUB-348

Radiation Protection Office
Quality Engineering Division

Ms. Pamela J. Henderson
Nuclear Materials Safety Branch 2
Division of Nuclear Materials Safety
U.S. Nuclear Regulatory Commission
Region I
475 Allendale Road
King of Prussia, Pa 19406-1415

Dear Ms. Henderson,

This refers to your letter dated March 8,1999 concerning "Decommissioning Plans for Buildings. 611B and 18, Picatinny Arsenal, ARDEC" (dated October 1998). The decommissioning plan for Bldg. 611B has been revised to be in accordance with the MARSSIM decommissioning provisions and is being resubmitted for your review, per guidance provided.

Reference to License No. SUB-348 amendment, which will authorize decommissioning of Bldg. 611B at Picatinny, will be made in the Radiation Work Permit prior to any decommissioning action rather than to the SUB-348, Amendment No. 21 mentioned throughout the workpackage prepared by the contractor.

Should you have any questions concerning this action Mr. Fabiano or the undersigned may be reached at 1-973-724-3126/3742; jfabiano@pica.army.mil, or rfliszar@pica.army.mil or fax number 1-973-724-7047.

Sincerely,

Richard W. Fliszar

RICHARD W. FLISZAR
Health Physics Manager
TACOM-ARDEC Radiation Protection Officer
Quality Engineering Directorate

Copies Furnished (w/o encl):

AMSTA-AR-QAW (Mr. Richard Eva)
AMSTA-AR-PSS (Mr. O.T. Perry – IRCC Chairman)
AMSIO-SF (Mr. Michael Styvaert)
AMSTA-CS-CZ (Ms. Karen McGuire)
AMCSF-P (Mr. John Manfre)
AMCSG-R (Lt. Col. Mark Melanson)

SUB-348
040-06377

DURATEK

PICATINNY ARSENAL DECOMMISSIONING PLAN

for

Buildings 611B

TACOM-ARDEC

Picatinny, NJ

Revision 0

November 1999

040 - 6377

Decommissioning Plan

for

Buildings 611B

TACOM - ARDEC

Picatinny Arsenal, NJ

November 1999
REVISION 0

Prepared by: ______________ for 11/23/99
Paul Jones Date
Radiological Engineer

Reviewed by: ______________ for. 11/23/99.
Robert Hornbeck Date
Operations Manager

Reviewed by: ______________ 11/23/99
Robin Shult Date
Manager, Byproducts

Approved by: ______________ ______
Mike Styvaert Date
Army Project Manager

Prepared By:
GTS Duratek
Radiological Engineering and Field Services
628 Gallaher Road
Kingston, TN 37763

127545

TABLE OF CONTENTS

1.0 GENERAL INFORMATION

The licensee for this decommissioning action is the US Army Tank Automotive Command (TACOM) - Armament Research, Development and Engineering Center (ARDEC) at Picatinny Arsenal, New Jersey 07806-5000. The License Number is SUB-348, currently operating under Amendment 21 with an expiration date of May 31, 2001.

This license is not being terminated by this decommissioning action. License SUB-348 is a multiple part document which authorizes five (5) laboratories, three (3) storage facilities, and one (1) test facility. The focus of this decommissioning action is the test facility, Building 611B and grounds.

Building 611B was designed for testing of munitions and contained only non-radioactive munitions until approximately 1959 when an east-west tunnel was added to the existing structure for depleted uranium (DU) munitions testing. The site has not been used for DU munitions testing since approximately 1985. Building 611B will no longer be used for DU munitions testing. The only radioactive components of concern at the site are contaminated with DU. DU use at the Building 611B site has been limited to indoor firing within the confines of the firing range and target room of the building. The target room was ventilated during firing by a High Efficiency Particulate Air Filter (HEPA) ventilation system. This system discharged after four stages of filtration to an area above the storage room located at the end of the firing range/target room.

There has been limited migration of DU from the active use areas to adjacent soils and facilities. DU migration was identified in the initial characterization report. The initial characterization report specifically identified the location of activity in soil around access points, throughout the interior of the structure and rain washout points outside the facility.

The overall project will be controlled by radiation safety personnel assigned to the Picatinny Arsenal. Their staff will be augmented by the Army's radioactive materials contracting organization and the Industrial Operations Command (IOC). Remediation activities will be performed by contract personnel. The contract organization, GTS Duratek, is contracted to TACOM - ARDEC through IOC, and is responsible to both organizations for the decommissioning work including the transportation and disposal of the residual radioactive waste. Remediation work to support the decommissioning will be performed under the U.S. Army License Number Sub-348, Amendment No. 21.

The Decommissioning Plan with appropriate attachments and documentation, upon document approval, and completion of decommissioning activities will constitute the majority of the submittal to the Nuclear Regulatory Commission (NRC) for license amendment. The amendment request will be for the removal of the test facility - Building 611B from the SUB-348 license, Amendment No. 21 and SUB-348 license application.

1.1 License Number SUB-348

The radioactive materials authorized for use on this license are:

- *Depleted Uranium* in *Any* form in amounts up to but not exceeding 11,000 kilograms,
- *Natural Uranium* in *Any* form in amounts up to but not exceeding 100 *kilograms,*
- *Thorium* in *Any* form in amounts up to but not exceeding 20 *kilograms,*

with authorized use in research and development as defined in 10 CFR 30.4, to wit:

Research and development means: (1) Theoretical analysis, exploration, or experimentation; or (2) the extension of investigative findings and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials and processes. "Research and development" as used in this part and Parts 31 through 35 does not include the internal or external administration of byproduct material, or the radiation therefrom, to human beings;

1.2 Facilities and Equipment - License Item 9

Areas defined by the license for exercise of the Authorized Use are the subject of Item 9 of the license and its letters and attachments. Each of those areas, including a brief description of their licensed function is described in the following: .

<u>Laboratory Facilities - Item 9.a.</u>

Building 320 contains an office area, a technical library, supply storage areas, restroom facilities that include a shower stall, a radiation counting area, radioisotope laboratory, non-radioisotope chemical laboratory, and a vented storage vault for the storage of radioactive materials.

Building 315 is a metallographic facility for analyzing and studying DU. The predominant areas in which DU is handled includes a machine shop and facilities to conduct metallographic, corrosion, stress corrosion, and mechanical testing. Because of the classified nature of the work done in this facility, the building is a limited access high security controlled entry building.

Building 355 houses Room 18 which is used to provide research and development (R&D) support in conjunction, at times, with work performed in Building 315. Room 18 contains several strength of materials test machines.

The only radioactive material specimens that have been tested on this machinery are those of depleted uranium.

Building 316 has been decommissioned and is now used as a HazMat (hazardous material) Facility. Prior to decommissioning B316 housed the laboratory in which metallurgical research of Depleted Uranium was conducted. The process employed in this laboratory, during operations and prior to decommissioning, cast DU alloys and turned the alloy into a long thin metallic ribbon which was extremely sharp and ignitable in air with very little friction.

Building 68 is in a secured enclosure that includes the Nuclear Maintenance Operation Procedures (NMOP). Classified operations are conducted in this enclosure. The mission of this facility is to evaluate proposed maintenance procedures on various training type nuclear weapons systems.

Storage Facilities - Item 9.b.

Building 3030 has been used to store various radioactive materials covered under the SUB-348 license. In addition, it is used to store classified items as well as special nuclear material which is licensed under NRC License No. SNM-561.

Building 55 is a standard Army tile block magazine (~120'x30') and is equipped with high security locks. It is used by the supply and transportation divisions for storage of packaged items awaiting shipment, distribution to users, or for long term storage, which may contain source material.

Building 312 is a newer storage facility for radioactive materials and radioactive waste. The building is located remote from other facilities and is always locked except during facility inspections or for incoming or outgoing shipments.

Test Facility - Item 9.c.

Building 611 B is a test range for DU Penetrators. The nature of the work conducted in this test facility makes it one of the most hazardous operations involving source material. The entire operation is a scaled down version of full size weapons ranges.

1.3 Building 611B -Test Facility

The subject of the required remediation and subsequent decommissioning is the Test Facility known as Building 611B. In accordance with regulatory guidance, a license amendment will be required to remove this building from License No. SUB-348, Amendment No. 21 and application for License SUB-348.

1.4 Procedure for Updating or Revising Pages

In accordance with guidance provided in Regulatory Guide 3.65, Page 3, Section 3.3, data and text in the Decommissioning Plan should be updated or revised by replacing pages.

2.0 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

This section provides a description of the planned decommissioning activities and tasks. In accordance with Regulatory Guide 3.65, *Standard Format and Content of Decommissioning Plans for Licensees Under 10 CFR 30, 40, and 70*, an *activity* is an organized unit of work for performing a function and may consist of several tasks. A task is a specific work assignment or job.

2.1 Decommissioning Objective, Procedures, Activities, Tasks, and Schedules

2.1.1 Decommissioning Objectives

The objectives of decommissioning Building 611B and associated grounds is to decommission/remediate the building and associated grounds according to Unites States Regulatory Commission (USNRC) Guidelines for Decontamination of Facilities and Equipment prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, USNRC 1993.

<u>Maximum Remediation Levels</u>

The maximum average fixed surface activity concentration: 5000 dpm/100 $cm^{2\cdot}$
The maximum loose surface activity concentration: 1000 dpm/100 cm^2.

Soil samples and exposure rate scans will be performed to determine compliance with the limiting value of depleted uranium in soil and external radiation above background as determined in Attachment C, Final Survey Plan.

The work will utilize several methods of decontamination; including, wiping, removal of components, and abrasive destruction (as necessary). All removed radioactive materials will be packaged and shipped in accordance with Department of Transportation (DOT) and Industrial Operations Command (IOC) procedure, *Shipping Procedures for Unwanted Radioactive Materials*. Following final approval of the decommissioning plan and successful decommision/remediation of Building 611B and associated grounds, this facility will be removed from NRC License SUB-348 Amendment No. 21 and application. An amendment will be submitted by TACOM-ARDEC to have item 9 of NRC Form 313, *Application for Material License,* modified removing Building 611 B as an authorized use location for any radioactive materials. The facility may then be designated for general use at Picatinny Arsenal.

2.1.2 Activities and Tasks

An in-depth radiological characterization of the Building 611B and associated grounds has been completed and published. There has been migration of DU from the active use areas to adjacent soils and facilities. The DU migration identified in the initial characterization report specifically identified the activity in soil around access points, throughout the interior of the structure and rain washout points outside the facility. Remediation of the radioactive contamination at the site is needed to prevent further spread of radioactive material and to ensure timely decommissioning of the facility.

The activities planned for accomplishing the remediation of Building 611B are described in the NRC Work Package which consists of this Decommissioning Plan, the Remediation Work Plan, the Final Survey Plan and the Health and Safety Plan. Each document serves as a part of the instruction which provides the consistency of operation required to successfully complete the decommissioning.

A final report will be prepared upon completion of Building 611B remediation. The final report, when complete, together with the approved Decommissioning Plan, will contain the required documentation supporting release the facility for unrestricted use. When complete, this report will constitute a revision to the decommissioning plan and will be added to that document. The remainder of this section provides a brief summary of the contents of each document in the work package.

2.1.2.1 Remediation Work Plan

The Work Plan provides the step-by-step work processes necessary to complete the characterization, remediation, or other specific task. The Work Plan also includes the basic background, site and facility description, operating history, previous survey information and final survey requirements.

The Work Plan for this project provides a summary discussion on the background of Building 611B, a site and facility description and its operating history. The Work Plan includes summary radiological data from the completed characterization report. It lists the instruments to be used, their detection capabilities, and discusses the required calibration data and documentation.

Those sections that address step-by-step work processes are divided into each individual area involved. The contamination levels, amount of area contaminated, and the location(s) of the contamination will be identified.

Decontamination methods will provide the most efficient contamination removal with the least amount of personnel exposure or an appropriate application of ALARA principles. Although remediation methods are discussed in the Work Plan, it does not negate the potential of using a different procedure, should one be required. The goal will always be to utilize the most efficient and dose effective methods available.

There will be no new decontamination techniques attempted during the remediation phase of this project. Remediation techniques will consist of washing, abrasion, cutting, scarification and other typical methods.

Washing techniques will be employed for flat surfaces which may be easily and effectively decontaminated with a damp cloth. Media used for decontamination purposes will be disposed of as radioactive waste. Abrasion techniques will normally be limited to the removal of contamination from surfaces into which radioactive contamination has penetrated and is not easily removed by nonagressive techniques. Such surfaces would be concrete walls, floors, rusted and/or deteriorated metal surfaces and similar porous surfaces. The abrasion technique currently planned is scarification, which will be performed using vacuum shrouded equipment to prevent the spread of contamination to personnel or the environment. Air sampling will be performed during all abrasive decontamination to monitor airborne activity levels for workers and to assure no release of airborne activity in excess of NRC established limits.

All personnel working with or in proximity to any decontamination process which could potentially produce an airborne condition, may be required to wear respirator protection. They will continue to use respiratory protection until the job is complete or air sampling verifies that no airborne hazard exists.

The removal of potentially contaminated drain lines may be accomplished by pipe removal using a low speed reciprocating saw. The fines will be collected in a drip containment placed under and/or around the cutting evolution. If it is necessary to cut compressed gas lines, GTS will take prudent precautionary measures.

Other typical methods may include large area removal of contaminated metal walls, floors, etc., by use of cutting torch. This method would also require the use of HEPA ventilation. HEPA vacuuming of loose surface debris for decontamination will also be used. A"hot work permit" will be required if a cutting torch is used.

The work objective for Building 611B and associated grounds is considered a remediation and normal remediation work is conducted in the same manner as the decontamination of any surface. An example is that

decontamination is conducted from an area of lowest contamination to an area or areas of highest contamination

Partial or full electrical input to the facility may be terminated and lockout/tagout procedures implemented prior to remediation. This allows for isolation of the building electrical systems for easy removal and prevents the possibility of electrical shock to workers.

The existing water supply to the facility may be terminated at the main supply station to prevent the inadvertent introduction of liquid.

NOTE: Due to the age of the structure, the possibility that floor tiles, baseboard cove molding, mastic, and the construction concrete may contain some level of Asbestos Containing Material (ACM) was considered. Sample analysis of the facility has shown that ACM is limited to the floor tiles. The basic provisions for handling the potential have been built into the remediation process, but if a more extensive ACM problem is determined, the Work Package will be revised to reflect the additional restrictions imposed by ACM.

Real Property Office has stated that the State Historical Preservation Office (SHPO) included Building 611B as a historical site and that as much as possible of the building and its appurtenances should be preserved notwithstanding the task at hand.

The methodology for transporting and disposing of residual radioactive waste is described in the Remediation Work Plan. The Remediation Work Plan also describes the detailed remediation process by area, task, and activity beginning with the:

Instrument Room has minor contamination on the walls and floor. Contamination will be removed by wiping and/or removing the paint. The floor tiles will be removed or vacuumed to eliminate the contaminated dusts that have collected in the crevices.

Drain system to the waste water holding tank will be surveyed inside the piping, capped, and cut out with a reciprocating saw. The slow speed of the saw will minimize the potential for the spread of contamination.

Foyer entrance has only minor contamination on door handles, at light switches and on the floor which is associated with the foot traffic from the contaminated area. As with the instrument room, this is easily removed by washing and removing the floor tiles.

Outside storage area or gazebo is a wood frame structure with plywood flooring which has become contaminated by transfer and staging of materials. It has been painted to prevent migration of the existing contamination. The most efficient method of decontamination is to remove the plywood flooring, cut and package the material as required and survey the remaining framing structure and ground below the flooring which may be potentially contaminated. A HEPA vacuum will be used to control the cutting debris.

HEPA ventilation system contains the highest levels of contamination found. This unit will be isolated and removed as one piece. Ducting will be carefully cut using a bagged containment and disposable cutting tools. Breaches will be sealed and the unit lifted off the roof by a crane. The HEPA unit will be completely wrapped and sealed and placed in a B-25 box for storage and shipping.

Non-DU Firing Tunnel has dust associated with the firing that occurred in the DU Tunnel. Dust has collected on the electrical wiring, lights, and has settled onto the walls and floors. Where possible, contaminated components will be removed, wrapped, and placed in containers for storage and shipping. The concrete walls may be scabbled if necessary, as wall as those portions of the floor that are open concrete. A portion of the tunnel floor is tiled and the tile will be removed as necessary.

DU Firing Tunnel and Target Room has collected dust from the firings similar to the non-DU tunnel and will be handled in the same manner as previously described.

The separation wall associated with the target room will be unbolted and removed. Many of the surfaces in this tunnel have contamination impinged into the metal. The metals in this tunnel are very thick and heavy. The effort required to decontaminate onsite may not be worthwhile. Some of the decontamination techniques that may be used in this tunnel include, cutting, washing, grinding, scabbling, etc.

The poured concrete floors of the tunnel are covered with floor tiles. It is unlikely that just removing the floor tiles will decontaminate these floors. Abrasives may be required to remove residual contamination from the floor.

Waste water holding tank was part of the DU upgrade in 1981 and is annotated on the Real Property Record (See Figure 1). It was used to collect water from the sink in the instrument room. This sink was where personnel washed their hands and face following entry into the firing area.

There appears to be some radioactive contamination inside the tank, but since there were no hazardous chemicals associated with the activities of the testing facility, the tank is not expected to contain a mixed waste. Working with the environmental department at Picatinny, the tank will be sampled to verify its contents. If the sample indicates only radioactive contamination, the tank water will be handled in the same manner as any radioactive liquid. Once removed from the ground, it is anticipated that the tank may be decontaminated and reused or disposed of as clean scrap metal.

2.1.2.2 Health and Safety Plan (HASP)

The Health and Safety Plan (provided in Attachment A) defines the applicability and responsibilities with respect to compliance with Federal and State Regulations and contractor safety procedures Federal and State regulatory and procedural guidance used in the preparation of the work package are identified.

The HASP identifies key health and safety personnel for both contractor and/or all appropriate site personnel. They are listed by location, organization, and phone number. The HASP provides a more detailed overview of the site or job location history and provides a hazards analysis for the project.

<u>Operational History</u>

Based on background investigations of Building 611B, it is known that the building was modified or upgraded to include the testing of DU projectiles from 1979 to July, 1981. The facility operated the DU testing program for approximately 3½ years. All testing was terminated in late 1984 or early 1985.

Figure 1 is the Real Property Record for Building 611B and indicates the DU upgrade complete date as 22 July 1981. Figures 2 and 3 are the construction drawings for the DU upgrade. Figure 2 is the HEPA installation for venting of the DU target box inside the tunnel. Figure 3 is an illustration of the additions and changes made to the physical structure that was in use for testing Tungsten penetrators. Figure 4 describes modifications to Building 611B Instrument Room/Non-DU tunnel.

Historical site review indicates that several small fires occurred inside the HEPA ventilation system for the facility that contributed to contamination outside the facility. No other incidents were discovered that document spills or leaks of hazardous material during the years of DU testing that would create either a personnel or environmental hazard during cleanup.

Interviews with site personnel indicate that at least two (2) fires occurred in the HEPA ventilation unit. During the characterization phase of the project, soil samples were taken in all areas that would have been affected by these incidents. The results of soil sampling in those areas indicated that while there was no contamination in the general areas, there are some small quantities of contamination in the soil on the back side of the HEPA platform and inside the storage building. The path and pattern of the contamination appears to be associated with migration by rainwater.

These areas will be remediated by removal of soils and re-sampled until the areas meet the soil contamination limits listed in Attachment C, Building 611B Final Survey Plan. The only other contamination associated with the unit is contained within the unit or within the supporting structures for the unit.

In addition, all workers that worked in the facility were part of the Army's bioassay program and had yearly, bioassays. Workers who have not retired and are no longer radiation workers are in the process of having their termination radiation physicals. An evaluation of documented internal contaminations from the Army's bioassay records at Redstone Arsenal do not show any DU contaminations associated with Picatinny Arsenal.

Figure 1
Real Property Record - Buildings

Figure 1
Real Property Record - Buildings

DATE COMPLETED	VOUCHER NUMBER	DESCRIPTION	DESIGNED CAPACITY	BASE UNIT FLOOR AREA (Sq. Ft.)
(1929)		ORIGINAL BUILDING		
5 Jul 56	26-57	Concrete foundation, floor and		
		walls,		
		Cost $6,000		
27 Mar 61	43-61	Alterations $28,710 (22,210)	→DP 57821	→Light Gas Gun
		Aug 27		
		INV. COMPLETED July 1969		
22 Jul 81	81-20	Cap Imp 1569 (30,279)	→VP 148840	→DU VP Grade
		INV. COMPLETED FEB 1991		

64

S-611 B
B-39068 B

REAL PROPERTY RECORD - BUILDINGS

1. INSTALLATION: Picatinny Arsenal, Dover, New Jersey		2. DESIGNATION: Ordnance Facility	
3. DATE: 20 March 1961	4. DRAWING NUMBER: DP-57821	5. ☐ PERMANENT ☐ TEMPORARY	6. BUILDING NUMBER: 611-B

7. DIMENSIONS		8. MATERIALS		9. SPACE HEATING	
a. MAIN BLDG.	See Remarks	a. FOUNDATION	Conc	a. SOURCE	Elec Heaters
b. OFFSETS		b. FLOORS	Conc	b. FUEL	Powerhouse (Electric)
c. WINGS		c. WALLS	Conc and Conc Blk	11. HOT WATER FACILITIES	
d. BASEMENT		d. ROOF	Corr Steel Pipe-Built up	a. CAPACITY	
e. ADDITIONS		10. NO. OF USABLE FLOORS	1	b. TEMP. RISE	

12. FIRE PROTECTION FACILITIES: No

13. UTILITY CONNECTIONS	NUMBER	SIZE	CAPACITY
a. WATER	No		
b. SEWER	No		
c. ELECTRIC	1	110/220V 3Ø	4-Wire 300A
d. GAS	No		
e. STEAM	No		
f. CONDENSATE	No		

14. REMARKS: Pipe - 8' ID - 40' L Main Bldg 59' x 9' Addition - 16'4" x 9'
Addition - 25'5" x 5'

(CONTINUE ON REVERSE SIDE)

Figure 2
Construction Drawing - HEPA

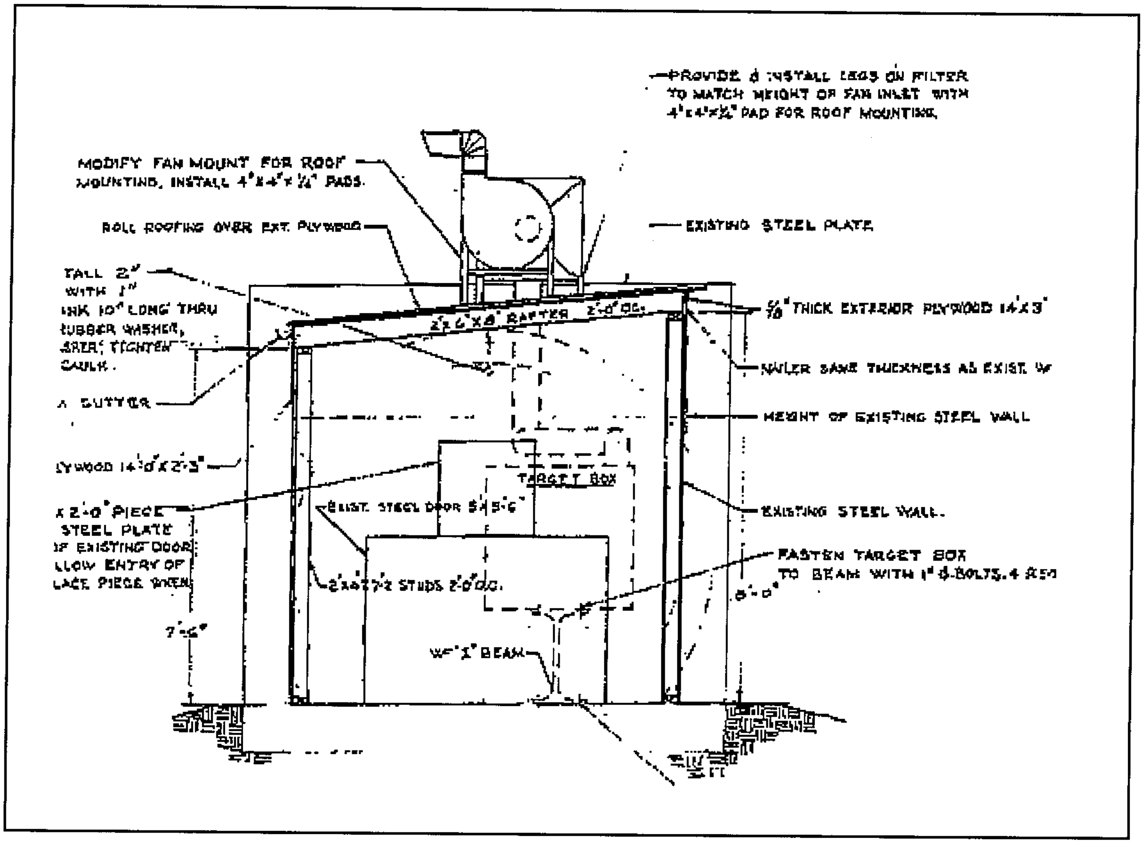


Figure 3
Construction Drawing - DU Modifications to 611B
Tunnel Area

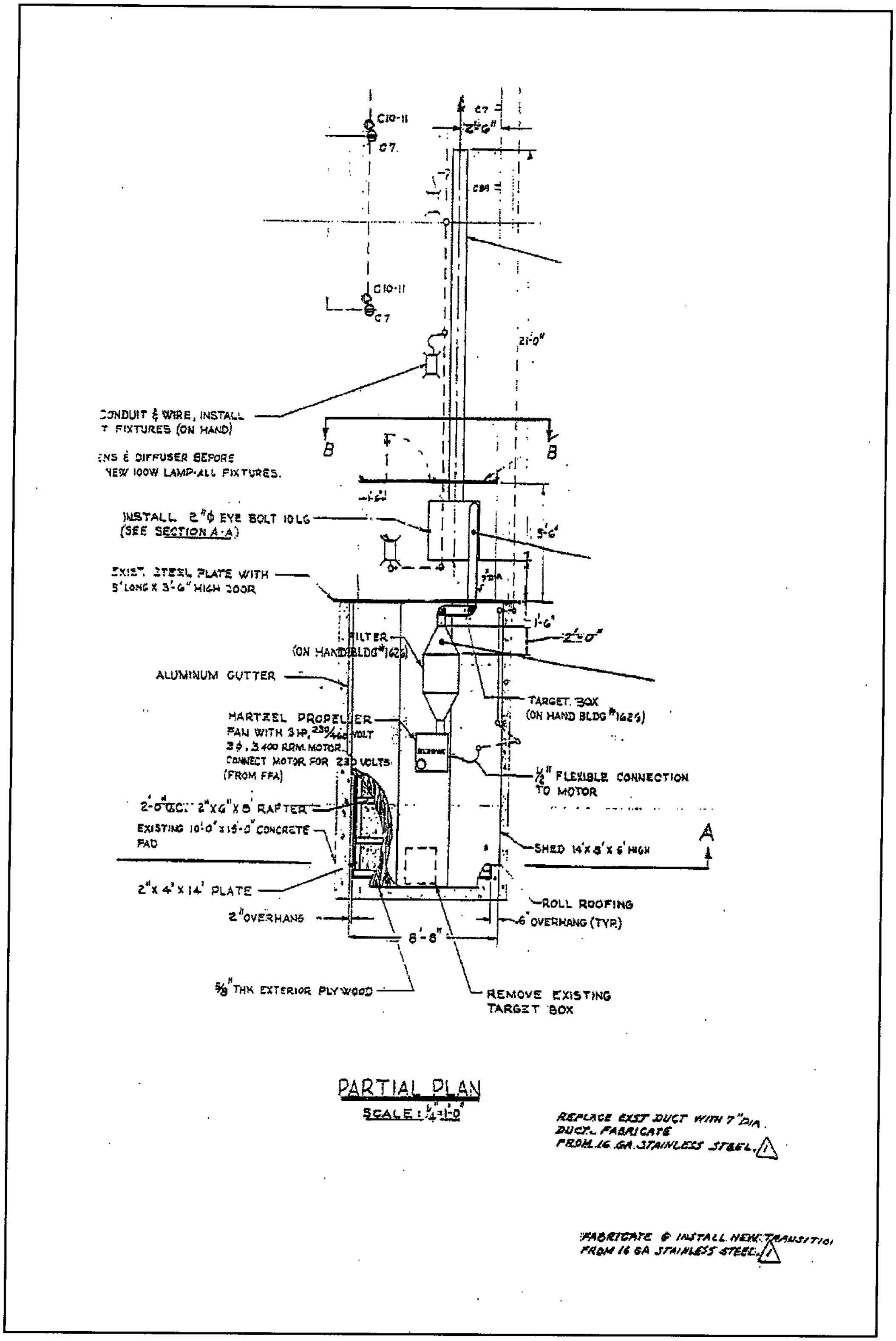
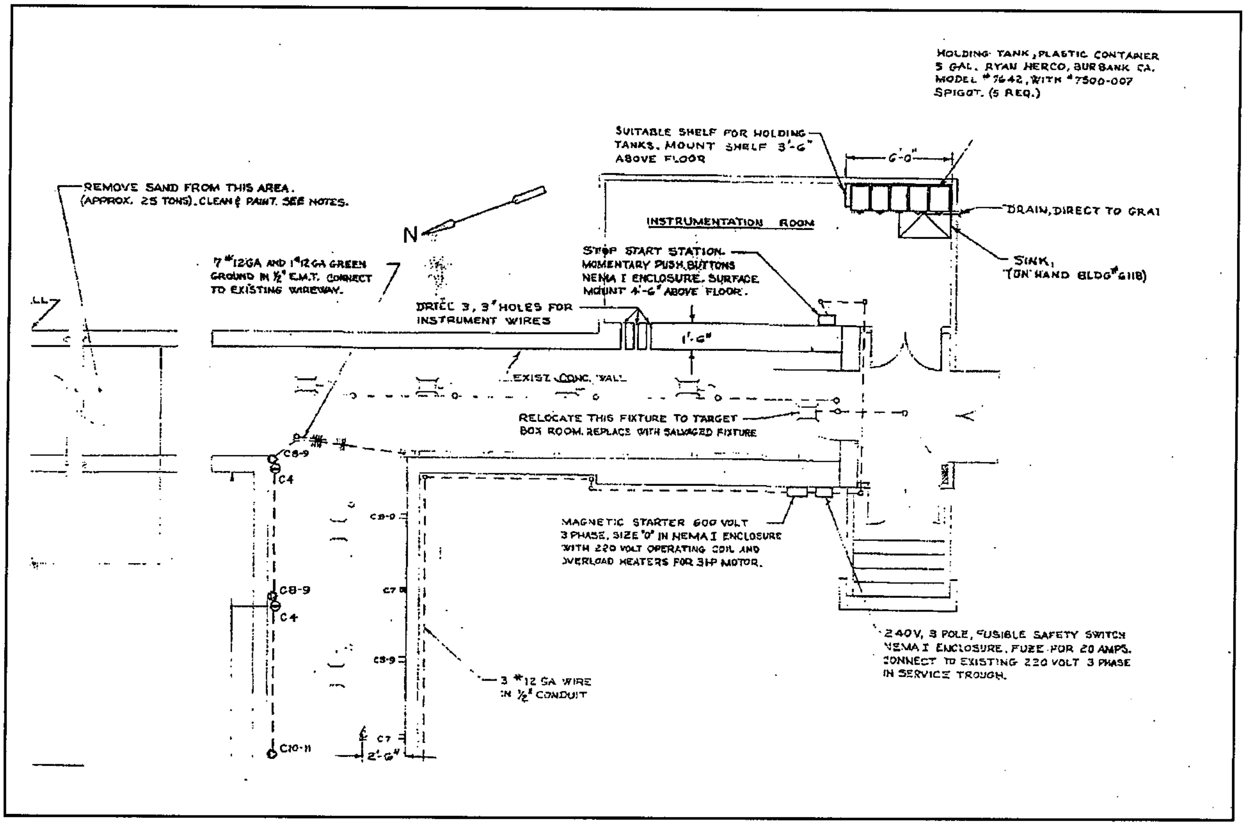


Figure 4
Construction Drawing - DU Modification to Building 611B
Instrument Room/Non-DU Tunnel



An initial cleanup was conducted during the characterization phase. The characterization effort required that a significant portion of the extraneous materials be surveyed and released or packaged and staged for disposal in accordance with IOC procedures. This was performed to render the permanent structures accessible for survey.

The results of the previous characterization indicate that the total activity on the permanent structures of Building 611B is less than one (1) millicurie. The only nuclides of concern are Depleted Uranium and its short-lived daughter products. Building 611B and associated grounds is to be decontaminated below the guideline levels as defined in Attachment C, Final Survey Plan. Any soil remediation levels will be consistent with the limits established in Attachment C, Final Survey Plan. Final survey guidance will be in accordance with MARSSIM, NUREG-1575.

2.1.3 Procedures

Decommissioning activities and tasks shall be conducted in accordance with US Army procedures, AR 385-11, AMCR 385-25, AR 11-9 and the ARDEC Health Physics Program, as defined in the license. The licensee has implemented the control system as discussed in Regulatory Guide 10-4, *Guide for the Preparation of Applications for Licenses to Process Source Material.*

The governing body for the control of radiation is the Ionizing Radiation Control Committee (IRCC). All areas of the Radiation Protection Program are directly responsible to the IRCC. By its charter, the purpose of the IRCC is, *To advise on command policies for safe use, handling, storage, receipt, shipment and disposal of sources of ionizing radiation and radiation producing devices.*

The first listed responsibility of the IRCC is: *Review and provide comment on new radiation programs, new radiation facilities, and new/revised standard operating procedures.*

To ensure that this control system is properly executed, the IRCC is directed by the Chief of the Safety Office and that individual is directly responsible to the site commander for actions as the IRCC Director.

2.1.4 Schedules

The time line shown (see Figuire 5) is based on a projected start date and task durations and is an example of the potential work schedule for the remediation of Building 611B and associated grounds. The actual start time is contingent upon incorporation of comments from interested parties,

reciept of an approved Decommissioning Plan from the NRC and the prospects of favorable weather. An example of the actual start date would be in the mid to late March 2000 time frame. Only the major activities are shown in Figure 5, Compressed Work Schedule.

Figure 5
Compressed Work Schedule

Task Name	Start Date	Duration	End Date
On-Site Job Specific Training	12/1/99	1.00d	12/1/99
• Boundaries Marked	12/2/99	.50d	12/2/99
• Waste Water Holding Tank	12/2/99	1.50d	12/3/99
• Soil	12/4/99	2.00d	12/6/99
• Pre-Job Surveys	12/7/99	.50d	12/7/99
Remediation	12/8/99	10.0d	12/17/99
• Instrument Room	12/8/99	1.50d	12/9/99
• Foyer Room	12/9/99	.50d	12/9/99
• Gazebo	12/10/99	.50d	12/10/99
• Inside Storage Area	12/10/99	1.50d	12/11/99
• HEPA Ventilation System	12/12/99	1.50d	5/13/99
• Non-DU Firing Tunnel	12/13/99	1.50d	5/14/99
• DU Firing Tunnel and Target Room	12/15/99	3.00d	12/17/99
Final Survey	12/1/99	Ongoing	12/22/99

The Remediation Work Plan has these major activities organized. The order in which they are performed may be altered, but the amount of time required for completion may be affected by an addition or change in allocated resources. Allocated resources would include finishing a task ahead of schedule.

2.2 Decommissioning Organization and Responsibilities

The overall project will be controlled by Radiation Safety personnel assigned to Picatinny Arsenal. Their staff will be augmented by the Army's radioactive materials contracting organization, the IOC. Remediation activities will be performed by contract personnel. The contract organization, GTS Duratek, is contracted to TACOM - ARDEC through IOC, and is responsible to both for decommissioning/remediation and transportation and disposal of the residual radioactive waste.

The **TACOM - ARDEC** project personnel are:

Radiation Protection	
Richard W. Fliszar	Radiation Protection Officer
Joseph A Fabiano	Health Physicist & Contract Interface
Armaments Technology	
Michael F Clune	CCAC/Previous IRCC Chairman
Management	
O.T. Perry	Current IRCC Chairman

Safety and Occupational Health Specialist
John Kirkpatrick

Asbestos Program Manager
Timothy Miller

Environmental Restoration Hydrologist
Paul Reibel

Security Desk Officer (extension 46666)

The **IOC** project personnel are:

Radiation Protection & Safety	
Michael Styvaert	Health Physicist
Kelly Crooks	Senior Health Physicist
Robert Matthys	Contracting Officer

The **GTS** project personnel are:

Radiation Protection	
Paul A. Jones	Site Safety & Health Officer
John L. McGehee	Site Safety & Health Officer (Alternate)
Management	
Robert Hornbeck	Operations Manager
Robin Shult	Manager, Byproducts

The GTS Project Team has over 20 years experience in radioactive project management and operations. Some of the operations performed by the Radiological Engineering and Field Services Division are: characterization, decontamination, remediation, decommissioning, surveillance, packaging and shipping, and consulting. GTS Duratek personnel will provide the required skills to decontaminate, remediate, survey, document, and release the structures and environs. They will be responsible for the packaging and shipping of the radioactive waste.

The TACOM - ARDEC Project Team will have overall responsibility for the safe completion of the remediation and decommissioning of Building 611B and associated grounds including transportation and disposal of residual radioactive waste. Mr. Fliszar and Mr. Fabiano are responsible for the use, control, and management of contract personnel.

The IOC Project Team provides the management and guidance associated with the terms of the contract, that allows the GTS Duratek team to conduct operations at the Picatinny Arsenal site. Along with the TACOM - ARDEC Team, they have reviewed GTS Duratek's decommissioning technical approach.

The Decommissioning Team consists of personnel from ARDEC, as the license holder, and GTS Duratek, who will perform the remediation work. The GTS Duratek team has written the Work Package for this project, but ARDEC and IOC have final approval over the contents. The Work Package consists of the Remediation Work Plan (Attachment B) the Health and Safety Plan (Attachment A) and the GTS Duratek Quality Assurance and Procedures Manual. The Decommissioning Plan was written by GPI, Inc. and edited for MARSSIM applicability by GTS Duratek, but the ARDEC team provided more direct-contact and information to this effort.

2.3 Training

Training requirements for this decommissioning include, but are not limited to:

- Site-Specific Health and Safety Plan,
- Radiation Worker Training,
- Respiratory Training (as applicable),
- Unexploded Ordnance (UXO) Safety Training,
- Daily Tailgate Hazard Communication,
- First Aid/CPR Training (SSHO),
- Fall Protection,
- Event Reporting,
- Operation of decontamination and remediation equipment, and
- Confined space (as applicable)

In addition to the above, all project personnel will receive documented Picatinny Arsenal site specific orientation. This will include any training to any site hazards identification and controls encountered during the project. All project personnel training records and safety meeting attendance sheets will be held in the on-site project office and will be available for review as necessary.

2.4 Contractor Assistance

ARDEC has chosen the option of a contractor assisted remediation and decommissioning on Building 611B. The remediation project will be conducted by GTS Duratek and GTS Duratek trained personnel. GTS Duratek was submitted for IOC's Qualified Bidders' List (QBL) review and was approved for work on IOC radioactive materials contracts.

Decommissioning will meet the requirements of TACOM - ARDECs license SUB-348, Amendment No. 21. GTS Duratek holds Radioactive Material License R-73018-E00 for decontamination and decommissioning issued by the State of Tennessee. This license authorizes GTS Duratek personnel to perform assessment, decontamination, decommissioning, and remediation operations including the possession, processing, storage, packaging, and/or shipping of radioactive materials. The GTS Duratek Radiation Safety Guide -2 (RSG-2) summarizes the regulations, safety practices, and radiation protection policies GTS Duratek follows for work performed under our license. From these policies, specific procedures have been developed to assure compliance with regulations and to maintain radiation exposures, resulting from GTS Duratek operations, to a level as low as is reasonably achievable (ALARA). RSG-2 and the operating procedures constitute the Radiation Protection Program for GTS Duratek's Radiological Engineering and Field Services group. Although this project will not be performed under GTS Duratek's license, the guidelines contained in these documents will be followed for work on this project where appropriate and applicable.

3.0 DESCRIPTION OF METHODS USED FOR PROTECTION OF OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

3.1 Facility Radiological History Information

Building 611B was constructed in 1929 as a test tunnel for firing rounds of artillery. In 1959, a gas gun was installed and that same year, another tunnel was constructed and an instrumentation room was added to the front of the old rectangular structure.

With the installation of the gas gun, the Army began testing specific types of projectiles. The first projectiles were made of tungsten metal that arrived at Building 611B as pre-fabricated rounds.

In 1979, the second tunnel addition was modified by adding an inner wall at the end of the tunnel, reinforced steel walls, and HEPA ventilation system. The instrumentation room was enlarged, the sink was moved to the other side of the room, and a packing platform was added where the sink had been.

In 1980, testing of DU began in the newly modified tunnel. There were two (2) major differences in the Staballoy rounds and previous rounds: 1) the new projectiles were radioactive, and 2) explosive propellant was associated with each projectile. Explosives were not used in these rounds and the projectiles themselves were solid and did not contain any energetics. The amount of propellant associated with each round was determined by the velocity required for the evaluation. The propellant portion of each of the DU rounds was hand packed after it reached Building 611B.

The radioactive materials associated with this testing were used only in the portion of the 611B facility known as the DU tunnel. However, due to the migration of radioactive dusts created by each explosion, the second tunnel has nominal amounts of contamination. The attached structures have some contamination associated with foot traffic. The only radionuclides of concern in Building 611 B are Depleted Uranium and its short-lived daughter products.

The highest contamination levels were found inside the HEPA ventilation unit. The average activity concentration was 20,000 dpm/100cm^2. Pages 6 and 7 of the Characterization Summary in Attachment D show by calculation that the maximum activity on site is conservatively estimated to be less than one (1) millicurie (mCi).

Testing was performed in accordance with SOP No. 385-1, *Operation of Staballoy Test Range Building 611B*. There were no modifications made to the building after the DU testing began. The only modifications were for the purpose of beginning DU testing.

A hand-written log of the activities conducted is maintained by the Radiation Protection Office at Picatinny Arsenal. The log identifies no significant spills, leaks, or accidents involving hazardous material over the ~3½ year period of DU testing. There are two (2) areas of soils associated with the filter fires, that will be remediated to the levels established in Attachment C, Final Survey Plan.

Interviews with personnel that worked in the facility during the entire period indicate that at least two (2) fires occurred in the HEPA Unit. This information was consistent with the pattern of contamination encountered during the characterization. Those areas that were potentially contaminated by the effects of the fire were identified and sampled during the characterization.

In June, 1999 Building 611B was deemed eligible for inclusion on the National Register of Historic Places.

3.2 Ensuring that Occupational Radiation Exposures Are As Low As Reasonably Achievable (ALARA)

Both the licensee and GTS Duratek have formal ALARA Programs in accordance with their NRC and State of Tenessee licenses. The principles of GTS Duratek's ALARA program are found in their Radiation Safety Guide (RSG-2).

The only gamma radiations associated with Depleted Uranium are from First Segment decay to its daughter products, Th-234 in the 50 KeV to .1 MeV range on average and Pa-234 in the 1 MeV range. Dose rates in the general area of the rooms with the highest contamination are less than 1 mrem/hour. The primary detection capability for contamination on surfaces is due to the Firft Segment daughter product beta (β^-) emissions in the 0. 1 to 2.3 MeV range, on average.

The contamination is adhered to most surfaces, requiring some pressure to create smearable conditions. This makes it highly unlikely that radioactive material will become airborne. In those remediation situations where the contamination will be made airborne, HEPA ventilated containments and respiratory protection may be used to prevent personnel or environmental contamination.

The control of handling and storage of radioactive waste is addressed by the licensee in item 11 of SUB-348, Amendment No. 21. In part, it specifies that ... *All contaminated items will be stored in proper storage containers. ...*

3.3 Health Physics Program

The licensee will provide oversight of the remediation project, However, the contractor will normally provide the day-to-day site supervision. GTS Duratek will comply with the TACOM - ARDEC Health Physics Program and the GTS Duratek Health Physics Procedures. The day-to-day health physics operations, (i.e. air sampling and surveying) will be performed using GTS Duratek operating

procedures except in cases where the TACOM - ARDEC Health Physics program procedures are more restrictive. The TACOM - ARDEC Health Physics procedures will be followed in these cases.

The specific instrumentation selected for this remediation is listed and described in the Work Package documents in Attachment C, Final Survey Plan. Instrumentation will be used in accordance with GTS Duratek approved procedures.

Potential sources of contamination that may be created by the remediation have been examined in previous sections of this document. The method of control and prevention of exposure to workers or the public was also discussed.

3.4 Radioactive Waste Management

TACOM - ARDEC will handle and store radioactive waste in accordance with SUB-348, Amendment 21 in Item 11 of that license. Radioactive waste will be packaged and transported according to guidance provided by GTS Duratek procedures in accordance with U.S. Department of Transportation Regulations contained in 49 CFR Parts 100 to 185. The radioactive waste will be transported to a facility approved for disposal.

TACOM - ARDEC, as with all Army facilities, does not handle its disposal of radioactive wastes. The radioactive waste scheduled for disposal is transferred to IOC. These wastes are handled under, *IOC, AMSIO-DMW, Standard Operating Procedures for Shipping Unwanted Radioactive Materials, May 1997.*

Item 11, in part, states, ...*Actual radioactive waste processing/packaging will be performed by either AMCCOM (IOC) or ARDEC.* The IOC handles the disposition of all Army radioactive waste. This processing/packaging may also be performed by contract personnel approved by and working under the auspices of IOC.

The potential issue of encountering a mixed waste has been addressed in the Work Package. The effect will be that the job will be stopped at that point, all appropriate personnel will be notified and involved, which includes site environmental personnel. TACOM - ARDEC site personnel will have the responsibility for notifying the EPA, as applicable.

The Work Package will be amended to address the new situation and all involved personnel will review and approve the changes. Following this sequence of events and dependent upon the type of problem encountered, work will resume.

4.0 PLANNED FINAL RADIATION SURVEY

The Final Status Survey Plan for the release for unrestricted use of Building 611B and the immediate grounds is provided as Attachment C. The surveys will consist of surface scans (beta and gamma), fixed beta measurements, and smears for gross alpha and gross beta analysis on structural surfaces while the survey of the facility grounds will consist of gamma scans and soil sampling for gamma spectroscopy analysis. The surveys will be performed in accordance with MARSSIM while applying site specific Derived Concentration Guideline Levels (DCGL) based upon the future use of the facility and the grounds. The Final Status Survey will be used to support TACOM - ARDEC Picatinny Arsenal intent to remove Building 611B from their radioactive materials license and release the facility for unrestricted use. This required the development of alternative release criteria for the survey of the building to verify that no radioactive materials remain above the DCGLs.

GTS Duratek developed a Final Survey Plan based on the guidance provided in current regulations including NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, 10CFR20 Subpart E, *Radiological Criteria for License Termination*, Draft NUREG-1549, *Using Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination,* and the current NRC DandD code, Version 1.0. The criteria and survey protocols specified in the plan were designed to meet the intent of the current regulations for release for unrestricted use and are intended to support the removal of the facility from the Arsenal's Radioactive Materials License.

With regard to the local geology (New Jersey Highlands), an important consideration for this site is that the Reading Prong is known to contain radiologically significant amounts of radium and radon.

5.0 FUNDING

The US Army IOC has issued Purchase Order #DAA09-99-C-0057 to GTS Duratek to include the remediation of Building 611B at the Picatinny Arsenal Site. The contract value is for $234,130.00. The majority of planning for the remediation has been completed in the Health and Safety Plan, Remediation Work Plan, and the Final Survey Plan for Building 611B.

6.0 PHYSICAL SECURITY PLAN AND MATERIAL CONTROL AND ACCOUNTING PLAN PROVISIONS IN PLACE DURING DECOMMISSIONING

The existing security system is adequate to handle any contingency that may arise during decommissioning. There is no cause in the decommissioning plans, as written, for which the existing security should be modified.

7.0 ATTACHMENTS

7.1 Attachment A - Site Health and Safety Plan for the TACOM - ARDEC, Picatinny Arsenal Building 611B

7.2 Attachment B - Remediation Work Plan for the TACOM - ARDEC, Picatinny Arsenal Building 611B

7.3 Attenchment C - Final Survey Plan for the TACOM - ARDEC, Picatinny Arsenal Building 611B

Attachment A

GTS DURATEK

SITE HEALTH AND SAFETY PLAN

for the

TACOM - ARDEC
Building 611 B
Picatinny Arsenal

REVISION 0
November 1999

Prepared by: ______________________ 11/18/99
Paul Jones — Date
Project Site Safety and Health Officer

Reviewed by: ______________________ 11/23/99
Jimm Snoddy — Date
Corporate Health and Safety Officer

Reviewed by: ______________________ 11/18/99
Robert Hornbeck — Date
Project Sponsor

Approved by: ______________________ ____________
Mike Styvaert — Date
Army Project Manager

Prepared By:

GTS Duratek
Radiological Engineering & Field Services
628 Gallaher Road
Kingston, Tennessee 37763

Table of Contents

1.0 INTRODUCTION

This Site Health and Safety Plan (HASP) provides the basis for conducting all GTS Duratek decontamination and decommissioning (D&D) activities at the Picatinny Arsenal Building 611B site. All activities will be performed safely and in accordance with current Occupational Safety and Health Administration (OSHA) standards, the GTS Duratek Health and Safety Manual, and the US Army Tank Automotive Command (TACOM) - Armament Research, Development and Engineering Center (ARDEC) license number SUB-348, Amendment 21.

Work activities will be planned to identify the safety and health, and radiation/contamination hazards associated with the scope of work. Work plans and permits will be established to incorporate the use of engineering controls and safeguards to ensure that appropriate measures are taken to control the risks and protect the well-being of project personnel, the community and the environment.

2.0 MANAGEMENT COMMITMENT TO HEALTH AND SAFETY

It is GTS Duratek's policy to conduct operations in a way that protects and ensures the safety and health of employees, subcontractors, the public and the environment. Accordingly, all GTS Duratek activities will comply with both the letter and the spirit of all applicable environmental safety and health regulations and requirements. Without exception, safety will take precedence over production, remediation and survey goals for the duration of this project. In addition to meeting regulatory and other requirements, GTS Duratek is committed to good health and safety practices to reduce potential safety and health risks and to reduce exposures to hazardous substances and ionizing radiation to as low as reasonably achievable (ALARA).

3.0 APPLICABILITY

This Health and Safety Plan applies to all GTS Duratek employees, subcontractors and visitors to the project site. The HASP will be made available to all project personnel for review at any time and will be maintained by the GTS Duratek Project Manager for the duration of the project. All GTS Duratek employees, subcontractors and visitors will review the HASP and sign the Acknowledgment Sign-off-sheet, Attachment 1, prior to any on-site work. This will indicate personnel agreement to abide by its contents.

4.0 GENERAL

4.1 Discussion

It is GTS Duratek's intent to perform all decontamination and survey activities at the Picatinny Arsenal facility in accordance with the US Army license number SUB-348 and the GTS Duratek Health and Safety Manual requirements. The GTS Duratek Health and Safety Manual provides the rules, policies, procedures, regulations, recommended practices and other pertinent information to prevent exposure of employees to injury, illness, or work conditions that may adversely affect their health.

The GTS Duratek Health and Safety Manual contains information and guidance in the following areas:

- General Safety Rules
- Responsibilities
- Organization
- Employee Training
- Injury Reporting and Investigation

The manual also contains administrative, performance and equipment operational procedures. These procedures are prepared to cover specific areas and segments of work at GTS Duratek and off-site projects. Some of the procedures included in the manual apply to all employees regardless of their job function. Others are applicable only to the work activities or equipment referenced in the procedure.

4.2 Responsibilities and Organization

It is GTS Duratek's view that ultimate responsibility for safety at GTS Duratek projects rests with GTS Duratek management and supervision; however, each employee must be willing to participate in the safety effort and integrate safety into each job function.

This section describes the responsibilities and authorities of project personnel with regard to the Site HASP. Figure 4-1 is the organization chart for the building 611B decommissioning. All personnel shall be cognizant of the potential hazards during the project and aware of the methods implemented to reduce the risk of exposure to radioactive or hazardous materials. All personnel shall comply with the rules and procedures set forth in this HASP. It is GTS Duratek's intent to conduct all operations in accordance with GTS Duratek and Picatinny Arsenal facility safety plans.

Project Manager

The Project Manager will have overall responsibility for the project, and will be the principle interface with the client. The Project Manager is responsible for the safe and satisfactory completion of the project by providing the leadership and direction to organize, integrate and control project activities. The Project Manager will establish policy and direction, assign responsibility and allocate resources. The Project Manager is responsible for implementation of the GTS Duratek Radiological Engineering and Field Services (REFS) Quality Assurance Manual and Procedures. The Project Manager will also function as the Site Safety and Health Officer.

Site Safety and Health Officer

The Site Safety and Health Officer (SSHO), or his designee, is responsible for the development and oversight of the HASP. The SSHO shall be knowledgeable in the applicable safety standards and regulations and shall be trained and qualified in accordance with the requirements of Section 1.0 of the GTS Duratek Health and Safety Manual. The SSHO will ensure that the necessary radiation safety and health monitoring is performed and all required documentation is maintained. The SSHO has the authorization to stop work at any time the work conditions are considered to be dangerous to the health and safety of the community, the environment or project personnel. In addition, the SSHO is responsible for:

- Reviewing work plans and RHWPs,
- Monitoring the work place daily for safety concerns,
- Ensuring the performance of air monitoring and sampling as required,
- Requesting changes to this HASP based on changing work conditions,
- Performing periodic safety reviews, weekly inspections and monitoring activities of project operations to ensure compliance with this HASP,
- Documenting any overexposure to radioactive or hazardous materials,
- Ensuring that all training, medical and exposure records are complete and available for review,
- Conducting and documenting periodic safety meetings, and
- Maintaining Material Safety Data Sheets and Conducting HAZCOM Tailgate Training.

Health Physics Technicians

Health physics technicians will, in conjunction with the SSHO:

- Prepare Radiation/Hazardous Work Permits (RHWPs),
- Select proper personnel protective equipment (PPE),
- Perform radiological surveillance and monitoring as necessary,
- Ensure all monitoring equipment and instrumentation meet calibration requirements,
- Ensure traceable documentation is maintained for all instrumentation calibrations,
- Ensure that proper ingress and egress procedures are followed.

UXO Personnel

UXO Personnel are responsible for investigating and clearing work areas of potential UXO, prior to radiological sampling and surveying in those areas. The UXO personnel will also provide UXO updates during HAZCOM tailgate safety briefings.

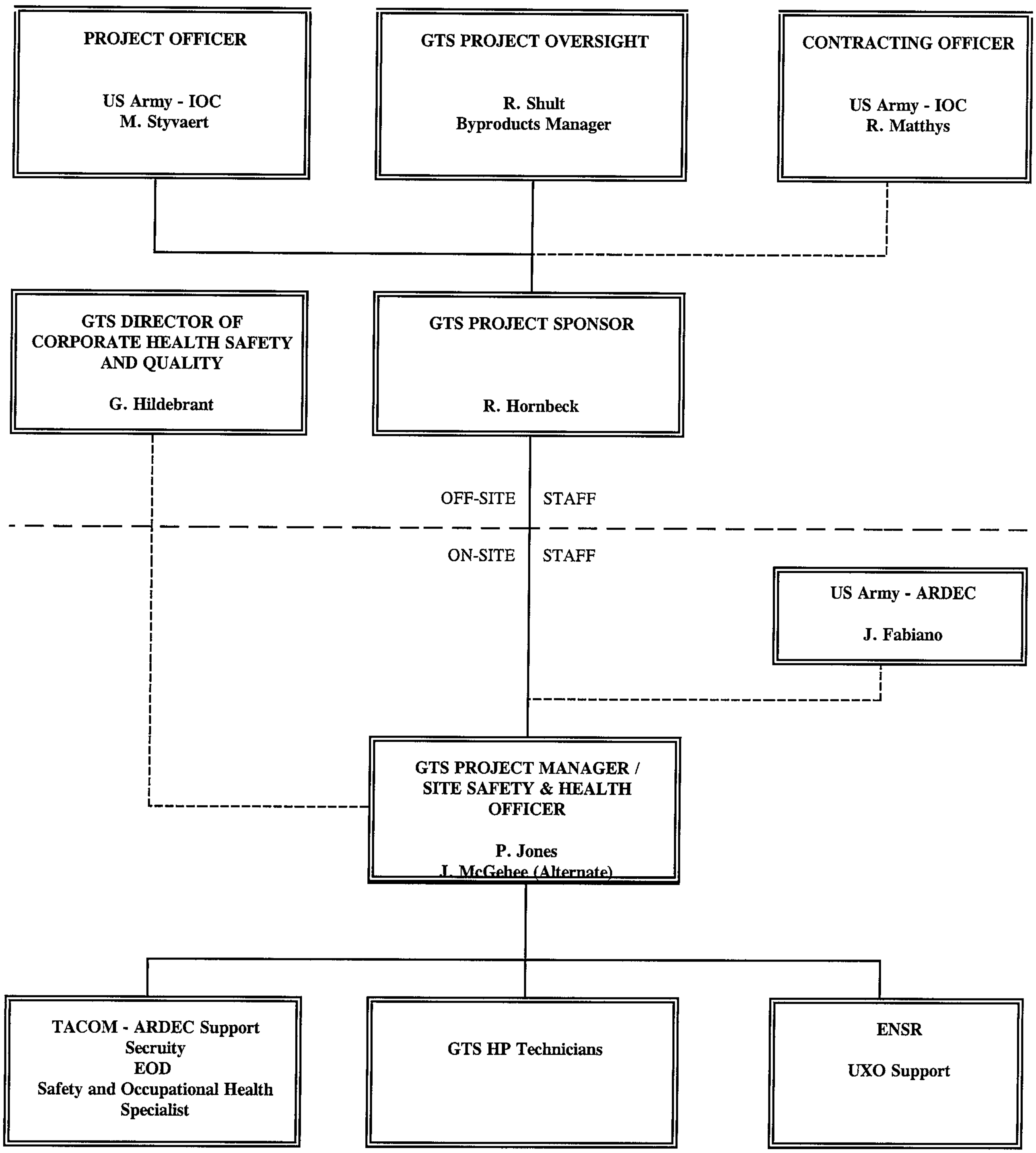
Safety and Occupational Health Specialist

Safety and Occupational Health Specialist to be present in discussions concerning delimitation of UXO area, stretching of caution tape and positioning of any heavy equipment such as cranes.

Site Visitors

Site visitors are responsible for reviewing this HASP and complying with all sections as applicable to their visit.

Figure 4-1
Building 611B Decommissioning Organization Chart



5.0 TRAINING

Training requirements for all project personnel are provided in Section 1.7 of the GTS Duratek Health and Safety Manual. Training requirements for this project include, but are not limited to:

- Site-Specific Health and Safety Plan,
- Radiation Worker Training,
- Respiratory Training (as applicable),
- Unexploded Ordnance (UXO) Safety Training,
- Daily Tailgate Hazard Communication,
- First Aid/CPR Training (SSHO),
- Fall Protection,
- Event Reporting,
- Operation of decontamination and remediation equipment, and
- Confined space (as applicable)

In addition to the above, all project personnel will receive documented Picatinny Arsenal site specific orientation. This will include any training to any site hazards identification and controls encountered during the project.

All project personnel training records and safety meeting attendance sheets will be held in the on-site project office and will be available for review as necessary.

6.0 HAZARDS AND CONTROLS

Anticipated hazards that may be encountered during the project include:

- Unexploded Ordnance (UXO),
- Depleted Uranium in various forms,
- Power Tool Operation,
- Welding and Cutting Operations,
- Heat Stress,
- Cold Stress,
- Power Equipment Operation,
- Compressed Gas Cylinders,
- Overhead Work,
- Slips/Trips/or Fall Hazards,
- Lockout/Tagout of Operational Equipment,
- Drum Handling,
- Noise, and
- Hazard Communication.

The GTS Duratek Health and Safety Manual provides the rules, procedures and guidance that will be used on this project to control the above hazards. In certain instances Picatinny Arsenal or subcontractor procedures will be used provided they are at least as stringent as the GTS Duratek controls. Some of the specific controls are addressed as follows:

6.1 Unexploded Ordnance (UXO) Safety

The site is a weapons testing facility. There is a strong probability for the presence of UXO in the ground or stored in areas at the site. Trained safety and ordinance personnel will be required to sweep all work areas to identify unexploded or unidentified ordinance. ALL personnel shall pay attention to orders and instructions given by persons assigned to protect site workers from explosive hazards. Explosive hazards and a review of items found will be discussed during the daily tailgate safety meetings.

All project personnel working in potential UXO areas:

- Shall be trained,
- Shall comply with UXO safety procedures,
- Shall work only in areas that have been checked and cleared for UXO,
- Shall **NOT** touch or move suspect UXO,
- Shall limit their movements between the job site which is B 611b and outside the enclosure (Movements other than this route are prohibited because of other energetic operations that may be going on),
- Shall ensure that the area supervisor is aware of the contractors presence,
- Shall ensure that they obtain the appropriate hot work permits for welding, cuting and spark producing equipment, and
- Shall be aware of surrounding UXO problem and avoid it entirely. Project personnel are not to touch UXO at all.

All UXO personnel

- Shall receive training regarding working in areas where the potential for UXO exists prior to any work at the site. This training will be given by the site UXO supervisor.

- Shall comply with all applicable provisions for safety as described in the US Army Engineering and Support Center's SAFETY CONCEPTS AND BASIC CONSIDERATIONS FOR UNEXPLODED ORDNANCE (UXO) OPERATIONS.

- Shall report and turn over to the EOD all uncovered UXO identified during surveys. UXO personnel shall follow guidance provided by EOD procedures or instructions as appropriate with regard to notification and turn-over when UXO is identified.

6.2 Welding and Cutting Operations

All project welding and cutting operations will be performed in accordance with GTS Duratek procedure REFS-HS-020, Welding and Cutting Operations. The REFS-HS-020 procedure establishes the requirements for effective control of fire, health, and safety hazards related to the project welding and cutting operations. Prior to performing welding and cutting operations, personnel shall obtain a permit from TACOM - ARDEC Fire Department Project personnel shall follow guidance provided by TACOM - ARDEC Fire Department procedures or instructions as appropriate with regard to project welding and cutting operations.

6.3 Power Equipment and Power Tool Operation

All electrical tools and equipment in the work areas shall be intrinsically safe or grounded. All electrical equipment shall be connected through a ground fault circuit interrupter when working in a damp or conductive environment or in the immediate vicinity of standing liquids. Damaged electrical cords shall be removed from service and will not be spliced together.

6.4 Slips, Trips and Falls

Prevention measures such as good housekeeping, level work surfaces, and defined walkways will be utilized. Elevated work will be performed using appropriate ladders and/or fall protection (i.e., body harness and lifeline), in accordance with 29 CFR 1910 Subpart D 1910.22 and 1910.23 and I 1910.132 and 29 CFR 1926 Subpart E 1926.95, 1926.104, 1926.106, M and L 1926.451. No employee may be exposed to a fall over 5 feet without being tied off. The best protection from falls is a permanent work platform or properly constructed scaffold. PPE, such as a safety harness system, may not be used as a substitute where construction of a proper scaffold is reasonable. Safety belts

for fall protection are not permitted; only safety harnesses may be used. Lanyards must be the shock absorbing type. Safety harnesses must be used when working from aerial lifts, cranes, or derrick hoisted personnel platforms. Safety harnesses are also required when complete scaffolds as previously discussed cannot be built.

6.5 Heat Stress

Conditions which may increase the potential for heat-related hazards will be monitored when ambient temperatures exceed 90°. Personnel wearing protective clothing will be observed as appropriate, throughout each shift, taking precautions to allow personnel the opportunity to acclimate and cool down as needed. Personnel will be provided adequate rest periods and liquids deemed necessary by the work supervisor.

6.6 Cold Stress

All GTS Duratek project staff working in cold environments will be dressed to minimize loss of body heat. Precautions will be taken to allow personnel adequate rest/warm-up periods. Scheduled breaks, environmental monitoring, and other administrative controls will be implemented to control cold stress.

6.7 Compressed Gas Cylinders

Compressed gas cylinders can be extremely hazardous if mishandled. The following guidelines have been prepared to ensure that all gas cylinders are properly handled and stored.

- Cylinders will be clearly labeled as to the contents and always be considered full unless labeled as empty.
- Cylinders in use, storage or transit will be secured using a chain, retaining bar or structure to prevent cylinders from falling or being knocked over.
- Protective valve caps will be in place on all cylinders in storage or transit.
- A regulator, gauge or regulating manifold will be used on all cylinders. Regulators, gauges and manifolds are to be matched to the specific type of gas and the service for which the cylinders are being used.
- Cylinder contents will be identified by means of legible labels or stencils or by identifying marking embossed on the cylinder by the supplier.
- Compressed gas cylinders should not be dropped, bumped or handled roughly.

6.8 Overhead Scaffolding Work

Overhead scaffolding work will be provided by and erected by a qualified scaffolding contractor. Erected scaffolding will comply with the applicable OSHA regulations. Erected scaffolding will be initially inspected by the scaffolding contractor. The SSHO will periodically inspect all erected scaffolding.

6.9 Lockout/Tagout of Operational Equipment

The GTS Duratek project SSHO shall ensure that all affected systems will be properly isolated. All GTS Duratek personnel will also be properly trained in the proper Lockout/Tagout procedures to be implemented at the Picatinny Arsenal facility.

Prior to working on any power equipment and machinery, GTS Duratek personnel will contact the SSHO who will in turn notify the Picatinny Arsenal representative. Upon notification, the Picatinny Arsenal representative will de-energize the specified pieces of equipment and ensure that the items are properly locked out and tagged out. The electrician will then proceed to try and operate the equipment verifying that it is de-energized. Once locked out, GTS Duratek will then place a Lockout/Tagout tag on the equipment. Once complete, GTS Duratek will remove the GTS Duratek tag and notify the Picatinny Arsenal representative to re-energizing the equipment.

6.10 Waste Container Handling

Drums and containers used during radiological decontamination and survey activities shall meet the appropriate DOT, OSHA and EPA regulations for the waste that they contain. Site operations shall be organized to minimize the amount of drum or container movement. All employees exposed to the drum or containers shall be warned of the potential hazards associated with the contents of the drums or containers.

6.11 Noise

Hearing protection devices in the form of earplugs or earmuffs will be provided and worn by all personnel working in areas where levels are suspected or shown to exceed 85 dBA.

6.12 Hazard Communication

The purpose of the Hazard Communication (HAZCOM) Program is to ensure that the primary radiological hazard of Depleted Uranium along with the hazards of chemicals used at Picatinny Arsenal are evaluated and that information concerning their hazards is communicated to the employees. The information concerning these hazards shall be transmitted to employees, contractors, and visitors by means of this Hazard Communication Program, and shall include, but not be limited to, container labeling and other forms of warning, material safety data sheets, asbestos awareness, and employee training. GTS Duratek employees at all levels have a personal responsibility to ensure the success of the Hazard Communication Program.

The SSHO will be responsible for maintaining material safety data sheets and conducting training to employees so that they become familiar with the signs and symptoms of overexposure to hazardous chemicals in addition to Depleted Uranium with which they will work. A chemical inventory list for this project may include:

- diesel fuel
- propane gas
- hydraulic oil
- motor oil
- Dow Bathroom Cleaner

6.13 Powered Material Handling Equipment

GTS Duratek places the safety of its employees in the forefront in all situations. The potential hazards associated with operating machinery and equipment or powered with operating machinery and equipment or powered industrial vehicles such as fork trucks, scissor lifts, transport equipment and other materialized material handling equipment necessitate strict adherence to an all inclusive policy and procedures on training and operation of these vehicles. The SSHO will ensure all workers are in compliance with the minimum requirements for operator training, equipment inspection, maintenance, and storage of powered material handling equipment as described in GTS Duratek procedure number HS-P-004, *Material Handling*.

7.0 PERSONNEL PROTECTIVE EQUIPMENT (PPE)

In addition to engineering controls and work practices, personnel protective equipment will be used to protect personnel from contaminants encountered during activities on site.

Primary personnel hazards anticipated during characterization surveys of structures/systems or during environmental hazardous material characterization are the inhalation of radioactive particulates associated with transuranics.

The use of protective clothing, respiratory devices with appropriate cartridges and the establishment of proper area controls will be used to reduce the possibility of personnel contamination.

Personnel Protective Equipment will be established by the SSHO. GTS Duratek staff will have work clothes, steel-toed shoes, safety glasses, hard hats, and protective gloves.

Used disposable gloves are not to be washed or decontaminated for re-use and are to be replaced as soon as practical when they become heavily soiled, or as soon as feasible if they are torn, punctured, or when their ability to function as a barrier is compromised. The SSHO will be informed immediately if bare skin has come in contact with hazardous material.

8.0 RADIATION SAFETY

It is GTS Duratek's intent to perform all activities involving radioactive materials in accordance with the US Army radioactive materials license number SUB-348, Amendment No. 21. This license describes the policies and responsibilities of the DOA Radiation Protection Program and the general radiation protection procedures for the operation, handling, and use of radioactive materials. A copy of the US Army radioactive materials license number SUB-348, Amendment No. 21 will be maintained by GTS Duratek at the project site for reference and guidance.

A list of procedures for this project is provided in the GTS Duratek Picatinny Arsenal Procedure Manual. GTS Duratek personnel will work under the Picatinny Arsenal monitoring and dosimetry program. Dosimetry will be worn as required by this program.

8.1 Radiation Monitoring

All GTS Duratek employees, contractors and visitors are included within the scope of the US Army radioactive materials license number SUB-348. Although not all elements of the radiation protection program may apply, the degree or level of implementation of these requirements and policies will be based upon the scope of work commensurate with the hazards present at the work site.

8.2 Respiratory Protection

Respiratory Protection should not be required for the majority of work to be performed on this project. Should the need arise for respiratory protection for radiological concerns, as determined by the Project Manager, a 30 day advance notification will be given to the NRC prior to its use.

9.0 EMERGENCY CONTACTS AND PHONE NUMBERS

All occupational related accidents, incidents and/or near misses will be immediately reported to the project SSHO, designee or alternate and no later than 24 hours after occurrence.

GTS Duratek project management shall have the employee complete the front portion of the GTS Duratek Accident or Occupational Illness Report (Attachment 2). Management shall complete the back of the report and return it to the Worker's Compensation Administrator in the GTS Corporate Headquarters and the Field Service Health and Safety Offices.

The route to the nearest medical facility for emergency care should be familiar to all site personnel. Attachment 4 provides a map and directions to the nearest medical facility.

The following list provides the names and telephone numbers for emergency contact personnel. In the event of a medical emergency personnel will take direction from the SSHO and notify the appropriate emergency organization.

Picatinny Arsenal Site Notifications	Off-site	On-site/Base
IOC POC: Mike Styvaert	(309) 782-0880	8-793-0880
Medical Emergency	(973) 724-6666	4-6666
Police (Base)	(973) 724-6666	4-6666
Fire	(973) 724-6666	4-6666
Radiation Protection Office	(973) 724-3742/3126	4-3742/3126
Environmental Affairs Office (contacts NJDEP)	(973) 724-5818	4-5818
Off-Site Notifications		
Hospital, St Claires Dover Emergency Dept.	(973) 989-3200	9 (973) 989-3200
Poison Control Center (New Jersey)	(800) 764-7661	9 (800) 764-7661
Region I Nuclear Regulatory Agency	(800) 432-1156	9 (800) 432-1156
NJ Department of Environmental Protection	(973) 724-5848	9 (973) 724-5848
GTS Duratek - Site Decontamination Team		
Off-site Project Mgr.: Robert Hornbeck	(865) 376-8269 pager (888) 522-1240	7 (865) 376-8269 pager 7 (888) 522-1240
On-site Project Mgr/SSHO : Paul Jones	(865) 376-8276 pager (888) 546-0460	7 (865) 376-8276 pager 7 (888) 546-0460
John McGehee (Alternate)	(865) 376-8219 pager (888) 564-3975	7 (865) 376-8219 pager 7 (888) 564-3975
GTS Duratek Corporate Health & Safety Coordinator: Jimm Snoddy	(865) 376-8262 pager (888) 509-1857	7 (865) 376-8262 pager 7 (888) 509-1857

In addition to an emergency situation, GTS Duratek will immediately (within 15 minutes) notify Picatinny Arsenal when any regulatory agency (e.g., NRC, EPA, OSHA, State of New Jersey) personnel call or visit the site.

10.0 REFERENCES

10.1 Project Management Plan for the Decontamination and Survey of Buildings 611B & 318 at Picatinny Arsenal, Rev 0, October 1999, GTS Duratek.

10.2 Project Health and Safety Plan for Picatinny Arsenal - ARDEC, Gutierrez-Palmenberg, Inc., October 1998.

11.0 ATTACHMENTS

GTS Duratek has established a system to control the issue, use, and revision of documents. Documents are controlled to ensure that the last revisions are distributed to and used by persons performing the activity or are available at appropriate work locations. The identification, review, and approval of controlled documents is the responsibility of the Manager of each specific organization.

Attachment 1 Acknowledgment Sign-off Sheet
Attachment 2 GTS Duratek Accident Reporting Form
Attachment 3 Picatinny Arsenal Building 611B Work Area Map
Attachment 4 Directions to Nearest Medical Facility

ATTACHMENT 1

BRIEFING ACKNOWLEDGMENT FORM

ATTACHMENT 1

BRIEFING ACKNOWLEDGMENT FORM

Name Print	Social Security #	Signature	Date

ATTACHMENT 2

GTS Duratek Accident or Occupational Illness Report Form

ACCIDENT OR OCCUPATIONAL ILLNESS REPORT

Forward original to GTS Duratek, 10100 Old Columbia Rd., Columbia, MD 21046
Attn.: Margaret Bergman

To be in compliance with the Workers' Compensation Act, all accidents/illnesses should be reported within 24 hours of occurrence. Please print clearly using blue or black ink.

EMPLOYEE INFORMATION

Employee__________________ Site________________ Position______________

SSN ___-___-_____ Date of Birth __/__/__ [] Male [] Female No. Of Dependents______

Accident: Date __/__/__ Time ______ [] AM [] PM Location__________ GTSD Property? [] Yes [] No

ACCIDENT INFORMATION (to be completed by employee if possible, or by site supervisor)

1. Describe fully how accident/illness occurred, and what you were doing.

____

____

2. What is the nature and location of injury? (sprain/contusion, right/left, part of body, etc.)

____

____

3. Any witnesses? [] Yes [] No If yes, give name, address, and daytime phone.

____

4. Was first aid given? [] Yes [] No If yes, give name and title of provider and describe care.

____

5. Name and address of attending physician and/or hospital:

____

____

The information provided above is true and correct to the best of my knowledge.

Employee Signature________________________ Date________________

Information on this page to be completed by GTS Duratek Site Supervisor only. Please print.

ADDITIONAL ACCIDENT INFORMATION

Site Supervisor________________________________ Phone Number______________________________

1. When were you first made aware of the accident/illness and by whom?

____

2. Was the accident/illness caused by employee's failure to observe safety regulations? [] Yes [] No
If yes, please explain:

____

3. Has injured returned to work? [] Yes [] No

If yes, date and hour?__________________ Wage/Position Change? [] Yes [] No ______________________

Full or Light Duty?__________________ Projected length of light duty?______________________

If no, probable length of disability?____

INVESTIGATIVE INFORMATION

1. Does the employee's account accurately describe the event? [] Yes [] No If no, please clarify:

____

____

2. Why did the accident happen? (Investigate facts regarding job and situation.)

____

____

3. What should be done to prevent recurrence of this type of accident? Are changes needed with respect to the equipment, material, or people used to perform the job?

____

____

4. What have you done to ensure there is no recurrence of this accident? If your authority limits your making changes, what changes have you recommended?

____

____

5. How will the changes initiated/recommended in 4. improve operations?

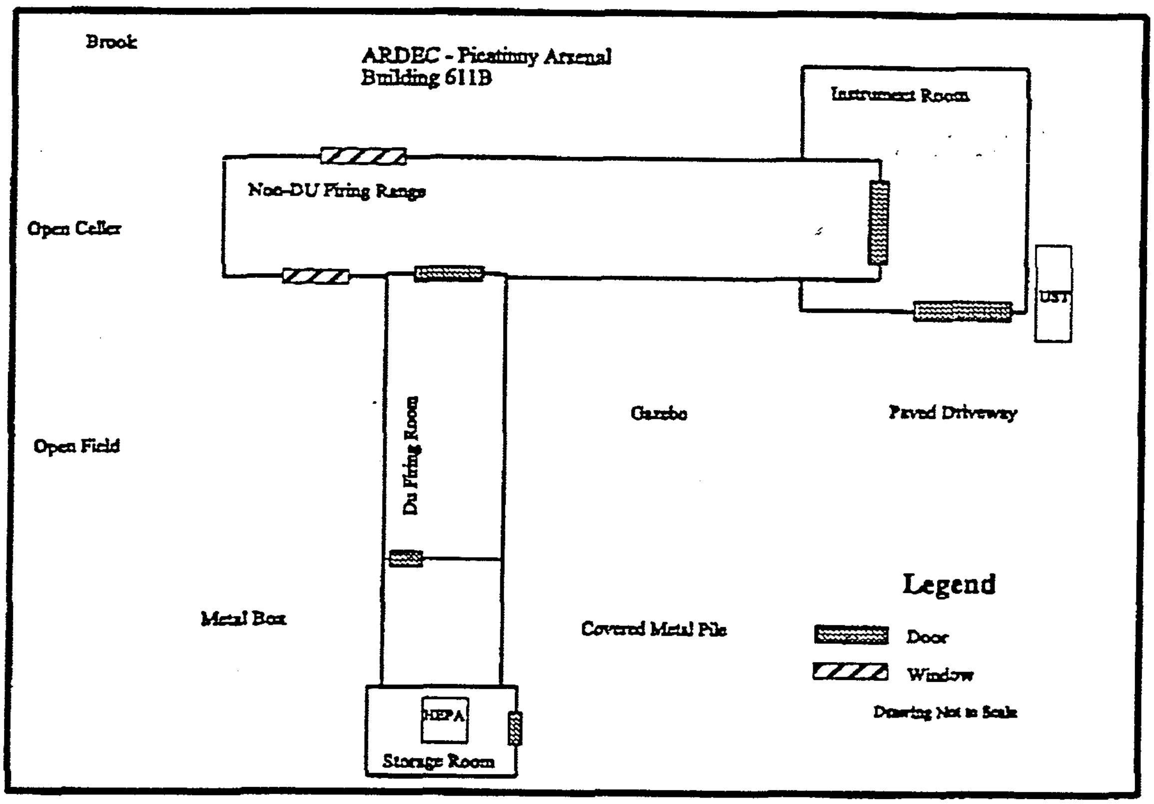
____

____

Site Supervisor Signature________________________________ Date______________________________

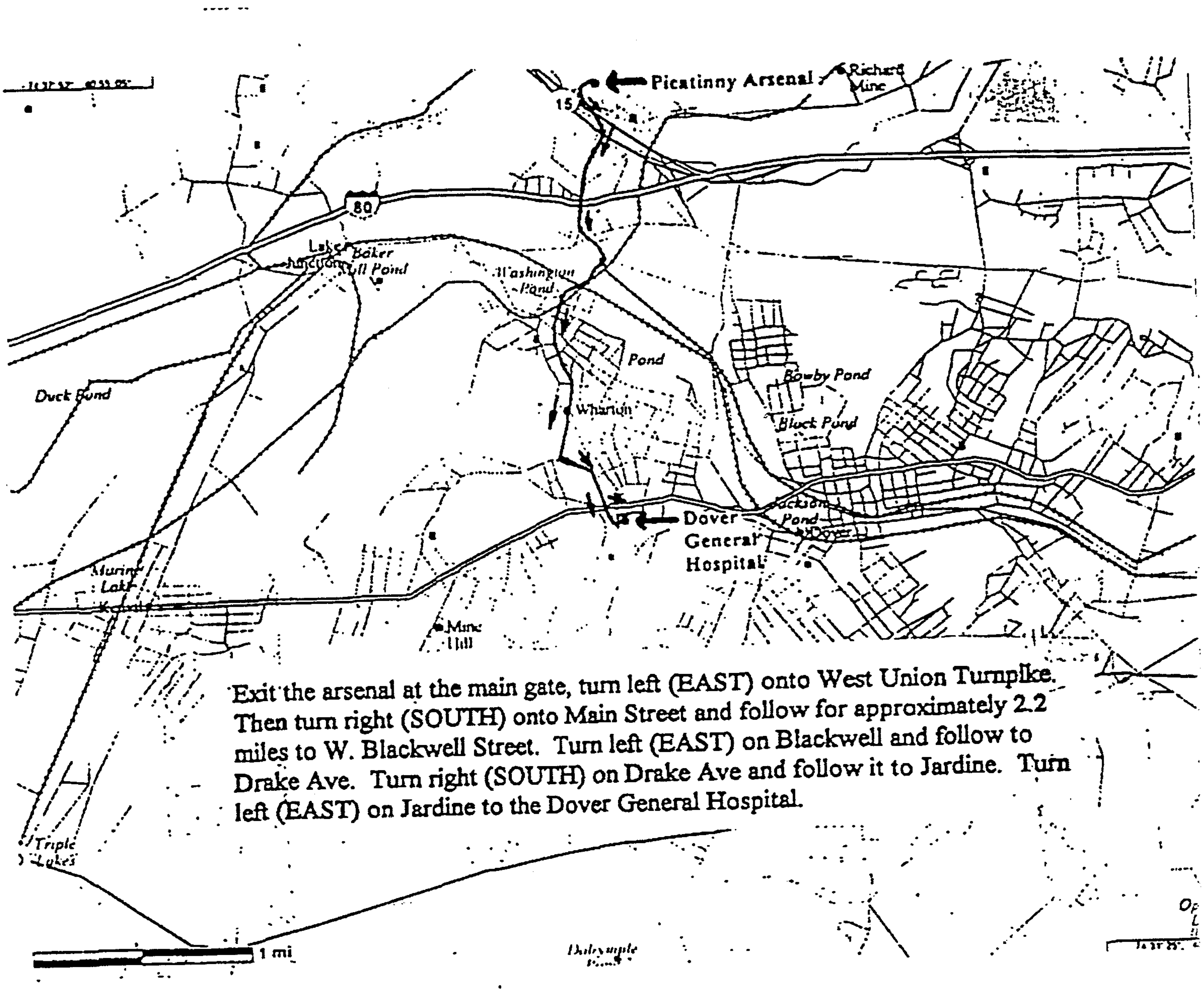
ATTACHMENT 3

Picatinny Arsenal Building 611B Work Area Map



ATTACHMENT 4

Directions to Nearest Medical Facility



Exit the arsenal at the main gate, turn left (EAST) onto West Union Turnpike. Then turn right (SOUTH) onto Main Street and follow for approximately 2.2 miles to W. Blackwell Street. Turn left (EAST) on Blackwell and follow to Drake Ave. Turn right (SOUTH) on Drake Ave and follow it to Jardine. Turn left (EAST) on Jardine to the Dover General Hospital.

NOTE: Medical Facility Phone Number (973) 989-3000

Attachment B

GTS DURATEK

REMEDIATION WORK PLAN

for the

TACOM - ARDEC
Building 611 B
Picatinny Arsenal, NJ

REVISION 0
November 1999

Prepared by: John McGehee for Paul Jones 11/19/99
Paul Jones — Date
Radiological Engineer

Reviewed by: Robert Hornbeck 11/19/99
Robert Hornbeck — Date
Operations Manager

Reviewed by: 11/19/99
Robin Shult — Date
Byproducts Manager

Approved by: ______________________ ____________
Mike Styvaert — Date
Army Project Manager

Prepared By:

GTS Duratek
Radiological Engineering & Field Services
628 Gallaher Road
Kingston, Tennessee 37763

127545

TABLE OF CONTENTS

1.0 BACKGROUND

Picatinny Arsenal is located near Dover, New Jersey, The arsenal designs, constructs and tests weapon systems for the United States Army. A characterization of Building 611B and associated facilities for radioactive materials, was completed in by Gutierrez-Palmenberg, Inc. (GPI) during April through June of 1997. GTS Duratek has been awarded the contract for decommissioning of Building 611B. The decommissioning is planned to begin in December, 1999.

Building 611B was originally constructed in 1929 for use as a test tunnel for firing artillery rounds. The only radioactive components of concern at the site are made of depleted uranium (DU). In its original configuration, the north-south tunnel (non-DU firing range) was 373', 9" long. The DU tunnel, which is perpendicular to the original tunnel, is approximately 40' long and was built around 1959. On-site personnel have indicated that only the east-west tunnel was used for DU munitions testing.

DU is used in munitions by the United States armed forces for momentum enhancement of projectiles. DU use at the Building 611B site has been limited to firing within the confines of the firing range and target room of the building. The target room was ventilated during firing by a High Efficiency Particulate Air Filter (HEPA) ventilation system. This system discharged after four stages of filtration to a dedicated area above the storage room located at the end of the firing range/target room.

There has been migration of DU from the active use areas to adjacent soils and facilities. DU migration was identified in the initial characterization report which specifically identified the location of activity in soil around access points and rain washout points at the facility.

Building 611B is located within and is a contributing structure to the recently designated Test Site Historic District at TACOM - ARDEC. As a structure which is eligible for inclusion on the National Register of Historic Places, Section 106 of the National Historic Preservation Act requires consultation with the New Jersey State Historic Office prior to any significant structural (interior/exterior) work being performed. A letter will be submitted with the remediation plan for Building 611B to the NJSHPO for their review and comments. The state will have 30 days to provide comments to TACOM - ARDEC concerning the planned remediation work.

1.1 Reason for Remediation

The Building 611B site was used for testing of munitions containing DU. Uranium-238 and its short-lived daughters are the only radionuclides of concern in DU. The site has not been used for DU munitions testing since approximately 1985. The facility will no longer be used for DU testing. Remediation of the radioactive contamination at the site is needed to prevent further spread of radioactive material and to ensure timely decommissioning of the facility. 1 2 7 5 4 5

1.2 Management Approach

In areas where surface contamination is found above the limits specified in the Building 611B, Final Survey Plan for the TACOM - ARDEC Picatinny Arsenal Building 611B, controls will be established in accordance with the Picatinny Arsenal Health Physics Program and GTS Duratek procedures as required for protection of workers, the general public, and the environment. These methods and processes for control of work will meet the requirements of Federal regulations and US Army SUB-348, Amendment No. 21, NRC license conditions and procedures.

Areas of elevated activity will be compared to the guideline, remediated and re-surveyed.

GTS Duratek anticipates all areas to be remediated below the guideline value without the need for further analyses.

All contaminated material will either be decontaminated for reuse or disposed as clean material, or packaged and prepared for proper disposal as radioactive waste in accordance with 49 CFR, Industrial Operations Command (IOC) and GTS Duratek procedures. These actions are intended to minimize potential adverse environmental impact.

On-site project work will be completed by GTS Duratek employees with on-site direction provided by the project manager. Records will be maintained on site by the Project Manager.

2.0 SITE DESCRIPTION

Building 611B at the Picatinny Arsenal is located on the side of a large hill which slopes 10% to 20% from a field littered with spent munition shells to a paved road which is below the grade of Building 611B. The road leads to a an open storage structure with Building 611B on the east side.

2.1 Type and Location of facility

Building 611B was constructed with a combination of wood, concrete and metal materials and used for munitions testing including munitions that contain DU. The Building 611B test facility will not remain operational. In June 1999 Building 618B was deemed eligible for inclusion on the National Register of Historic Places.

2.2 Ownership

The TACOM - ARDEC Picatinny Arsenal facility is owned and operated by the United States Army.

2.3 Facility Description

The work area is in an enclosed field with several structures that provided containment for testing and storage of munitions. The main structure is Building 611B that contains the DU munitions testing rooms and the non-DU munitions testing area.

2.4 Buildings

The following are the rooms of building 611B and the surrounding structures requiring survey and remediation.

- Building 611B (Includes Instrumentation room, non-DU firing room, DU firing room, target room, and inside storage area (behind the target room),
- Outside Storage Area (gazebo-like wood structure with floor and roof, no walls),
- Two external storage areas (mobile storage rooms).
- HEPA filter bank (above the storage area).

2.5 Grounds

The area of concern outside of the buildings is a field of approximately 40,000 square feet bounded on one side by a chain link fence. On the other side of the field is a small brook with a maximum width of a few feet and a flow rate of as much as 20 gallons per minute during rainy times.

3.0 OPERATING HISTORY

The facility was designed for testing of munitions and contained only non-radioactive munitions until approximately 1959 when the east-west tunnel was-built for DU munitions testing.

3.1 Licensing and Operations

This facility is licensed by the NRC. Depleted Uranium and its associated short-lived daughters are the only radionuclides of concern. This remediation action will be conducted under the license held by the facility. The license number is SUB-348, currently operating under Amendment 21 with an expiration date of May 31, 2001. The licensee will provide oversight of the remediation project, however, the contractor (GTS Duratek) will normally provide the day-to-day site supervision. GTS Duratek personnel will adhere to the TACOM - ARDEC Health Physics Program and any guidance from TACOM - ARDEC personnel. The day-to-day health physics operations, (i.e. air sampling and surveying) will be performed using the GTS Duratek operating procedures except in cases where the TACOM - ARDEC Health Physics Program procedures are more restrictive. The TACOM - ARDEC Health Physics procedures will be followed in these cases.

3.2 Processes

No new processes will be attempted during the remediation phase of this work. Remediation techniques will consist of washing, abrasion, cutting, scarifying, and other typical methods for removal of radioactive contamination from facility surfaces.

3.3 Waste Disposal Practices

Radioactive waste generation for this remediation will be limited to protective clothing. decontamination materials, dusts from vacuuming, HEPA filters, materials identified during the remediation phase as radioactive, cement dusts and dirt, outside soils known to be contaminated, and old packaging for materials. The contaminant has been found to be present in all rooms within Building 611B and in the HEPA ventilation system, the outside storage area, and in the soil outside the access to the Building 611B foyer and the access to the inside storage area.

Waste generated from Building 611B and grounds will be packaged and removed for future disposal. Radioactive waste will be packaged and transported according to guidance provided by GTS Duratek procedures in accordance with U.S. Department of Transportation Regulations contained in 49 CFR Parts 100 to 185. The radioactive waste will be transported to a facility approved for disposal.

As practicable, protective clothing and equipment waste that are generated during this project will be frisked for release as clean waste to ensure that waste volume is minimized. Contaminated waste will be placed into appropriately designed containers. Waste minimization will be incorporated into the entire decontamination project.

In the event that asbestos containing material (ACM) is contaminated and has to be removed, guidelines provided by OSHA and EPA will be incorporated to address working with and disposal of asbestos containing material.

4.0 REMEDIATION ACTIVITIES

This remediation will ensure Building 611B is decontaminated to the limits specified in, *The TACOM - ARDEC Building 611B Final Survey Plan,* for release for unrestricted use of the building and its general area.

The primary concerns about the remediation from a project management standpoint are dose minimization, industrial safety and prevention of further environmental contamination. The following information is provided to establish GTS Duratek management guidelines for the final remediation of the site.

4.1 Objectives

The objectives of this scope of work are to remediate all radioactive materials from the site and ensure proper disposition of any radioactive and or contaminated materials removed or generated, while maintaining radiation dose to workers and members of the public **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA).

Soil samples and exposure rate measurements will be taken to determine compliance with the limiting value of depleted uranium in soil and external radiation above background as provided in the Final Survey Plan for TACOM - ARDEC Building 611B.

In order to meet the preceding objectives, the remediation will include a series of samples, smears, direct activity and exposure rate measurements as described in the Final Survey Plan for the TACOM - ARDEC Building 611B.

4.2 Results of Previous Surveys

Process knowledge has indicated that the only likely radionuclide is Depleted Uranium and its associated short-lived daughters. A TACOM - ARDEC radioactive material survey dated in 1996, provided the location of the maximum loose surface activity as the vent opening inside the DU target room.

The total loose surface activity at the site is conservatively estimated to be less than one (1) millicurie. Surface activity was found to be less than anticipated, but more wide spread than originally projected by the characterization work plan. The location of the maximum loose surface activity is the DU Tunnel floor at the DU target room entrance. That loose surface activity concentration was approximately 154,000 dpm/100 cm^2.

4.3 Remediation Procedures

The characterization survey provided information regarding the degree of radioactive contamination of the facility and the approximate amount of material to be removed from the site during this remediation phase. This information has been used to assist in the development of the project plans and procedures for facility remediation.

Controls for ACM may require additional precautions as specified in the project Health and Safety Plan. Work plan amendment(s) may be required and will be performed as necessary prior to working on ACM.

4.3.1 Preparation

In preparation for remediation of the facility, a complete survey for the existence of unexploded ordinance (UXO) was performed during the characterization phase of this project. This survey was conducted by qualified, experienced individuals. All areas where work will be completed for the remediation that have a potential for the presence of UXO shall be cleared prior to allowing GTS Duratek remediation personnel access to these areas, The only areas during the remediation phase where UXO becomes a concern is in outside areas where soil must be removed from the facility.

The following section describes the procedure and precautions for evaluation of the grounds at TACOM - ARDEC - Picatinny Arsenal Building 611 B for the presence of unexploded ordnance. Unexploded ordnance is an item of ordnance that has failed to function as designed or has been abandoned or discarded, and is still capable of functioning and causing injury to personnel or damage to structures.

DANGER

No GTS Duratek personnel or visitors will be allowed to walk in, sample in, or excavate soil from areas that are outside of the work area boundaries. All work areas outside the facility where soil excavation work will be conducted must be checked for the presence of UXO prior to working in those areas.

4.3.2 UXO Procedures

4.3.2.1 The work area boundaries will be clearly identified and marked in consultation with the Safety and Occupational Health Specialist with caution tape or other appropriate boundry. This will ensure that all personnel are aware of the site limits.

4.3.2.2 All work areas will be thoroughly screened for the presence of UXO prior to any sampling or soil excavation work.

4.3.2.3 After each area where work will be conducted is determined, Explosive Ordnance Disposal (EOD) personnel will conduct a thorough search. If necessary, the EOD personnel will utilize Schonstedt Magnetic Locators, Model GA-52Cx, or equivalent, to assist in checking areas of limited visibility.

4.3.2.4 All suspect UXO located during the search phase will be identified with pin flags. After all areas are searched, the EOD personnel will return to the suspect UXO items located and attempt to identify them and record their locations.

4.3.2.5 All UXO items identified that are determined to be of an immediate danger will be reported to Security at TACOM - ARDEC - phone number 4-6666 as soon as possible for UXO removal by on-post EOD (Explosive Ordinance Detachment.

4.3.2.6 All intrusive sampling points will be checked for geophysical anomalies with the Schonstedt Magnetic Locator Model GA-52Cx, or equivalent, prior to any samples being taken.

4.3.3 Pre-job Surveys

4.3.3.1 A survey will be performed to identify and validate the observations of the previous surveys. During the survey, areas identified as above background response will be noted on survey forms.

4.3.3.2 An ambient air sample will be taken daily or as indicated by the project manager to identify the typical component of airborne activity present at the work site. This will be used to ensure that work is controlled to account for the natural component and not unnecessarily stopped for sample results due to the presence of natural activity. The RSO or a GTS Site Health and Safety Officer will determine the location of the ambient air sample; it shall be taken approximately 30 feet or more from the known location of activity in Building 611B.

4.3.3.3 Potentially contaminated areas will be posted, as appropriate, to prevent inadvertent access to the area during remediation operations.

4.3.3.4 All unnecessary materials will be surveyed and removed from the facility. All radioactive materials will be packaged to control contamination prior to removal. Packaged radioactive material will be placed in a controlled storage area located away from work activities.

4.3.3.5 All chips of concrete and dusts will be vacuumed with a High Efficiency Particulate (HEPA) Filter vacuum cleaner, The radioactive waste collected and the filter from that system will be packaged as radioactive waste and stored in a controlled area located away from work activities.

4.3.3.6 Survey results from all areas will be recorded as soon as the readings are taken. A summary of the results obtained will be entered into the project manager's log. Survey results shall be used to determine the degree of contamination of material surfaces.

4.3.4 Remediation

This section provides a detailed procedure for each of the rooms, buildings, and systems to be decontaminated, removed, or disposed of during the remedial action at TACOM - ARDEC Building 611B.

In general, remediation work shall be conducted (as is practical) as the normal decontamination of any surface. For example, decontamination shall be conducted from the area of lowest contamination to areas of highest contamination. Areas of lowest contamination shall be decontaminated first and re-contamination of these

areas shall be prevented after cleaning is completed. If needed, porous surfaces should be covered with a non-porous covering to prevent re-contamination of activity into the material surface.

All or part of the existing electrical systems shall be removed from the facility prior to remediation. This serves multiple purposes, it allows for isolation of electrical systems for easy removal, prevents the possibility of electrical shock to remediation workers, and allows for easy removal of electrical systems once supply systems are disconnected. Electrical safety precautions shall be taken at all times during the project. Electrical lockout/tagout procedures shall be followed until all power supply boxes are verified to be de-energized.

The existing water supply to the facility may be terminated and/or verified to be isolated at the main supply station to prevent the inadvertent introduction of liquid.

4.3.4.1 Instrument Room

The instrument room has minor contamination associated with splashing of water or soap from hand washing after working with DU projectiles. The small spots of contamination should be easily removed by washing the wall but if necessary, the contamination will be removed by removing the contaminated paint from the walls. All tiles on the floor will be removed to allow collection of the contaminated dusts that settled into the cracks between tiles over the years.

Contamination removal from the sink area

a. Prepare a drop cloth under the work area to be washed/ decontaminated.
b. Wash the contaminated wall surface with a mild detergent mixture.
c. Dry the surface. Collect all materials used for the decontamination.
d. Monitor the surface to ensure that all detectable activity has been removed.
e. If the wall surface has not been decontaminated, use a mild abrasive such, as steel wool or a pot scrubber for removal of any residue.
f. Do not grind, burn, or seriously abrade the surface without project manager approval. If this is necessary, a method to contain dusts shall be designed to ensure that contamination is not spread from the work area.
g. When all contaminated material has been removed from the sink surfaces, package all contaminated materials (cleaning supplies used, drop cloth, rags, etc.) for disposal.

Removal of the drain system to the Waste-Water Holding Tank

a. Prepare for removal of the drain system by evaluating the outside wall of the facility at the location of the drain pipes. The series of bricks on the outside of the building can be used as an indicator to help locate the drain.
b. Do not open or remove covers from the drain system at this time. The pipe should be kept intact for contamination control until an opening in the floor and wall is made to facilitate easy pipe removal.
c. Remove the outside bricks to allow access to the piping system. Attempt to keep as much of the wall intact as possible. Do not remove any structural members from the wall.
d. Observe the piping configuration to determine how much of the floor and wall to remove in order to work on the pipe.
e. When a clear path is established for removal of the piping system, setup contamination controls (a drop cloth) to contain any contamination which may be released when the pipe is breached.
f. Cut the pipe with a slow reciprocating blade at as many places as needed to facilitate removal.
g. Use controls at each break point to prevent the spread of contamination.
h. Block any remaining open pipes by taping a plastic bag to the end of the open pipe. This will isolate any activity present in the pipe.
i. Package all piping and contaminated radioactive materials used for disposal as radioactive waste.
j. Survey the inside area of the instrument room and all surfaces in the areas which may have been affected by leakage from the drain system.
k. Collect and dispose of all radioactive pieces.

Contamination removal from the floor

a. Remove loose tiles and pry up more tightly bound with a crow bar, pick, screwdriver, or similar tool to minimize breakage of the tiles.
b. Collect all tiles into separate plastic bags (one for contaminated tiles and one for non-radioactive tiles) or similar containment to prevent spread of contamination. A cardboard lining in the bag will prevent breakage of the bag. Do not overload the bags. Double bag material as necessary.
c. When all of the tiles have been removed and separated, package the contaminated portion as radioactive materials and vacuum the dusts from the floor with the HEPA vacuum cleaner. Monitor the area to ensure all radioactive dusts have been collected.

d. After collection of the dusts, remove the tile mastic minimizing the amount of mastic collected as radioactive. Separate the radioactive and non-radioactive mastic in different containers.

4.3.4.2 Foyer Entrance

The contamination in the foyer entrance is associated with foot traffic from the contaminated area and, although it is detectable only on the floor, it also exists in very small quantities on surfaces where contaminated hands rubbed the doorjamb and door surfaces. The small areas of contamination on these surfaces should be easily removed by washing. All tiles on the floor will be removed to allow collection of the contaminated dusts that settled in cracks between tiles.

<u>Contamination removal from doorjamb and door surfaces</u>

a. Prepare a drop cloth under the work area to be decontaminated.
b. Wash the contaminated wall surface with a mild detergent mixture.
c. Dry the surface. Collect all materials used for the decontamination.
d. Monitor the surface to ensure that all detectable activity has been removed.
e. If the wall surface has not been decontaminated, use a mild abrasive such as steel wool or a pot scrubber for removal of any residue.
f. Do not grind, burn, or seriously abrade the surface without project manager approval. If this is necessary, a method to contain dusts shall be provided to ensure that contamination is not spread from the work area.
g. When all material has been removed from the door and doorjamb surfaces, package all contaminated materials (cleaning supplies used, drop cloth, rags, etc.) for disposal.

<u>Contamination removal from floor</u>

a. Remove loose tiles and pry up more tightly bound tiles with a crowbar, pick, screwdriver, or similar tool to minimize breakage of the tiles.
b. Collect all tiles into separate plastic bags (one for contaminated tiles and one for non-radioactive tiles) or similar containment to prevent spread of contamination. A cardboard lining in the bag will prevent breakage of the bag. Do not overload the bags. Double bag material as necessary.
c. When all of the tiles have been removed and separated, package the contaminated portion as radioactive materials and vacuum the dusts from the floor with the HEPA vacuum cleaner. Monitor the area to ensure all radioactive dusts have been collected.

d. After collection of the dusts, remove the tile mastic minimizing the amount of mastic collected as radioactive. Separate the radioactive and non-radioactive mastic in different containers.

4.3.4.3 Outside storage area (gazebo)

The outside storage area is a wood frame structure that has been contaminated by transfer of materials from the target and storage rooms of the facility. During the characterization, the wood surfaces of the floor of this area were covered with paint to prevent migration of the activity before remediation.

a. Beginning in the northwest corner of the area, pry up the plywood one piece at a time and cut and/or package the material as survey results require.
b. Vacuum the exposed wood surfaces, as practicable, before, during and after cutting to prevent radioactive dusts and debris from contaminating soil.
c. Remove any vegetation (leaves, grasses, surveying as they are removed.
d. Survey the materials found under the removed wood surface. If any materials are found to be contaminated, remove and package them to control the activity.
e. After each piece of plywood is removed, replace it with a non-radioactive piece cut to size. This must be done to maintain the integrity of the structure.

4.3.4.4 Inside Storage Area

This area is located behind the target room of Building 611B and served as a storage area for items which were used in the firing room and target rooms and for both radioactive and non-radioactive munitions. This room is contaminated in several areas of the walls and floor. It also appears that some activity from the HEPA ventilation system on the roof of this structure has seeped through the roof. This is a postulation based on the presence of loose surface activity on the ceiling of the room.

The floor surfaces of this room are bare concrete, the walls are steel plate and the ceiling is the bottom of the wooden platform supporting the HEPA ventilation system. The back wall of the structure is heavy steel plate designed to be a backstop for very high energy rounds that may have penetrated the back wall of the target room.

Contamination removal from ceiling surfaces

Note: This section should not be completed until the HEPA ventilation system has been removed from the roof of the inside storage area.

a. Re-survey to identify the areas of the ceiling which are above contamination limits. Be sure to survey both the ceiling and the top of the roof once the ventilation system is removed. Based on the observation of leaching of contamination through the wooden surfaces of the roof from the ventilation system, it is likely that levels on top of the roof will be higher than those observed inside the room.
b. If activity is detected on both sides of the wood surface, the most reasonable method for removal of the activity would be removal of the wood.
c. Define the extent of the contamination on the roof and remove any roofing materials that have been contaminated.
d. Identify areas of the roof that are not contaminated and prepare to make cuts to remove the contaminated portion of the roof by cutting on the non-contaminated portion of the wood.
e. Cut the contaminated wood out of the roof without cutting through the roof support structure. To do this, set the saw to cut only the thickness of the wood structure.
f. Remove all contaminated wood from the roof and package as radioactive material for disposal.
g. Cover or replace roofing material as needed to prevent water from seeping through the roof.

Contamination removal from back wall surfaces

a. Remove all items from the room. Some of these materials will have to be cut for packaging. All items should be cut on the non-radioactive portions, if possible, so as to minimize the spread of radioactive contamination. If this is not possible, they should be brought into the contaminated portions of the facility and cut under ventilated conditions.
b. Re-survey the walls of the facility and mark the contaminated areas for decontamination.
c. Place a drop cloth for collection of metal grindings under the area to be decontaminated.
d. Establish ventilation in the area where DU will be removed from the metal wall surface.
e. Establish a fire watch to ensure that none of the sparks from grinding cause fire outside the room.

f. The person grinding to remove activity will wear personal protective equipment as defined in the Site Health and Safety Plan and/or radiation work permit.
g. Grind surfaces to remove activity concentrations to ensure compliance with the remediation guidelines.
h. When all wall surfaces have been decontaminated, package and properly dispose all radioactive or contaminated materials which are no longer useful for decontamination work.

Contamination removal from floor surfaces

a. Clean all non-radioactive debris from the floor and collect radioactive materials (leaves, dirt, etc.) for disposal as radioactive material.
b. Re-survey the floor to identify the contaminated areas.
c. Cover non-contaminated areas to prevent the spread of contamination.
d. Prepare the surface to be decontaminated by painting it with an easily identified color of acrylic-based paint (i.e., fluorescent yellow or orange). Allow the paint to dry on all contaminated areas of the floor.
e. Since it is likely that there was not significant penetration of DU particles into the concrete, a mild surface abrasion should be adequate to dislodge and allow for collection of the particles from the surface.
f. Scarify the area as needed using HEPA filtered vacuum shrouded equipment. Since background count rates are low, monitor frequently to determine when all activity has been removed from the floor surface.
g. When activity is removed from an area, cover that area with plastic to prevent re-contamination.
h. When all wall surfaces have been decontaminated, package and properly dispose of all radioactive or contaminated materials that are no longer useful for decontamination work.

4.3.4.5 HEPA Ventilation System

The HEPA ventilation system used during operations is a three stage filter unit with a collection plenum, fan and motor sections. Contamination levels in the unit are higher than any other levels on-site. Therefore, the unit should be kept intact during all movement and disposal operations. A Dutch Tarp Roof may be placed over the system toward the beginning of December, 1999 to prevent further deterioration of the HEPA ventilation Bank and potential spread of contamination.

a. Isolate the ventilation system by disconnecting all electrical

connections to the motor assembly. This will prevent any unexpected operation of the system during disassembly.

b. Verify removal of electricity from the system by measurement, and remove the motor from the system.

c. Disconnect and remove the motor structure from the fan assembly, making sure that the final filter continues to isolate the fan from the contaminated area of the system.

d. Disconnect and remove the fan assembly on the system and isolate the filter structure by taping plastic wrap to the open end of the filter to contain the contaminated system.

e. Cut and isolate the plenum from the in take duct by making a contained cut on the intake duct. This will be done inside a bag with a disposable saw. Package both open ends of the intake duct to contain all activity in the pipe.

f. Unbolt the ventilation system structure from the roof by removal of the external bolts that connect it to the steel mounting plate.

g. Ensure all contamination is contained within the assembly by taking a smear survey of the system. If all activity is not contained, wrap additional areas as needed.

h. Prepare a lay down area with pallets and plastic drop cloth for placement of the ventilation system when removed from the roof.

i. Rig the system for removal from the roof and lift it with a crane to the prepared lay down area. The crane position will be reviewed by the TACOM - ARDEC Safety and Occupational Health Specialist.

j. Completely wrap the system and place it into a B-25 box or similar disposal container.

k. Survey and remove the steel support plate on the roof. Wrap and dispose of it as radioactive material.

l. Remove any contaminated roofing material and package for disposal. Cover the remaining portions of the roof and continue with decontamination by using the procedure outlined for the ceiling of the Inside Storage Area.

4.3.4.6 Non-DU Firing Tunnel

The Non-DU tunnel has collected dusts as a result of firing into the target room. The explosions in the target room occurred when DU projectiles were fired into metal targets and were sufficiently powerful to project DU particles and dusts over all interior areas of the building. The dusts in the nonlinear tunnel primarily appear on horizontal surfaces although some vertical walls have also collected dusts from the firing. Many of the contaminated items are associated with the electrical and lighting systems in the non-DU firing range. Asbestos containing materials (ACM) will require controls as specified in the project Health and Safety Plan.

<u>Removal of electrical systems</u>

a. Disconnect electrical systems to the non-DU firing range and verify disconnection by lockout/tagout methods.
b. Remove all of the components of the electrical system and dispose of all components with measurable contamination as radioactive materials.

Contamination removal from vertical wall surfaces

a. Painted wall surfaces will require washing or scabbling to remove the activity from the walls.
b. The first attempt at decontamination will be to wash a small area of the wall with a mild detergent to determine if this simple technique is effective for removal of radioactive materials.
c. Set up a drop cloth area and scrub the contaminated wall surface using a stiff, non-metallic brush and a soapy detergent solution.
d. Monitor the surface of the wall to determine the activity present prior to decontamination using a wash solution.
e. Scrub an area of painted wall 10' by 8' on the target end side of the non-DU range to determine the effectiveness of removal by washing.
f. Monitor the surface after drying to determine the decrease in activity of the area.
g. If there is significant reduction in the surface activity after one wash then the project manager will determine if it is likely that further washing will reduce the activity level below surface contamination limits for remediation.
h. If it is decided to wash further, then continue with steps e. through g. to achieve remediation of the area.

If it is determined that further decontamination by washing will not be effective to remove contamination below the remediation limit, then prepare to remove the contamination by surface abrasion.

Contamination removal from horizontal wall surfaces (ledges and sills)

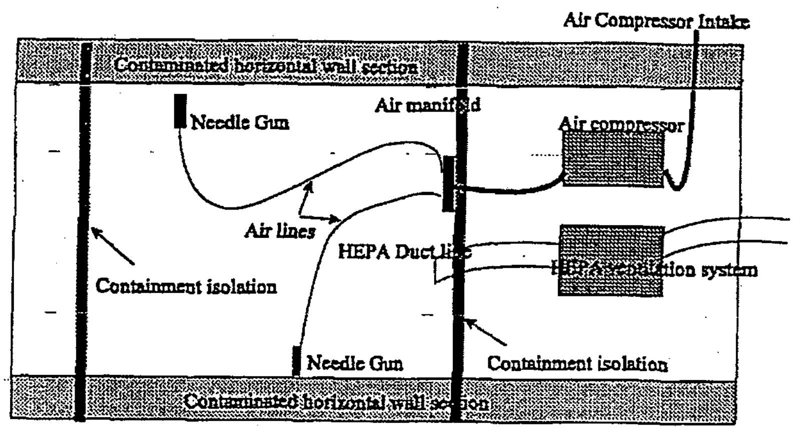
a. The horizontal wall surfaces (ledges and sills) are rough concrete surfaces that have been painted in some cases. However, the surfaces cannot be decontaminated by washing and will require physical abrasion of the surface.
b. Ensure no other decontamination activities will be done in the same area.
c. Establish a controlled area by posting the area of the room where scabbling will be done.

d. Prepare the area for abrasive removal of radioactive materials by establishing containment of the area with ventilation and service

access for the air powered needle guns. Ensure isolation of all areas from outside of the facility by placing tape as needed so as to seal holes to the outside. Construct the containment with specific attention to the location of equipment and isolation of the decontamination area from the open firing range (see Figure 1).

Figure 1
Abrasive Containment
(Example)

Typical arrangement of a work area to contain material during abrasive removal techniques. All surfaces to be protected including tools and equipment are isolated from the work area where concrete dusts and radioactive materials will be airborne.



e. Cover all cracks in the structure and seams in the concrete to prevent dusts from settling into areas where it may be hard to remove them.

f. Place an inlet filter on the structure or integral to the structure to ensure that sufficient air will enter the containment to prevent it from collapsing.

g. Turn on the ventilation system and test the inflow with smoke to the containment from any available opening. If the containment fails to isolate the area, repair the areas of the containment that are preventing isolation and repeat the smoke test.

h. Inspect the structure and support with the radiation protection supervisor to ensure that it has adequate air flow and isolation from other areas of the facility.

i. Turn on the air compressor for the needle guns and ensure that the air entering the chamber does not change the negative atmosphere of the HEPA ventilated containment. If it does, repeat step (g) to ensure adequate isolation of the containment before allowing work inside.

j. Use the needle guns to etch the activity from the surface for

collection by the vacuum system. Use adequate personal protective equipment for particles and noise that are generated during use of the needle guns.

k. Before dismantling this containment, use it to perform any other work that requires isolation.

l. Upon completion of all scabbling with the needle gun or other isolation work, vacuum out the containment structure. Dismantle and dispose of the containment material as radioactive waste.

<u>Contamination removal from non-DU tunnel floor</u>

a. Ensure no other decontamination activities will be done in the same area.
b. Clean all non-radioactive debris from the floor and collect radioactive materials (leaves, dirt, etc.) for disposal as radioactive material.
c. Re-survey the floor to identify the contaminated areas.
d. Cover non-contaminated areas to prevent spread of activity from the decontamination of DU contaminated areas.
e. Remove loose tiles and pry up more tightly bound tiles with a crow bar, pick, screwdriver, or similar tool to minimize breakage of the tiles.
f. Collect all tiles into separate plastic bags (one for contaminated tiles and one for non-radioactive tiles) or similar containment to prevent spread of contamination. A cardboard lining in the bag will prevent breakage of the bag. Do not overload the bags. Double bag material as necessary.
g. When all of the tiles have been removed and separated, package the contaminated portion as radioactive materials and vacuum the dusts from the floor with the HEPA vacuum cleaner. Monitor the area to ensure all radioactive dusts have been collected.
h. After collection of the dusts, remove the tile mastic minimizing the amount of mastic collected as radioactive. Contain the radioactive and non-radioactive mastic in different containers.
i. Use the containment constructed for the non-DU tunnel ledge (horizontal wall surfaces) scabbling to ensure proper controls for decontamination at the floor to wall interface on the ramp up to the fired round collection box at the end of the tunnel.
j. Ensure all personnel in the area wear PPE as required by the Health and Safety Plan before starting work in this area.
k. Use a jack hammer or other concrete cutting device to remove concrete from the floor at the wall interface.
l. Make small cuts and survey after each to determine depth for removal.
m. Before dismantling this containment, use it to perform any other work which requires isolation.

n. Upon completion of all jack hammer or other isolation work, vacuum out the containment structure. Dismantle and dispose of the containment material as radioactive waste.

4.3.4.7 DU Firing Tunnel and Target Room

The DU Firing tunnel and DU Target Room have collected radioactive dusts as a result of firing DU projectiles into the target room. The explosions in the target room occurred when DU projectiles were fired into metal targets were sufficiently powerful to project DU particles and dusts over all interior areas of the building. The dusts in the DU tunnel and Target Room primarily appear on floor surfaces, electrical systems, and the gun stand. Many of the items contaminated in this area are associated with the electrical and lighting systems in the DU firing range and the metal wall that separate the DU target room and the DU firing room.

Removal of electrical systems

a. Disconnect all electrical systems to the non-DU firing range and verify disconnection by lockout/tagout methods.
b. Remove all components of the electrical system and dispose of all components with measurable contamination as radioactive materials.

Removal of the separation wall

a. Unbolt all areas of the wall that separates the DU Target Room and the DU Firing Tunnel. This is a steel wall that is provided support by metal braces across the walls and ceiling of the DU Target Room.
b. Package and dispose of all collected metal as radioactive waste as it all contains significant activity.

Removal of the gun stand

Note: The gun stand is 21' long and about 2' high. It is made of steel and is about 18" wide. Many surfaces of this structure are contaminated above limits and may not be practical to decontaminate.

a. If it is decided to decontaminate the gun stand, establish an area similar to that described for scabbling and prepare the area in containment with filtered ventilation.
b. Remove all attachments (like gun vises) from the stand. Package these items and prepare them for disposal or, if decided, decontamination.
c. Identify the most appropriate method of decontamination of this stand by test washing with a detergent. If washing is ineffective, then use

abrasive methods as needed. Control all grindings or shavings as radioactive material.

d. After decontamination of the stand, contact site personnel to see if they have any use for it. Assist them in removal of the stand if necessary. If not, cut the stand into five equal parts (about 4 feet 3 inches each). This will make the pieces easier to move and capable of disposal as non-radioactive waste.

e. If it is decided not to decontaminate the stand/or found to be unfeasible, then cut the stand into five equal parts and prepare each part for disposal as radioactive waste.

<u>Contamination removal from wall surfaces</u>

a. The tunnel wall surfaces will require scabbling to remove the activity from the walls.

b. Ensure no other decontamination activities will be done in the same area.

c. Establish a controlled area by posting the area of the room where scabbling will be done.

d. Cover non-contaminated areas to prevent spread of activity from the decontamination of DU contaminated areas.

e. Prepare the area for abrasive removal of radioactive materials by establishing containment of the area with ventilation and service access for the air powered needle guns. Ensure isolation of all areas from outside of the facility by placing tape as needed so as to seal holes to the outside. Construct the containment with specific attention to the location of equipment and to isolation of the decontamination area from the open firing range.

f. Cover all cracks in the structure and seams in the concrete to prevent dusts from settling into areas where it may be hard to remove them.

g. Place an inlet filter on the structure or integral to the structure to ensure that sufficient air will enter the containment to prevent it from collapsing.

h. Turn on the ventilation system and test the inflow with smoke to the containment from any opening that may be available. If the containment fails to isolate the area, repair the areas of the containment that are preventing isolation and repeat the smoke test.

i. Inspect the structure and support with the radiation protection supervisor to ensure that it has adequate air flow and isolation from other areas of the facility.

j. Turn on the air compressor for the needle guns and ensure that the air entering the chamber does not change the negative atmosphere of the HEPA ventilated containment. If it does, repeat step (g) to ensure adequate isolation of the containment before allowing work inside

k. Use the needle guns to etch the activity from the surface for

collection by the vacuum system. Use adequate PPE for particles and noise that are generated during use of the needle guns.

l. Before dismantling this containment, use it to perform any other work that requires isolation.

m. Upon completion of all scabbling with the needle gun or other isolation work, vacuum out the containment structure. Dismantle and dispose of the containment material as radioactive waste.

<u>Contamination removal from the DU tunnel floor</u>

The floors of the DU tunnel are poured concrete inside of the large concrete pipe that makes up the walls. Dust from firing DU rounds has settled into cracks between the floor and walls. Dust has also migrated into the cracks between tiles on the floor.

a. Ensure no other decontamination activities will be done in the same area.

b. Ensure all personnel in the area wear PPE as required by the Health and Safety Plan before starting work in this area.

c. Establish a controlled area by posting the area of the room where remediation will be done.

d. Clean all non-radioactive debris from the floor and collect radioactive materials (leaves, dirt, etc.) for proper disposal.

e. Re-survey the floor to identify the contaminated areas.

f. Cover non-contaminated areas to prevent spread of activity from the decontamination of DU contaminated areas.

g. Remove loose tiles and pry up more tightly bound tiles with a crow bar, pick, screwdriver, or similar tool to minimize breakage of the tiles.

h. Collect all tiles into separate plastic bags (one for contaminated tiles and one for non-radioactive tiles) or similar containment to prevent spread of contamination. A cardboard lining in the bag will prevent breakage of the bag. Do not overload the bags. Double bag material as necessary.

i. When all of the tiles have been removed and separated, package the contaminated portion as radioactive materials and vacuum the dusts from the floor with the HEPA vacuum cleaner. Monitor the area to ensure all radioactive dusts have been collected.

j. After collection of the dusts, remove the tile mastic minimizing the amount of mastic collected as radioactive. Contain the radioactive and non-radioactive mastic in different containers.

k. Use the containment constructed for the DU tunnel wall surface scabbling to ensure proper controls for decontamination at the floor/ wall interface.

l. Use a jack hammer or other concrete cutting device to remove

concrete from the floor at the wall interface.

m. Make small cuts (approximately six inches) and survey after each to determine depth for removal.
n. Before dismantling this containment, use it to perform any other work that requires isolation.
o. Upon completion of all jack hammer or other isolation work, vacuum out the containment structure. Dismantle and dispose of the containment material as radioactive waste.

4.3.4.8 Soil

The GPI characterization report identified three areas where soil may require remediation. Contamination was possibly spread to the area under the entrance to the foyer by foot traffic. A combination of foot traffic and rain dispersal from the HEPA on the roof is the probable cause of contamination at the entrance to the inside storage area connected to Building 611B. The back side of this storage area was also contaminated by rain run off from the HEPA located on the roof.

Contamination removal from under the foyer entrance

Note: Check with site UXO personnel and/or local utility agencies as necessary to ensure it is safe to dig in the area.

a. Position a B-25 container nearby to hold the contaminated soil.
b. Prepare a clean area, with plastic sheeting or other non-porous material between the dig site and the B-25 box to prevent cross contamination of soil.
c. Block off the stairs to prevent access.
d. Remove portions of the stairs as necessary to perform the dig.
e. Use shovels and heavy equipment as necessary to remove, approximately six inches of soil from the contaminated area and deposit the soil in the B-25 box.
f. Hand frisk the remaining soil to determine whether to remove more soil. If necessary, remove more soil in thin layers (approximately three inches at a time) and frisk between layers.
g. Remove contaminated pavement at the bottom of the steps and frisk to determine further soil removal in this area.
h. After frisk measurements have determined removal of all soil and pavement contaminated above release limits, take three representative soil samples from the remediated area.
i. Remove any contaminated soil from the lay down area and place it inside the B-25 box. If practical, save the lay down material for use at other dig sites.

Contamination removal from the entrance to the Inside Storage Building

Note: Check with site UXO personnel and/or local utility agencies as necessary to ensure it is safe to dig in the area.

a. Position a B-25 container nearby to hold the contaminated soil.
b. Prepare a clean area, with plastic sheeting or other non-porous material between the dig site and the B-25 box to prevent cross contamination of soil.
c. Ensure all site personnel are notified of the dig to take place and are clear of the area.
d. Use shovels and heavy equipment as necessary to remove approximately six inches of soil from the contaminated area and deposit the soil in the B-25 box.
e. Hand frisk the remaining soil to determine whether to remove more soil. If necessary, remove more soil in thin layers (approximately three inches at a time) and frisk between layers.
f. After frisk measurements have determined removal of all soil contaminated above release limits, take three representative soil samples.
g. Remove any contaminated soil from the lay down area and place it inside the B-25 box. If practical, save the lay down material for use at other dig sites.

Contamination removal from the backside of the Inside Storage Building

Note: Check with site UXO personnel TACOM - ARDEC Safety and Occupational Health Specialist and/or local utility agencies as necessary to ensure it is safe to dig in the area.

a. Position a B-25 container nearby to hold the contaminated soil.
b. Prepare a clean area, with plastic sheeting or other non-porous material between the dig site and the B-25 box to prevent cross contamination of soil.
c. Ensure all site personnel are notified of the dig to take place and are clear of the area.
d. Use shovels and heavy equipment as necessary to remove approximately six inches of soil from the contaminated area and deposit the soil in the B-25 box.
e. Hand frisk the remaining soil to determine whether to remove more soil. If necessary, remove more soil in thin layers (approximately three inches at a time) and frisk between layers.
f. After frisk measurements have determined removal of all soil contaminated above release limits, take three representative soil samples.

g. Remove any contaminated soil from the lay down area and place it inside the B-25 box. If practical, save the lay down material for use at other dig sites.

4.3.4.9 Waste Water Holding Tank

The waste water holding tank (WWHT) is located on the west side of the instrument room. Configuration and historical knowledge of the facility describe the WWHT as a catch basin for the wash sink located in the instrument room. During the characterization, minor amounts of contamination were found around the inside of the threads for the cover of the fill pipe and in silt collected from inside the tank, GTS Duratek and/or its contractors will remove the WWHT according to Federal and State regulations. It is anticipated that this tank will be decontaminated as necessary and disposed of as scrap metal.

Tank Removal

NOTE: Check with site UXO personnel and/or local utility agencies as necessary to ensure it is safe to dig in the area.

a. Obtain heavy equipment and personnel as necessary to dig and lift the tank from the ground.
b. Check with site personnel to locate an area to obtain clean fill for the hole once it is excavated and verified to be free of activity.
c. Ensure all site personnel are notified of the dig to take place and are clear of the area. Put up a tape boundary as practical to exclude personnel from the dig area.
d. Disconnect and seal all connections to the WWHT.
e. Prepare separate plastic lay down areas for the soil and WWHT to be removed. Also, stage a B-25 box nearby and prepare a lay down area between it and the dig site.
f. Conduct a detailed survey of the asphalt over the location of the WWHT.
g. Remove the asphalt over the WWHT. If contaminated material is found, separate as practical, any contaminated asphalt material into the B-25 box for disposal as radioactive waste. Pile the clean asphalt outside of the work area.
h. If contaminated material is found, survey as necessary and mark with pin flags the ground areas where contaminated asphalt was found.
i. Ensure that EOD personnel check the area before proceeding.
j. If contaminated material is found, remediate soil from the marked areas, following digging precautions given by EOD, until contamination above background is no longer found. Place contaminated soil in the staged B-25 box.

k. Dig as necessary to uncover the WWHT. Place the clean soil on the prepared lay down area.

l. Use heavy equipment and personnel as necessary to secure and move the WWHT onto the prepared lay down area. Establish a barrier (e.g., caution tape) to keep all personnel away from the hole created by the dig.

m. Survey and swipe the external surfaces of the WWHT.

n. Perform a remote instrument survey of the bottom and sides of the hole. Use safety precautions outlined in the health and safety plan to protect workers near the edge of the excavation.

o. If contamination is found, remediate soil with the heavy digging equipment or shovels and small tools as necessary and resurvey. Place contaminated soil in the staged B-25 box. If one evolution does not remove all measurable contamination, consult with the project manager before continuing attempts.

p. Use the heavy digging equipment to obtain three soil samples; one from the bottom and two from the sides of the hole.

q. Place boundary tape around the hole to exclude personnel.

r. Obtain samples of soil from the clean pile and send off for expedited analysis. Excavated soil will be returned to the hole along with other clean fill pending results of the analysis.

s. Using external surface survey results, decontaminate the outside of the WWHT. Use soapy water and/or abrasive scrub pads as necessary. Grind the surface with tools only at the direction of the project manager. Segregate all radioactive waste for proper disposal.

t. Take precautions as outlined in the health and safety plan and cut the WWHT in half horizontally (lengthwise). The horizontal cut will allow containment of bottom silt from the interior of the WWHT.

u. Survey the interior of each half of the WWHT Decontaminate the interior of the WWHT using rags, soapy water, scrub pads and the HEPA vacuum as necessary. Perform surface grinding with tools only at the direction of the project manager. Segregate all radioactive waste for proper disposal.

v. Survey the interior of the WWHT.

w. Use heavy equipment to dispose of the WWHT as clean waste at a location specified by site personnel.

x. If the soil sample results do not allow return of the soil to the excavated hole, load it into the staged B-25 box for disposal as radioactive waste.

y. Consult with the project manager before backfilling the excavated WWHT hole. Backfill the hole with the clean fill obtained from site personnel and soil removed from the hole (as sample analysis results allow).

5.0 FINAL SURVEY PROCEDURES

The final surveys will be performed in accordance with the Final Survey Plan for the TACOM - ARDEC Building 611B and associated grounds. The surveys will consist of surface scans (beta and gamma), fixed beta measurements, and smears for gross alpha and gross beta analysis on structural surfaces while the survey of the facility grounds will consist of gamma scans and soil sampling for gamma spectroscopy analysis. The surveys will be performed in accordance with MARSSIM while applying site specific derived Concentration Guideline Levels (DCGL) based upon the future use of the facility and the grounds.

Attachment C

GTS DURATEK, INC.

FINAL SURVEY PLAN

for the

TACOM - ARDEC
PICATINNY ARSENAL
BUILDING 611B

REVISION 0
November 1999

Prepared by: John McGehee for Michael Carr Date 11/19/99
Michael Carr, CHP
Senior Radiological Engineer

Reviewed by: ______________ for Date 11/22/99
Robert Hornbeck,
GTS Duratek REFS Operations Manager

Reviewed by: ______________ Date 11/19/99
Robin Shult,,
GTS Duratek REFS Manager, Byproducts

Approved by: ______________ Date ________
Mike Styvaert,
Army Project Manager

Prepared By:

GTS Duratek
Radiological Engineering and Field Services
628 Gallaher Road
Kingston, TN 37763

127545

PREFACE

The Picatinny Arsenal located in Picatinny, NJ intends to remove Building 611B from their radioactive materials license and release the facility for unrestricted use. This will require the development of alternative release criteria and a survey of the building to verify that no radioactive materials remain above the Derived Concentration Guideline Levels (DCGLs). In order to accomplish this task, the Building, support facilities and surrounding area will be surveyed in accordance with this survey plan.

GTS Duratek developed this Plan based on the guidance provided in current regulations including NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, 10CFR20 Subpart E, *Radiological Criteria for License Termination*, Draft NUREG-1549, *Using Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination,* and the current NRC DandD code, Version 1.0. The criteria and survey protocols specified in this plan have been designed to meet the intent of the current regulations for release for unrestricted use and are intended to support the removal of the facility from the Arsenal's Radioactive Materials License.

TABLE OF CONTENTS

1.0 SITE INFORMATION

Building 611B is licensed to the US Army Tank Automotive Command (TACOM) - Armament Research, Development and Engineering Center (ARDEC) at the Picatinny Arsenal in New Jersey under the NRC Radioactive Materials License Number SUB-348, Amendment No. 21. The focus of this Final Survey is to remove Building 611B and the immediate grounds from these license conditions. The license itself is not being terminated since it is a multiple part document which authorizes the use/storage of radioactive materials at several facilities.

1.1 Site Description

Building 611B is centrally situated in an approximately 40,000 ft^2, fenced area. The building is a single-story structure of about 1,100 ft^2 containing two test firing ranges, one of which was a Depleted Uranium (DU) range while the other was a non-DU range. The walls of the non-DU range are constructed of concrete block; the floors are concrete and tile; and the roof is a steel, hemispherical structure that is approximately 6 feet wide, 8 feet high, and 40 feet long. The DU range is a concrete tube about 8 feet in diameter and 40 feet long. Other structures include an instrument room, foyer, and two storage rooms.

A diagram of the Building and the surrounding area is provided as Figure 1-1.

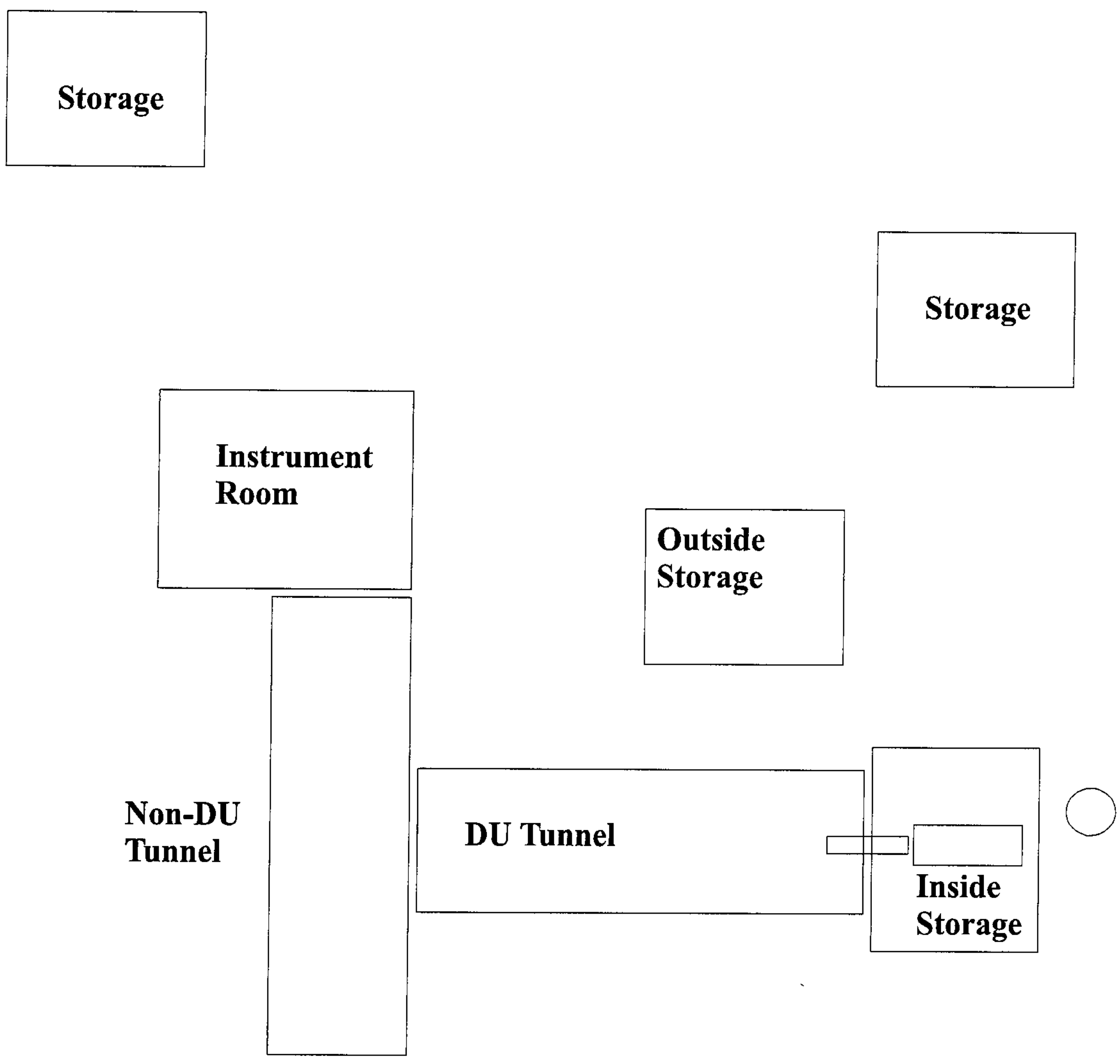
1.2 Site History

Building 611B was designed for testing of munitions and contained only non-radioactive munitions until approximately 1959 when an east-west tunnel was added to the existing structure for DU munitions testing. The site has not been used for DU munitions testing since approximately 1985 and will no longer be used for DU testing.

Depleted Uranium use within Building 611B consisted of limited DU firing within the confines of the firing range and target room of the building. The target room was ventilated during firing by a High Efficiency Particulate Air Filter (HEPA) ventilation system. This system discharged cycled air after four stages of filtration to an area above the storage room located at the end of the firing range/target room.

There has been limited migration of DU from the active use areas of Building 611B to adjacent soils and areas within the facility. DU migration was identified in the characterization report where activity was identified in the soil around the building at the access points, on the interior structural surfaces of the building and areas around the building runoff locations.

Figure 1-1
Building 611B Layout



1.3 Identity of Contaminants

The radioactive materials authorized under this license (SUB-348) are:

- *Depleted Uranium* in any form up to but not exceeding 11,000 kilograms,
- *Natural Uranium* in any form up to but not exceeding 100 kilograms, and
- *Thorium* in any form up to but not exceeding 20 kilograms,

with authorized use in research and development as defined in 10CFR30.4 as; (1) Theoretical analysis, exploration, or experimentation; or (2) the extension of investigative findings and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials and processes. According to site personnel only DU was used at Building 611B.

2.0 ORGANIZATION AND RESPONSIBILITIES

GTS Duratek will implement an integrated management approach that includes project management oversight and technical support. The full resources of GTS Duratek's Bear Creek and Gallaher Road offices, including professional engineering and quality assurance staff, will support the Project Sponsor and the on-site team to ensure successful project execution and completion.

The on-site survey team will consist of a Project Manager/Supervisor and senior HP technicians. These personnel will, as a minimum, be trained, qualified, and experienced in field radiological survey procedures and have current HAZWOPPER training.

2.1 Project Sponsor (Off-site)

The Project Sponsor provides the project lead for any home office support on an as needed basis. He/she will assist the Project Manager with the coordination of any project activities as needed.

2.2 Project Manager/Supervisor (On-site)

The Project Manager is the primary point of contact and interface. The minimum requirements for the Project Manager are 5-10 years of health physics experience including prior management experience.

He/she will be responsible for the supervision and coordinate the daily activities including the overview of the final status surveys. In order to ensure regulatory compliance, he/she will be qualified in the use of the survey instruments used and be familiar with the aspects of surveying as described in NUREG-1575 and this Survey Plan.

2.3 Health Physics (HP) Technician(s)

The HP Technician(s) are responsible for performing the final status surveys and collecting samples as necessary. They will be qualified in the use of the survey instruments and the performance of surveys in accordance with NUREG-1575 as well as this Survey Plan.

3.0 SURVEY OVERVIEW

This section provides the basis for developing the MARSSIM survey of the facility. In order to design the survey, several parameters must be set to ensure that the survey will stand up to and meet the statistical evaluations to justify the release of the facility. These include the establishment of the Data Quality Objectives, Release Criteria or Derived Concentration Guideline Levels, establishing the acceptable decision errors and the calculation of the Relative Shift in order to determine the number of required measurements per survey unit.

3.1 Data Quality Objectives

To ensure the proper release of the facility, the objectives of this survey plan are:

- The proper selection of appropriate instrumentation to adequately detect the radionuclides of concern,
- Establish proper count times and measurement MDAs (Minimum Detectable Activities) to verify that the release criterial are met,
- Perform surveys to verify the radiological status of the facility,
- Ensure that personnel exposure from residual contamination will not exceed 25 mrem/year to an individual based on the intended use of the facility, and
- Statistically evaluate the data to ensure that sufficient data is collected to prepare a report supporting the removal of the facility from the Radioactive Materials License.

Surveys and data evaluation will be based on the guidance in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, and include measurements for direct surface activity, removable activity and exposure rates.

3.2 Derived Concentration Guideline Levels (DCGL)

The Derived Concentration Guideline Level is defined in MARSSIM as the radionuclide specific concentration within a survey unit corresponding to the release criterion. As specified in the current regulations and regulatory guidance, the release criteria is dose based and the Total Effective Dose Equivalent (TEDE) to an individual will not exceed 25 mrem/yr plus ALARA as a result of any residual contamination distinguishable from background.

The DCGL is dependent upon several factors including the radionuclides of interest, applicable dose pathways, area occupancy and the future use of the facility. Contained within the current regulations, specific average guidelines ($DCGL_W$s) have been documented for a variety of radionuclides following typical default parameters for either residential or building occupancy scenarios. These guidelines are documented as surface contamination limits (dpm/100 cm^2) and concentration limits (pCi/g) which correspond to a TEDE of 25 mrem/yr.

For most radionuclides, the documented release criteria are easily achieved; however, problems are encountered when dealing with the naturally occurring radionuclides and alpha emitters such as uranium and thorium as present at the Picatinny Arsenal. The guideline levels using the default codes have resulted in unachievably low DCGLs for radionuclides such as DU. As a result, alternative guidelines are currently recommended as specified in Federal Register, Vol. 63, No 222 dated Wednesday, November 18, 1998; *"The NRC staff is assessing current screening approaches for sites with alpha emitters and for soil contamination. For such sites, licensees are encouraged to use, in the interim period, site-specific dose assessments based on actual site conditions."*

- Building Surfaces

  In order to develop alternative release guidelines for building surfaces, the Building Occupancy Scenario of the NRC DandD code, Version 1.0 was used. An arbitrary contamination level of 100 dpm/100 cm^2 was entered for building surfaces, with an activity distribution of 30.5% ^{234}U, 1.3% ^{235}U and 68.2% ^{238}U to obtain the resulting TEDE to an individual. The DU activity distribution is based on previous conversations with the NRC, providing a conservative depletion rate of less than 0.3% ^{235}U (by weight). A copy of the DandD output is provided in Attachment C, showing the input parameters and defaults. The result was 25.9 mrem/yr per 100 dpm/100 cm^2. Upon scaling the contamination level to a TEDE of 25 mrem/yr, a DU surface contamination level of 96.5 dpm/100 cm^2 was determined.

The DandD code default Building Occupancy Period used for the derivation of the above DU surface contamination level is 97.46 (24 hour)days/yr, or 2,339 hours. A more realistic assumption for Building 611B, based on the building's design, age, condition, and lack of utilities, is that the building will not normally be occupied, and will only be accessed for periodic inspections and maintenance. Conservatively, it is assumed that the building will be accessed once a month for approximately 2 hours, or a total of 24 hours per year. Scaling the default surface contamination level to the site specific model results in a Derived Concentration Guideline Level (DCGL) of 9,404 dpm/100 cm^2.

In order to demonstrate compliance with the DCGL, direct beta surveys will be performed on all accessible building surfaces. However, only the ^{238}U component of DU emits detectable betas. The depleted uranium used by the army is 68% ^{238}U by activity. Survey instrumentation efficiency will be adjusted to account for ^{238}U isotope abundance, beta energy and beta yields.

In accordance with the guidance provided in Federal Register, Vol. 63, No. 222, the level of removable activity will be less that 10% of the DCGL. In addition, and in accordance with the ALARA philosophy, attempts will be made to reduce removable contamination to the extent practical (HEPA vacuum, masslin, wet wipes, etc.).

- Soil

Initially, the DandD code was also utilized to determine a Derived Concentration Guideline Level (DCGL) for the exterior grounds as shown in Attachment D. An arbitrary value of 100 pCi/g of DU, with the same isotopic ratios as above for building surfaces, was input using the default Residential Scenario. This resulted in a TEDE of 5129 mrem/yr, as shown in Table 3-1. Scaling to a TEDE of 25 mrem/yr results in a concentration guideline level of 0.49 pCi/g.

Table 3-1
Pathway Component of Maximum Annual Dose from 100 pCi/g of Depleted Uranium

Pathway	TEDE (mrem)	Percentage
External	0.328	0.01
Inhalation	0.053	0.00
Agricultural	8.98	0.18
Soil	0.027	0.00
Drinking	1,230	23.96
Irrigated	2,550	49.80
Aquatic	1,340	26.06
Total	**5,129.3**	**100**

As can be seen in the above table, The results were extremely high, due mainly to the water pathways including groundwater irrigation of crops, consumption of aquatic foodstuff, and drinking water from a well on the site.

Appendix E of draft NUREG-1549 allows for the modification of pathways based on input from a site specific model. For example, the aquatic pathway (the consumption of fish from a contaminated pond), can be set to zero if there is no pond or surface water that could support fish. The Building 611B site does not contain such surface water. However, the removal of this pathway increases the guideline level only about 50% to 0.66 pCi/g.

The two other major dose producing pathways, irrigation and drinking water, both assume that there is, or will be, a well on the site providing contaminated groundwater for drinking and crop irrigation. Without further information on the future uses of the site, it would be imprudent to assume that the development of a groundwater well would not occur.

In order to determine a more reasonable (and achievable) DCGL for the soils surrounding the building, it was necessary to modify the contaminated zone affecting the groundwater aquifer. The DandD code does not lend itself to this modification, so the computer code RESRAD Version 5.82 was used.

Using the same input concentrations as above for the DandD code, RESRAD was first run using all default parameters for all pathways. The result was a TEDE of 102 mrem/yr for an input concentration of 100 pCi/g. When scaled

to a TEDE of 25 mrem/yr, this provides a soil concentration of 24.5 pCi/g. The resulting RESRAD output is provide as Attachment E.

The input parameters were then modified to more accurately reflect the Building 611B site conditions as follows:

1. The total area initially considered affected (above 35 pCi/g) is approximately 300 m2. (Reference 8.8) The total area of the Building 611B site is approximately 4,000 m2 (Reference 8.7). The RESRAD input parameter "Contaminated Zone" was changed from a default of 10,000 m^2 to the more conservative site-specific value of 4,000 m^2.

2. Characterization survey soil sample results from the Building 611B site show that the soil contamination is restricted to the top 6 inches (15 cm) of soil. The RESRAD input parameter "Thickness of contaminated zone" was changed from the default of 2 meters to a conservative site-specific value of 0.25 meters.

Using the above site-specific parameters, RESRAD was run again (Attachment F). The result was a TEDE of 13.4 mrem/yr for an input concentration of 100 pCi/g. When scaled to a TEDE of 25 mrem/yr, this provides a DCGL of 186 pCi/g.

In accordance with the ALARA philosophy, a remedial action level, based on the Minimum Detectable Activity (MDA) of the proposed scanning instrumentation will be established. Based on Table 6.7 of the MARSSIM, the action level will be approximately 100 pCi/g. Any soils identified during scanning which exceed this action level will be remediated. The intent being in part, to ensure that activity concentrations of samples collected during the Final Status Survey will not exceed the DCGL, thus eliminating the need for an elevated measurement criteria.

The above DCGL's are summarized in Table 3-2. Project personnel will compare the survey results with these values to assess the facility. This will determine the extent of any remediation, if required, and be used to support the removal of the facility from the Radioactive Materials License.

Table 3-2
Derived Concentration Guideline Levels

Building 611B Surfaces and Surrounding Soils DCGL's	
Building Surface Contamination	9,404 dpm/100 cm^2
Soil Contamination	186 pCi/g

3.3 Decision Error

There are two types of decision error applied to analytical results: Type I (α) and Type II (β) errors. A Type I error, or false positive, is the probability that a survey result/measurement is above the release criteria when in fact it is not, while a Type II error, or false negative, is the probability of determining that a result/measurement is below the release criteria when it is not. The probability of making decision errors can be controlled by adopting an approach called hypothesis testing. The null hypothesis (H_0) is treated like a baseline condition and is defined by MARSSIM as:

H_0 = residual radioactivity in the survey exceeds the release criterion.

This means that the site or survey area is assumed contaminated until proven otherwise. For the purpose of this Final Survey, both Type I and Type II, α and β, will be set at 0.05 or 5 percent.

3.4 Relative Shift

The relative shift is defined as Δ/σ where Δ is the DCGL - LBGR (Lower Bound of the Gray Region) and σ is the standard deviation of the contaminant distribution. In order to calculate the relative shift, the DCGL must be determined and two assumptions made to estimate the LBGR and the standard deviation of the measurement distribution. MARSSIM suggests that the LBGR be set at 50%, or ½, of the DCGL but can be adjusted later to provide a value for the relative shift between the range of 1 to 3. The standard deviation may be calculated from preliminary survey data, prior surveys of similar areas and materials or the standard deviation of a reference background area. It should be noted that σ represents the standard deviation prior to release after all area decontamination is thought to be complete. If no reference data is available to make a reasonable estimate, MARSSIM suggests using 30% of the mean survey unit background.

3.5 Number of Samples/Measurements

Once the relative shift is determined the calculated value, Δ/σ, can be used to obtain the minimum number of measurements or samples necessary to reject the null hypothesis based upon the initial assumptions and justify that the survey unit meets the requirements for release for unrestricted use. Attachment A (MARSSIM Table 5-3) contains the number of samples or measurements necessary for the given decision errors, α and β, and the calculated relative shift, Δ/σ, when dealing with non-radionuclide specific measurements or when the radionuclide is present in the background. The value N/2 from the Table represents the number of samples or measurements to be collected in each the survey unit and the reference background area. Attachment B provides the number of measurements of samples for the case in which the radionuclide is not in the background.

3.6 Sample/Measurement Number Reasonableness

Once the number of samples/measurements are determined, it must be assessed whether or not that number is reasonable for the survey unit and the survey unit size. It is possible, even if MARSSIM guidance is strictly followed, that there are not enough samples to produce the desired level of ***"comfort"*** or the number appears to be excessive. This is performed on a case by case basis and if the number of samples/measurements is not reasonable, then the data quality objectives or initial assumptions should be re-evaluated.

4.0 SURVEY DESIGN AND IMPLEMENTATION

The purpose of the survey is to collect sufficient survey data to remove Building 611B from Radioactive Material License SUB-348, Amendment 21 and the NRC license application. The project team will perform surveys according to project specific GTS Duratek procedures and this Survey Plan. Implementation of this Survey Plan will include the following:

- Survey instrumentation will be set up and source checked to ensure proper operation.
- The Project Manger/Supervisor will perform preliminary inspections of the areas to identify additional specific survey requirements.
- The Project Manager/Supervisor will develop survey packages for the survey areas.
- The project team will grid the survey areas as specified by the following survey protocols and mark or map the survey locations as applicable.
- The project team will take survey measurements and analyze samples using appropriate calibrated instruments and perform daily source and background checks before and after each day's work.
- Direct survey data collected during the project will be downloaded from the survey instrument into a database for storage and processing.

- The Project Manager will review the completed survey packages to ensure that all required surveys have been performed.
- The Project Manager will review the survey results to identify any areas exceeding the specified release criteria.

In order to support the final status surveys of the building, the facility will be cleared of all loose equipment and materials to the maximum extent possible. Surveys will then be performed as follows:

4.1 Instrumentation and Selection

Selection and use of survey instrumentation will ensure sensitivities are sufficient to detect the identified radionuclides at the minimum detection requirements. Table 4-1 provides a list of the instruments, types of radiations detected and calibration sources which may be utilized.

GTS Duratek will use the Ludlum Model 2350 Data Logger with a variety of detectors for direct measurements of beta surface activity as well as exposure rate measurements. The Data Logger is a portable micro-processor computer based counting instrument capable of operation with NaI(Tl) gamma scintillation, gas-flow proportional, GM and ZnS scintillation detectors.

Detector selection will depend upon the type of survey, surface contour and survey area size. The project team will typically use the 126 cm^2 gas-flow proportional detector for direct beta measurements for most areas and the 15.5 cm^2 GM detector for smaller areas in which the gas-flow proportional detector will not fit.

Exposure rate measurements and gamma scans will be performed using either a Ludlum Model 44-2 or 44-10 NaI(tl) gamma scintillation detector.

Analysis for removable alpha and beta activity will be performed using either Tennelec gross alpha/beta counter or the Eberline BC-4 and SAC-4 scaler counters.

Table 4-1
Survey Instrumentation

Instrument/Detector	Detector Type	Radiation Detected	Calibration Source	Use
Ludlum Model 2350 wt. 43-68, 43-98 or 43-94 detector	Gas-flow proportional (126cm^2)	Alpha or beta	^{99}Tc (β) ^{230}Th (α)	Direct beta surveys; Beta scans on solid surfaces, soil and sand.
Ludlum Model 2350 wt. 44-40 detector	Shielded GM (15.5cm^2)	Beta	^{99}Tc (β)	Direct beta surveys; Beta scans on solid surfaces, soil and sand.
Ludlum Model 2350 wt. 44-2 or 44-10 detector	NaI(Tl) Scintillator	Gamma	^{137}Cs	Gamma exposure rate and gamma scans.
Eberline SAC-4 Scaler Counter	ZnS scintillator	Alpha	^{230}Th (α)	Smear counting
Eberline BC-4 Scaler Counter	Shielded GM	Beta	^{99}Tc (β)	Smear counting
Tennelec Planchette Counter	Shielded Gas-flow proportional	Alpha and Beta	^{99}Tc (β), ^{230}Th (α)	Smear counting
EG&G NOMAD Gamma Spetrometer	HPGe	Gamma energy and intensity	Mixed gamma	Nuclide identification and quantification soil and sand samples.

4.1.1 Instrument Calibration

The data loggers, associated detectors and all other portable instrumentation are calibrated on a semi-annual basis using National Institute of Standards and Technology (NIST) traceable sources and calibration equipment. Calibration typically includes:

- High Voltage calibration,
- Discriminator/threshold calibration,
- Window calibration,
- Alarm operation verification, and
- Scaler calibration verification

The detector calibration includes:

- Operating voltage determination,
- Calibration constant determination, and
- Dead time correction determination

Calibration labels showing the instrument identification number, calibration date and calibration due date are attached to all portable field instruments.

4.1.2 Sources

All sources used for calibration or efficiency determinations for the survey will be representative of the instrument's response to the identified radionuclides and are traceable to NIST. The sources which will be used during the surveys will include ^{99}Tc, ^{230}Th, ^{137}Cs and mixed gamma sources.

Health Physics Technicians will control the radioactive sources used for instrument response checks and efficiency determination as required in AR 11-9 for bringing and using check sources on post. Sources will be stored securely and signed out when needed in the field. A source sign-out log will track the location of all sources when they are removed from the GTS Duratek field office.

4.2 Survey Unit Classification

Depending upon site operations and operational histories, the potential for residual contamination may vary from survey unit to survey unit. In order to facilitate final surveys, areas are classified based upon their potential with more extensive surveys being performed in areas with greater contamination potential. According to MARSSIM, areas are either classified as impacted or non-impacted. Impacted areas have the potential for contamination while a non-impacted area has no radiological impact from site operations and doesn't require surveys.

Impacted areas are further classified as either Class 1, Class 2 or Class 3. Class 1 impacted areas are areas which have, or had prior to remediation, a potential for radioactive contamination based on site operating history or known contamination above the $DCGL_W$. Class 2 areas have or had prior to remediation a potential for radioactive contamination or known contamination which is not expected to exceed the $DCGL_W$. Class 3 areas are any impacted areas that are not expected to contain any residual radioactivity or are expected to contain levels of residual activity at a small fraction of the $DCGL_W$.

Class 1 impacted areas have the greatest potential for contamination and therefore receive the highest degree of survey effort. Based upon the operational history of Building 611B and the surrounding area, the facility is considered to be impacted with the immediate firing ranges being considered Class 1 areas while the surrounding support areas are either Class 2 or 3. Due to the small size of the building and the areas to be surveyed, all the survey areas/units will be treated as Class 1 and will receive a 100% survey.

The survey areas/units will consist of the:

- DU tunnel,
- DU target area,
- Inside storage area,
- Non-DU tunnel,
- Instrument room and foyer,
- Outside storage areas (3),
- Building exterior (roof), and
- the facility grounds immediately surrounding the facility.

Upon arrival on site and the facility inspection, additional survey areas/unit may be added or some of the areas above combined. This will depend upon the similarities of the areas (contamination potential) and the facility layout.

4.3 Survey Package Development

For each survey area/unit, the project team will develop a package, or portfolio, by performing a walk-down and preparing a worksheet/tracking sheet outlining the general survey instructions, location codes, and any specific survey instructions for any abnormal conditions within the survey area. Completion and review signature blocks will be used to track the progress of the surveys.

During the survey, the project team will update the survey package(s) with the survey data and results of any special surveys or sample analyses performed.

4.4 Survey Protocols/Requirements

The final status survey of the building will consist of surface scans (beta and gamma), fixed beta measurements, and smears for gross alpha and gross beta analysis. The survey of the facility grounds will consist of gamma scans and soil sampling for gamma spectroscopy analysis. Surveys will be performed as follows:

4.4.1 Surface Scans

a. Beta Scans

Beta scans will be performed over 100% of the accessible building surfaces (interior) and the roof using a gas-flow proportional detector while listening to the audible output of the instrument. All areas of elevated activity will be identified for further investigation and potential decontamination. Any area exceeding the $DCGL_W$ will be identified and decontaminated. Scan speeds will be established such that contamination at levels of approximately 50% of the $DCGL_W$ will be detected.

b. Gamma Scans

Gamma scans will be performed inside Building 611B above the floor as well as outside the building around the facility grounds immediately around the building contingent on EOD clearance and clearance from the Safety and Occupational Health Specialist. A NaI(Tl) gamma scintillation detector will be used with the Ludlum Model 2350 to help identify any areas of residual contamination in the soil or the building interior. The building floor and the grounds will be 100% scanned with the detector being moved in a serpentine manner in close proximity with the ground while listening to the audible output of the instrument. Any areas where a noticeable increase in the count rate is determined will be flagged for further investigation and/or sampling.

4.4.2 Direct Surface Activity Measurements/Sampling

Direct surface activity measurement will be taken on the structural surfaces of Building 611B within each survey area/unit. The number of measurement and spacing will be determined in accordance with MARSSIM and this Plan.

a. Number of Measurements/Samples

Determine the number of measurement/samples for each survey unit in accordance with section 3.5 of this plan. A relative shift of between 1 and 3 should be used, providing approximately 10-30 samples/measurement per survey unit depending upon the measurement distribution and the size of the area.

b. Sample/Measurement Grid Spacing

The grid spacing for the measurement and samples is estimated in two ways depending upon the shape of the grid (either triangular or rectangular gridding). If a triangular grid is used, the grid spacing is estimated as follows:

$$L = \sqrt{\frac{A}{0.866 * N}}$$

Where A = Survey unit Area
N = Number of measurements

If a square grid is used, the spacing is estimated as follows:

$$L = \sqrt{\frac{A}{N}}$$

c. Starting location

Once the number of measurements and the grid spacing are determined, a starting point for the survey must be established for each survey unit. This will be performed by selecting a reference point for the survey unit such as the corner of the room and a random number generator providing a random number between 0 and 1 for an initial offset from the reference point in both the x and y coordinates. The random number pair will be multiplied by the calculated grid spacing providing the offset from the reference point for the first grid location.

Upon establishing the fist grid location, the calculated grid spacing will be used to establish a grid system throughout the survey unit. If the survey unit includes the floor, walls and ceiling, the grid is extended to all surfaces from the initial point.

Once gridded, ensure that the number of grid locations satisfies the calculated number of measurements. If not, then a smaller grid spacing must be used to ensure the minimum number of measurements/samples are obtained.

4.4.3 Removable Activity Measurements

Smears will be taken at each direct measurement location for gross alpha and gross beta analysis.

4.4.4 Soil Sampling

A surface soil sample (0-15 cm) will be obtained at each grid node for the facility grounds immediately around Building 611B and any other survey unit/area determined to be necessary contingent on TACOM-ARDEC clearances from EOD and the Safety and Occupational Health Specialist. An adequate amount of soil will be collected at each location for split sample analysis. A total of approximately 1 gallon of soil should be collected, dried, homogenized and sieved to minus 1/4-inch.

4.4.5 Minimum Detectable Activity

Minimum Detectable Activity (MDA) is defined as the smallest amount or concentration of radioactive material that will yield a net positive count with a 5% probability of falsely interpreting background responses as true activity. The MDA is dependent upon the counting time, geometry, sample size, detector efficiency and background count rate. As a Data Quality Objective, the MDAs will be set to approximately equal to or less than 50% of the applicable Derived Concentration Guideline Level. There are two different MDAs which will be utilized, one for direct surface activity measurements and one for field scanning. These are calculated differently as follows. The equation used for calculating the MDA for direct field instrumentation is:

$$MDA = \frac{\frac{2.71}{t_s} + 3.29\sqrt{\frac{R_b}{t_s} + \frac{R_b}{t_b}}}{E\left(\frac{A}{100}\right)}$$

Where:

	MDA	=	Minimum Detectable Activity (dpm/100 cm^2)
	R_b	=	Background Count Rate (cpm)
	t_b	=	Background Count Time (min)
	t_s	=	Sample Count Time (min)
	A	=	Detector Area (cm^2)
	E	=	Detector Efficiency (c/d)

The equation for the scanning MDA is:

$$MDA = \frac{d' * \sqrt{b_i} * \frac{60}{i}}{E_i * E_s * \sqrt{p} * \frac{A}{100}}$$

Where:			
	MDA	=	Minimum Detectable Activity (dpm/100 cm^2)
	d′	=	Decision error taken from Table 6-5 of MARSSIM
	i	=	Observation counting interval (scan speed divided by the detector width)
	b_i	=	Background count per observation interval
	E_i	=	Detector Efficiency (c/d)
	E_s	=	Surface Efficency (typically around 50% for beta contamination on concrete)
	p	=	Surveyor Efficiency (typically 50%)
	A	=	Detector Area (cm^2)

4.5 Survey Records

The project team will maintain records of surveys in the survey packages for each area according to project procedures. The survey package may include the following records depending upon the survey design and protocols:

- Survey Package Worksheet giving the package identification, survey location information, general survey instructions and any specific survey instructions.
- Survey Unit Diagram of the area to be surveyed as available.
- Photographs of the survey area, as necessary, to show special or unique conditions.
- Printout of laboratory analysis results (if performed).
- Ludlum Model 2350 data files and Paradox® converted values for all radiation survey measurements.

GTS Duratek will use a proprietary computer program to download the contents and survey data from the Data Loggers memory to a database and generate a survey report that presents all raw data, converted data, and information by survey location. The survey technician and supervisor will review these reports for completeness, accuracy, suspect entries and compare the data to the guideline values in Table 3-2.

Any changes to the database tables such as detector efficiency and background, that could affect survey results will require management approval. In addition, changes to data in the primary table will require a written explanation on a change request. The change request will be attached to the survey report and maintained as a permanent record.

The equation for the scanning MDA is:

$$MDA = \frac{d' * \sqrt{b_i} * \frac{60}{i}}{E_i * E_s * \sqrt{p} * \frac{A}{100}}$$

Where:			
	MDA	=	Minimum Detectable Activity (dpm/100 cm^2)
	d'	=	Decision error taken from Table 6-5 of MARSSIM
	i	=	Observation counting interval (scan speed divided by the detector width)
	b_i	=	Background count per observation interval
	E_i	=	Detector Efficiency (c/d)
	E_s	=	Surface Efficency (typically around 50% for beta contamination on concrete)
	p	=	Surveyor Efficiency (typically 50%)
	A	=	Detector Area (cm^2)
	E	=	Detector Efficiency (c/d)

4.5 Survey Records

The project team will maintain records of surveys in the survey packages for each area according to project procedures. The survey package may include the following records depending upon the survey design and protocols:

- Survey Package Worksheet giving the package identification, survey location information, general survey instructions and any specific survey instructions.
- Survey Unit Diagram of the area to be surveyed as available.
- Photographs of the survey area, as necessary, to show special or unique conditions.
- Printout of laboratory analysis results (if performed).
- Ludlum Model 2350 data files and Paradox® converted values for all radiation survey measurements.

GTS Duratek will use a proprietary computer program to download the contents and survey data from the Data Loggers memory to a database and generate a survey report that presents all raw data, converted data, and information by survey location. The survey technician and supervisor will review these reports for completeness, accuracy, suspect entries and compare the data to the guideline values in Table 3-2.

Any changes to the database tables such as detector efficiency and background, that could affect survey results will require management approval. In addition, changes to data in the primary table will require a written explanation on a change request. The change request will be attached to the survey report and maintained as a permanent record.

Data and document control will include the maintenance of the raw data files, translated data files (Paradox® database files) and documentation of all corrections made to the data. The databases will be backed up on a daily basis.

5.0 DATA QUALITY ASSESSMENT AND EVALUATION

Once all the surveys are complete, the data will be assessed and evaluated to ensure that the $DCGL_W$ was met. All areas exceeding the $DCGL_W$ will be remediated, scanned and the data point re-surveyed. Once complete, the data will be evaluated following the methodology specified in MARSSIM and this Plan to re-calculate the number of measurements based on the survey standard deviation to ensure that the proper number of measurements were taken. If it is determined that enough data was not collected, the grid size must be reduced and the survey area re-gridded and re-surveyed.

Provided an adequate number of measurements were taken and that NO measurements exceed the $DCGL_W$, the survey area/unit meets the requirements for release for unrestricted use and no further statistical tests are required. If there is data in excess of the $DCGL_W$, the area will be decontaminated unless an evaluation is made by the Project Manager that it is not necessary. In this case, the data must be statistically evaluated using non-parametric statistics and the elevated measurement evaluated against the $DCGL_{EMC}$.

5.1 Elevated Measurement Comparison

If elevated measurements above the $DCGL_W$ exist, an elevated measurement comparison must be performed in accordance with MARSSIM; otherwise, the area will be decontaminated.

5.2 Statistical Evaluation

If elevated measurements remain, the data must be statistically evaluated using either the Wilcox Rank Sum Test or the Sign Test in accordance with MARSSIM.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

GTS Duratek's Quality Assurance/Quality Control Programs ensure that all quality and regulatory requirements are satisfied. All activities affecting quality are controlled by procedures and this plan. These documents include the following Quality Control measures as an integral part of the survey process.

6.1 Selection of Personnel

Project management and supervisory personnel are required to have extensive experience with GTS Duratek procedures and be familiar with the requirements of MARSSIM and this Survey and Sampling Plan. Management must have prior experience with the radionuclide(s) of concern and a working knowledge of the instruments used to detect the radionuclides on site. Project management and supervision are required to maintain OSHA safety qualifications as safety is a primary concern of GTS Duratek.

GTS Duratek will select supervisory personnel to direct the survey based upon their experience and familiarity with the survey procedures and processes. Likewise, Health Physics technicians who will perform the surveys will be selected based upon their qualifications and experience.

6.2 Training

All project personnel will receive site specific training to identify the specific hazards present in the work and survey areas. Training will also include a briefing and review of this Plan, GTS procedures and the Site Safety and Health Plan.

During site orientation and training, survey personnel will become familiar with site emergency procedures. In the event of an emergency, personnel will act in accordance with all applicable site emergency procedures and the Site Safety and Health Plan.

6.3 Written Procedures

All survey tasks which are essential to survey data quality will be controlled by procedures and this plan.

6.4 Instrumentation Selection, Calibration and Operation

GTS Duratek has selected instruments proven to reliably detect the radionuclides present at the facility. Instruments will be calibrated by GTS Duratek or qualified vendors under approved procedures using calibration sources traceable to the National Institute of Standards and Technology (NIST).

All instruments and detectors will be inspected and source checked daily when in use to verify proper operation. Control charts and/or source check criteria will be established at the beginning of the project for reference.

Procedures for calibration, maintenance, accountability, operation and quality

control of radiation detection instruments implement the guidelines established in American National Standard Institute (ANSI) standard ANSI N323-1978 and ANSI N42.17A-1989.

6.5 Survey Documentation

Survey packages will be the primary method of controlling and tracking the hard copy records of survey results. Records of surveys will be documented and maintained in the survey package for each area according to GTS procedures. Each survey measurement will be identified by the date, technician, instrument type and serial number, detector type and serial number, location code, type of measurement, mode of instrument operation, and Quality Control (QC) sample number, as applicable.

6.6 Chain of Custody

Procedures establish responsibility for the custody of samples from the time of collection until results are obtained. If samples are shipped off site for analysis, they will be accompanied by a chain-of-custody record to track each sample.

6.7 Records Management

Generation, handling and storage of survey data packages are controlled by an approved procedure.

6.8 Duplicate Review of Survey Results

The survey package and survey data from each area will be reviewed by two separate people to verify all documentation is complete and accurate. This will include the surveyor and either the Project Manager or his designee.

6.9 Sample Analysis

GTS Duratek will perform quality assurance and quality control checks on 5% of all sample analyses (except smears). This will consist of the analysis of split and/or duplicate samples. Split samples will be analyzed if an ample amount of material is collected in a sample. The sample will be homogenized and split into two separate samples for analysis. Duplicate analysis will be performed on samples where there wasn't enough material collected to prepare two separate samples. The same sample will be analyzed twice at different times and different detectors if possible to check the quality of the analyses.

7.0 SURVEY REPORT

GTS Duratek may begin preparing the Survey Report during the surveys. General information can be drafted early to expedite report preparation when work is completed. The report will contain brief descriptions of the site and the surveys performed, photographs of the survey and sample locations as necessary and survey results in tabular and graphical form.

GTS Duratek will submit a draft report for comment after completing site activities and receiving all sample analyses. The final report will be submitted following resolution of all comments.

8.0 REFERENCES

8.1 NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, December 1997.

8.2 USNRC, Reg. Guide DG-4006, *Demonstrating Compliance with the Radiological Criteria for License Termination*, March 13, 1998.

8.3 Draft NUREG-1549, *Using Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination.*

8.4 Federal Register, Volume 63, No. 222, Wednesday, November 18, 1998, pages 64132-64134.

8.5 USNRC, DandD code, Version 1.0.

8.6 10 CFR20, *Standards for Protection Against Radiation.*

8.7 *Decommissioning Plan for Building 611B, Picatinny Arsenal-ARDEC*, GTS Duratek, October 1999

8.8 *Report of Radiological Characterization, Building 611B, ARDEC-Picatinny Arsenal*, GPI, May, 1997

ATTACHMENT A

Values for N/2 for a Given Relative Shift (Δ/σ) and decision errors α and β when a Contaminant is Present in the Background.

	α=0.01					α=0.025					α=0.05					α=0.1					α=0.25				
	β					β					β					β					β				
	0.01	**0.025**	**0.05**	**0.1**	**0.25**	**0.01**	**0.025**	**0.05**	**0.1**	**0.25**	**0.01**	**0.025**	**0.05**	**0.1**	**0.25**	**0.01**	**0.025**	**0.05**	**0.1**	**0.25**	**0.01**	**0.025**	**0.05**	**0.1**	**0.25**
0.1	5452	4627	3972	3278	2268	4627	3870	3273	2646	1748	3972	3273	2726	2157	1355	3278	2646	2157	1655	964	2268	1748	1355	964	459
0.2	1370	1163	998	824	370	1163	973	823	665	440	998	823	685	542	341	824	665	542	416	243	570	440	341	243	116
0.3	614	521	448	670	256	521	436	369	298	197	448	359	307	243	153	370	298	243	187	109	256	197	153	109	52
0.4	350	297	255	211	146	297	248	210	170	112	255	210	175	139	87	211	170	139	106	62	146	112	87	62	30
0.5	227	193	166	137	95	193	162	137	111	73	166	137	114	90	57	137	111	90	69	41	95	73	57	41	20
0.6	161	137	117	97	67	137	114	97	78	52	117	97	81	64	40	97	78	64	49	29	67	52	40	29	14
0.7	121	103	88	73	51	103	86	73	59	39	88	73	61	48	30	73	59	46	37	22	51	39	30	22	11
0.8	95	81	69	57	40	81	68	57	46	31	69	57	48	38	24	57	46	38	29	17	40	31	24	17	8
0.9	77	66	56	47	32	66	55	46	38	25	56	46	39	31	20	47	38	31	24	14	32	25	20	14	7
1.0	64	55	47	39	27	55	46	39	32	21	47	39	32	26	16	39	32	28	20	12	27	21	16	12	6
1.1	55	47	40	33	23	47	39	33	27	18	40	33	28	22	14	33	27	22	17	10	23	18	14	10	5
1.2	48	41	35	29	20	41	34	29	24	16	35	29	24	19	12	29	24	19	15	9	20	16	12	9	4
1.3	43	36	31	26	18	36	30	26	21	14	31	26	22	17	11	28	21	17	13	8	18	14	11	8	4
1.4	38	32	28	23	16	32	27	23	19	13	28	23	19	15	10	23	19	15	12	7	16	13	10	7	4
1.5	35	30	25	21	15	30	25	21	17	11	25	21	18	14	9	21	17	14	11	7	15	11	9	7	3
1.6	32	27	23	19	14	27	23	19	16	11	23	19	16	13	8	19	16	13	10	6	14	11	8	6	3
1.7	30	25	22	18	13	25	21	18	15	10	22	18	15	12	8	18	15	12	9	6	13	10	8	6	3
1.8	28	24	20	17	12	24	20	17	14	9	20	17	14	11	7	17	14	11	9	5	12	9	7	5	3
1.9	26	22	19	16	11	22	19	16	13	9	19	16	13	11	7	16	13	11	8	5	11	9	7	5	3
2.0	25	21	18	15	11	21	18	15	12	8	18	15	13	10	7	15	12	10	8	5	11	8	7	5	3
2.25	22	19	16	14	10	19	18	14	11	8	16	14	11	9	6						[illegible]	8	6	4	2
2.5	21	18	15	13	9	18	15	13	10	7	15	13	11	9	6						9	7	6	4	2
2.75	20	17	15	12	9	17	14	12	10	7	15	12	10	8	5						9	7	5	4	2
3.0	19	16	14	12	8	16	14	12	10	6	14	12	10	8	5						8	6	5	4	2
3.5	18	16	13	11	8	16	13	11	9	6	13	11	9	8	5						8	6	5	4	2
4.0	18	15	13	11	8	15	13	11	9	6	13	11	9	7	5						8	6	5	4	2

WRS Test
—ob

ATTACHMENT B

Values for Nfor a Given Relative Shift (Δ/σ) and decision errors α and β when a Contaminant is NOT Present in the Background.

	α=0.01					α=0.025					α=0.05					α=0.1					α=0.25				
	β					β					β					β					β				
	0.01	0.025	0.05	0.1	0.25	0.01	0.025	0.05	0.1	0.25	0.01	0.025	0.05	0.1	0.25	0.01	0.025	0.05	0.1	0.25	0.01	0.025	0.05	0.1	0.25
0.1	4095	3476	2984	2463	1704	3476	2907	2459	1989	1313	2984	2459	2048	1620	1018	2463	1989	1620	1244	725	1704	1313	1018	725	345
0.2	1035	879	754	623	431	879	735	622	503	333	754	622	518	410	258	623	503	410	315	184	431	333	258	184	88
0.3	468	398	341	282	195	398	333	281	227	150	341	281	234	185	117	282	227	185	143	83	195	150	117	83	40
0.4	270	230	197	162	113	230	191	162	131	87	197	162	136	107	68	162	131	107	82	48	113	87	68	48	23
0.5	178	152	130	107	75	152	126	107	87	58	130	107	89	71	45	107	87	71	54	33	75	58	45	33	16
0.6	129	110	94	77	54	110	92	77	63	42	94	77	65	52	33	77	63	52	40	23	54	42	33	23	11
0.7	99	83	72	59	41	83	70	59	48	33	72	59	50	40	26	59	48	40	30	18	41	33	26	18	9
0.8	80	68	58	48	34	68	57	48	39	26	58	48	40	32	21	48	39	32	24	15	34	26	21	15	8
0.9	66	57	48	40	28	57	47	40	33	22	48	40	34	27	17	40	33	27	21	12	28	22	17	12	6
1.0	57	48	41	34	24	48	40	34	28	18	41	34	29	23	15	34	28	23	18	11	24	18	15	11	5
1.1	50	42	36	30	21	42	35	30	24	17	36	30	26	21	14	30	24	21	16	10	21	17	14	10	5
1.2	45	38	33	27	20	38	32	27	22	15	33	27	23	18	12	27	22	18	15	9	20	15	12	9	5
1.3	41	35	30	26	17	35	29	24	21	14	30	24	21	17	11	26	21	17	14	8	17	14	11	8	4
1.4	38	33	28	23	16	33	27	23	18	12	28	23	20	16	10	23	18	16	12	8	16	12	10	8	4
1.5	35	30	27	22	15	30	26	22	17	12	27	22	18	15	10	22	17	15	11	8	15	12	10	8	4
1.6	34	29	24	21	15	29	24	21	17	11	24	21	17	14	9	21	17	14	11	6	15	11	9	6	4
1.7	33	28	24	20	14	28	23	20	16	11	24	20	17	14	9	20	16	14	10	6	14	11	9	6	4
1.8	32	27	23	20	14	27	22	20	16	11	23	20	16	12	9	20	16	12	10	6	14	11	9	6	4
1.9	30	26	22	18	14	26	22	18	15	10	22	18	16	12	9	18	15	12	10	6	14	10	9	6	4
2.0	29	26	22	18	12	26	21	18	15	10	22	18	15	12	8	18	15	12	10	6	12	10	8	6	3
2.5	28	23	21	17	12	23	20	17	14	10	21	17	15	11	8	17	14	11	9	5	12	10	8	5	3
3.0	27	23	20	17	12	23	20	17	14	9	20	17	14	11	8	17	14	11	9	5	12	9	8	5	3

Attachment C

USNRC DandD Code Run

(Building Occupancy Scenario, Default Parameters)

Program : DandD Version 1.0
Session : Picatinny Arsenal
Description :
Building 611B

E... uted : 10/07/99 at 13:12:15

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
2...	31.00
235U	1.30
238U	68.20

Code-Generated Radionuclide Activities

Chain	dpm/100cm^2
234U	3.1000E+001
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
235U	1.3000E+000
Th	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
2[illegible]	6.8200E+001
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

Variable Parameters

No parameters have been changed.

Occupancy Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now
and ran for 1.00 year(s).

The peak dose of 2.59E+001 TEDE (mrem) occurred 1.00 year(s) after
license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
E[illegible]al	2.75E-003	0.01
Inhalation	2.59E+001	99.87
Ingestion	3.20E-002	0.12
Total	2.59E+001	100.00

Radionuclide Component of Maximum Annual Dose

Radionuclide	TEDE (mrem)	Percentage
234U	8.61E+000	33.26
230Th	9.53E-005	0.00
226Ra	3.94E-010	0.00
222Rn	1.07E-014	0.00
218Po	2.40E-016	0.00
214Pb	6.91E-012	0.00
218At	0.00E+000	0.00
214Bi	3.85E-011	0.00
214Po	2.20E-015	0.00
210Pb	5.10E-012	0.00
210Bi	5.68E-014	0.00
210Po	8.08E-013	0.00
235U	3.35E-001	1.29
231Th	3.81E-005	0.00
231Pa	3.67E-005	0.00
227Ac	2.00E-006	0.00
223Fr	2.01E-013	0.00
227Th	3.87E-009	0.00
223Ra	1.75E-009	0.00
219Rn	7.74E-012	0.00
215Po	2.47E-014	0.00
2[illegible]	9.04E-012	0.00
211Bi	6.47E-012	0.00
211Po	3.00E-015	0.00
207Tl	5.29E-013	0.00
238U	1.69E+001	65.41
234Th	6.23E-003	0.02
234mPa	1.32E-003	0.01
234Pa	3.19E-004	0.00
Total	2.59E+001	100.00

Attachment D

USNRC DandD Code Run
(Residential Scenario, Default Parameters)

Program : DandD Version 1.0
Session : Picatinny Guidelines
Description :
DU Surface contamination guidelines

:cuted : 10/12/99 at 10:38:07

NRC Report

Residential 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	pCi/gram
234U	30.50
235U	1.30
238U	68.20

Code-Generated Radionuclide Activities

Chain	pCi/gram
234U	3.0500E+001
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
235U	1.3000E+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
238U	6.8200E+001

234Th	0.0000E+000
234mPa	0.0000E+000
234Pa	0.0000E+000
234U	0.0000E+000
230Th	0.0000E+000
226Ra	0.0000E+000
22Rn	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
'Floor Dust'	0.1599	g/m^2	0.1599
'Unsaturated Zone'	1.2288	m	1.2288
'Layer Porosity'	0.4599	None	0.4599
'Unsaturated Porosity'	0.4599	None	0.4599
'Surface Layer Ratio'	0.1626	None	0.1626
'Unsaturated Ratio'	0.1626	None	0.1626
'Infiltration Rate'	0.2526	m/year	0.2526

Residential Output Section

Maximum Annual TEDE

This scenario started 0.00 year(s) from now and ran for 1000.00 year(s).

The peak dose of 5.13E+003 TEDE (mrem) occurred 4.00 year(s) after license termination.

Pathway Component of Maximum Annual Dose

Pathway	TEDE (mrem)	Percentage
External	3.28E-001	0.01
Inhalation	5.33E-002	0.00
Agricult.	8.98E+000	0.18
Soil	2.73E-002	0.00
Drinking	1.23E+003	23.96
Irrigated	2.55E+003	49.80
Aquatic	1.34E+003	26.06

Total	5.13E+003	100.00

Radionuclide Component of
Maximum Annual Dose

ionuclide	TEDE (mrem)	Percentage
234U	1.62E+003	31.52
230Th	3.87E-002	0.00
226Ra	3.35E-005	0.00
222Rn	2.04E-010	0.00
218Po	4.73E-012	0.00
214Pb	1.35E-007	0.00
218At	0.00E+000	0.00
214Bi	7.91E-007	0.00
214Po	4.31E-011	0.00
210Pb	5.29E-006	0.00
210Bi	4.50E-009	0.00
210Po	2.80E-006	0.00
235U	6.47E+001	1.26
231Th	4.07E-001	0.01
231Pa	1.00E-001	0.00
227Ac	4.19E-003	0.00
223Fr	3.65E-008	0.00
227Th	1.40E-005	0.00
223Ra	2.10E-004	0.00
219Rn	1.05E-007	0.00
215Po	3.38E-010	0.00
211Pb	2.66E-007	0.00
Bi	8.66E-008	0.00
211Po	4.27E-011	0.00
207Tl	6.43E-009	0.00
238U	3.24E+003	63.29
234Th	2.01E+002	3.91
234mPa	1.88E-001	0.00
234Pa	1.12E-001	0.00
Total	5.13E+003	100.00

Attachment E

RESRAD Version 5.82 Code Runs
(Residential Scenario, Default Parameters)

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

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	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(3)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	U-234	1.320E-01	1.320E-01	DCF2(6)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(7)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(8)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(3)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	U-234	2.830E-04	2.830E-04	DCF3(6)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(7)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(8)
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	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(6,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(6,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
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	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)

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)	2.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+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)	4.000E+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)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	3.050E+01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): U-235	1.300E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): U-238	6.820E+01	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(8)
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)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+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)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(6,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.319E-03	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(7,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.319E-03	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(8,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.319E-03	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
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	8.245E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.319E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.663E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)

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 Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.374E-03	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(5,1
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.778E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
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
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)	1.600E+02	1.600E+02	---	DIET(1)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+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
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)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	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
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:	2.00 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

U-234	3.050E+01
U-235	1.300E+00
U-238	6.820E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.401E+01	1.396E+01	1.383E+01	1.356E+01	1.269E+01	1.009E+01	5.359E+00	1.006E+02
M(t):	4.670E-01	4.655E-01	4.609E-01	4.519E-01	4.232E-01	3.364E-01	1.786E-01	3.353E+00

Maximum TDOSE(t): 1.006E+02 mrem/yr at t = 1.000E+03 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)

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
U-234	7.131E-03	0.0005	2.576E-01	0.0184	0.000E+00	0.0000	1.878E+00	0.1341	6.197E-02	0.0044	1.519E-01	0.0108	2.363E-01
U-235	5.621E-01	0.0401	1.023E-02	0.0007	0.000E+00	0.0000	7.553E-02	0.0054	2.492E-03	0.0002	6.110E-03	0.0004	9.502E-03
U-238	5.287E+00	0.3774	5.150E-01	0.0368	0.000E+00	0.0000	3.992E+00	0.2849	1.317E-01	0.0094	3.229E-01	0.0230	5.022E-01
Total	5.856E+00	0.4180	7.829E-01	0.0559	0.000E+00	0.0000	5.946E+00	0.4244	1.962E-01	0.0140	4.810E-01	0.0343	7.480E-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 mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Path mrem/yr
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	2.593E+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	6.660E-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	1.075E+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	1.401E+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
U-234	7.108E-03	0.0005	2.568E-01	0.0184	0.000E+00	0.0000	1.872E+00	0.1341	6.178E-02	0.0044	1.514E-01	0.0108	2.355E-01
U-235	5.603E-01	0.0401	1.020E-02	0.0007	0.000E+00	0.0000	7.554E-02	0.0054	2.533E-03	0.0002	6.090E-03	0.0004	9.479E-03
U-238	5.269E+00	0.3773	5.133E-01	0.0368	0.000E+00	0.0000	3.979E+00	0.2850	1.313E-01	0.0094	3.219E-01	0.0231	5.006E-01
Total	5.837E+00	0.4180	7.803E-01	0.0559	0.000E+00	0.0000	5.927E+00	0.4244	1.956E-01	0.0140	4.794E-01	0.0343	7.455E-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-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
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	2.585E+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	6.641E-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	1.072E+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	1.396E+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 = 4.000E+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
U-234	7.043E-03	0.0005	2.543E-01	0.0184	0.000E+00	0.0000	1.854E+00	0.1341	6.117E-02	0.0044	1.499E-01	0.0108	2.332E-01
U-235	5.547E-01	0.0401	1.011E-02	0.0007	0.000E+00	0.0000	7.556E-02	0.0055	2.669E-03	0.0002	6.030E-03	0.0004	9.411E-03
U-238	5.217E+00	0.3773	5.082E-01	0.0368	0.000E+00	0.0000	3.940E+00	0.2849	1.300E-01	0.0094	3.187E-01	0.0230	4.956E-01
Total	5.779E+00	0.4179	7.726E-01	0.0559	0.000E+00	0.0000	5.869E+00	0.4245	1.938E-01	0.0140	4.747E-01	0.0343	7.382E-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 = 4.000E+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
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	2.559E+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	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	1.061E+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	1.383E+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		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
U-234	6.936E-03	0.0005	2.493E-01	0.0184	0.000E+00	0.0000	1.817E+00	0.1340	5.996E-02	0.0044	1.470E-01	0.0108	2.286E-01
U-235	5.439E-01	0.0401	9.937E-03	0.0007	0.000E+00	0.0000	7.565E-02	0.0056	2.932E-03	0.0002	5.912E-03	0.0004	9.284E-03
U-238	5.114E+00	0.3772	4.982E-01	0.0367	0.000E+00	0.0000	3.862E+00	0.2849	1.274E-01	0.0094	3.124E-01	0.0230	4.858E-01
Total	5.665E+00	0.4179	7.574E-01	0.0559	0.000E+00	0.0000	5.755E+00	0.4245	1.903E-01	0.0140	4.653E-01	0.0343	7.237E-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+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
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	2.509E+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	6.476E-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	1.040E+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	1.356E+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		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
U-234	6.778E-03	0.0005	2.334E-01	0.0184	0.000E+00	0.0000	1.701E+00	0.1340	5.612E-02	0.0044	1.375E-01	0.0108	2.140E-01
U-235	5.092E-01	0.0401	9.434E-03	0.0007	0.000E+00	0.0000	7.609E-02	0.0060	3.728E-03	0.0003	5.535E-03	0.0004	8.921E-03
U-238	4.786E+00	0.3770	4.662E-01	0.0367	0.000E+00	0.0000	3.615E+00	0.2847	1.193E-01	0.0094	2.924E-01	0.0230	4.547E-01
Total	5.302E+00	0.4176	7.090E-01	0.0559	0.000E+00	0.0000	5.392E+00	0.4247	1.791E-01	0.0141	4.355E-01	0.0343	6.776E-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
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	2.349E+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	6.129E-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	9.733E+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	1.269E+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
U-234	8.208E-03	0.0008	1.853E-01	0.0184	0.000E+00	0.0000	1.353E+00	0.1340	4.461E-02	0.0044	1.091E-01	0.0108	1.699E-01
U-235	4.050E-01	0.0401	8.044E-03	0.0008	0.000E+00	0.0000	7.645E-02	0.0076	5.689E-03	0.0006	4.400E-03	0.0004	7.899E-03
U-238	3.794E+00	0.3759	3.697E-01	0.0366	0.000E+00	0.0000	2.866E+00	0.2839	9.456E-02	0.0094	2.318E-01	0.0230	3.605E-01
Total	4.207E+00	0.4168	5.630E-01	0.0558	0.000E+00	0.0000	4.295E+00	0.4255	1.449E-01	0.0144	3.453E-01	0.0342	5.383E-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-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
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	1.870E+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	5.075E-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	7.716E+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	1.009E+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+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
U-234	2.146E-02	0.0040	9.620E-02	0.0179	0.000E+00	0.0000	7.250E-01	0.1353	2.386E-02	0.0045	5.684E-02	0.0106	8.859E-02
U-235	2.107E-01	0.0393	5.059E-03	0.0009	0.000E+00	0.0000	6.368E-02	0.0119	6.939E-03	0.0013	2.286E-03	0.0004	5.362E-03
U-238	1.953E+00	0.3645	1.905E-01	0.0355	0.000E+00	0.0000	1.476E+00	0.2755	4.872E-02	0.0091	1.194E-01	0.0223	1.857E-01
Total	2.185E+00	0.4078	2.917E-01	0.0544	0.000E+00	0.0000	2.265E+00	0.4226	7.952E-02	0.0148	1.786E-01	0.0333	2.797E-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-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
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	1.012E+00
U-235	7.313E-02	0.0136	7.026E-04	0.0001	0.000E+00	0.0000	5.616E-03	0.0010	1.553E-05	0.0000	3.416E-05	0.0000	3.736E-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	3.974E+00
Total	7.313E-02	0.0136	7.026E-04	0.0001	0.000E+00	0.0000	5.616E-03	0.0010	1.553E-05	0.0000	3.416E-05	0.0000	5.359E+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		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
U-234	6.510E-02	0.0006	1.096E-02	0.0001	0.000E+00	0.0000	1.795E-01	0.0018	5.782E-03	0.0001	8.191E-03	0.0001	1.198E-02
U-235	2.140E-02	0.0002	8.078E-04	0.0000	0.000E+00	0.0000	1.450E-02	0.0001	2.041E-03	0.0000	2.309E-04	0.0000	9.658E-04
U-238	1.914E-01	0.0019	1.870E-02	0.0002	0.000E+00	0.0000	1.451E-01	0.0014	4.786E-03	0.0000	1.172E-02	0.0001	1.823E-02
Total	2.779E-01	0.0028	3.047E-02	0.0003	0.000E+00	0.0000	3.391E-01	0.0034	1.261E-02	0.0001	2.015E-02	0.0002	3.118E-02

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
U-234	2.768E+01	0.2751	3.430E-02	0.0003	0.000E+00	0.0000	2.129E+00	0.0212	1.028E-01	0.0010	3.877E-01	0.0039	3.061E+01
U-235	5.112E+00	0.0508	3.230E-02	0.0003	0.000E+00	0.0000	3.932E-01	0.0039	5.377E-02	0.0005	1.703E-02	0.0002	5.648E+00
U-238	5.836E+01	0.5802	6.181E-02	0.0006	0.000E+00	0.0000	4.489E+00	0.0446	2.125E-01	0.0021	8.204E-01	0.0082	6.433E+01
Total	9.115E+01	0.9061	1.284E-01	0.0013	0.000E+00	0.0000	7.012E+00	0.0697	3.690E-01	0.0037	1.225E+00	0.0122	1.006E+02

*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	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	8.502E-02	8.475E-02	8.391E-02	8.225E-02	7.697E-02	6.100E-02	3.139E-02	9.837E-01
U-234	Th-230	1.000E+00	0.000E+00	7.916E-07	3.077E-06	7.580E-06	2.196E-05	6.535E-05	1.456E-04	2.272E-04
U-234	Ra-226	1.000E+00	0.000E+00	2.123E-08	3.465E-07	2.150E-06	1.862E-05	1.799E-04	1.099E-03	6.711E-03
U-234	Pb-210	1.000E+00	0.000E+00	1.782E-10	9.242E-09	1.303E-07	2.874E-06	6.122E-05	5.447E-04	1.303E-02
U-234	∑DSR(j)		8.502E-02	8.475E-02	8.391E-02	8.226E-02	7.701E-02	6.130E-02	3.318E-02	1.004E+00
U-235	U-235	1.000E+00	5.123E-01	5.106E-01	5.056E-01	4.956E-01	4.638E-01	3.676E-01	1.893E-01	9.464E-01
U-235	Pa-231	1.000E+00	0.000E+00	2.367E-04	9.659E-04	2.381E-03	6.700E-03	1.771E-02	2.730E-02	8.057E-01
U-235	Ac-227	1.000E+00	0.000E+00	2.041E-06	2.771E-05	1.540E-04	1.032E-03	5.057E-03	7.079E-02	2.593E+00
U-235	∑DSR(j)		5.123E-01	5.109E-01	5.066E-01	4.981E-01	4.715E-01	3.904E-01	2.874E-01	4.345E+00
U-238	U-238	1.000E+00	1.576E-01	1.571E-01	1.556E-01	1.525E-01	1.427E-01	1.131E-01	5.824E-02	9.405E-01
U-238	U-234	1.000E+00	0.000E+00	2.403E-07	9.515E-07	2.332E-06	6.546E-06	1.729E-05	2.671E-05	2.793E-03
U-238	Th-230	1.000E+00	0.000E+00	1.155E-12	1.755E-11	1.072E-10	9.192E-10	8.756E-09	5.185E-08	1.789E-07
U-238	Ra-226	1.000E+00	0.000E+00	1.974E-14	1.302E-12	2.022E-11	5.226E-10	1.645E-08	2.813E-07	7.816E-06
U-238	Pb-210	1.000E+00	0.000E+00	1.342E-16	2.696E-14	9.450E-13	6.345E-11	4.721E-09	1.286E-07	2.110E-05
U-238	∑DSR(j)		1.576E-01	1.571E-01	1.556E-01	1.525E-01	1.427E-01	1.131E-01	5.827E-02	9.433E-01

*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 = 30 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	3.528E+02	3.540E+02	3.575E+02	3.647E+02	3.896E+02	4.894E+02	9.042E+02	2.989E+01
U-235	5.856E+01	5.872E+01	5.922E+01	6.022E+01	6.363E+01	7.685E+01	1.044E+02	6.905E+00
U-238	1.903E+02	1.909E+02	1.928E+02	1.967E+02	2.102E+02	2.652E+02	5.148E+02	3.180E+01

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 = 1.000E+03 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
U-234	3.050E+01	1.000E+03	1.004E+00	2.989E+01	1.004E+00	2.989E+01
U-235	1.300E+00	1.000E+03	4.345E+00	6.905E+00	4.345E+00	6.905E+00
U-238	6.820E+01	1.000E+03	9.433E-01	3.180E+01	9.433E-01	3.180E+01

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

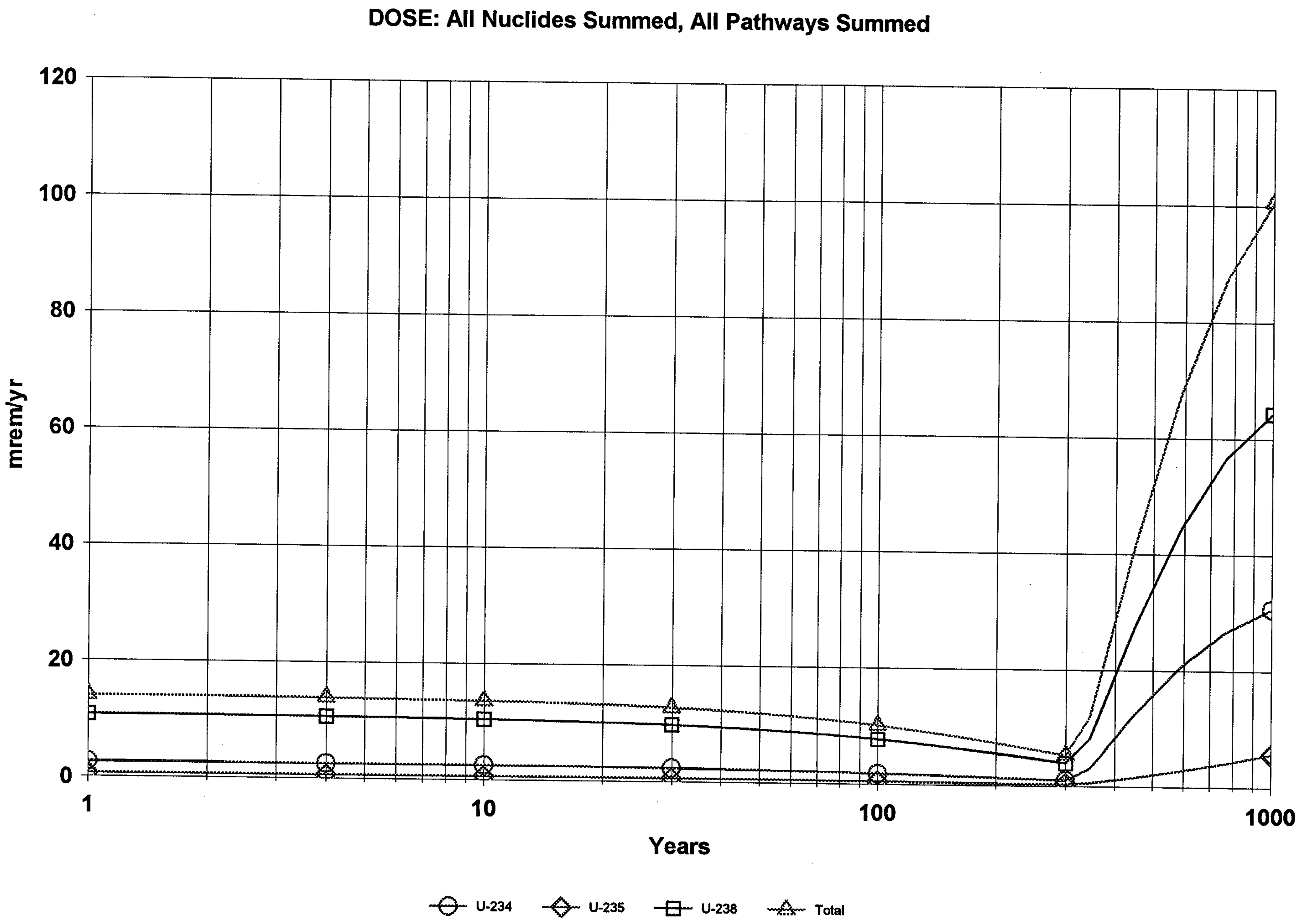
Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	2.593E+00	2.585E+00	2.559E+00	2.509E+00	2.347E+00	1.860E+00	9.573E-01	3.000E+01
U-234	U-238	1.000E+00	0.000E+00	1.639E-05	6.489E-05	1.590E-04	4.464E-04	1.180E-03	1.821E-03	1.905E-01
U-234	∑DOSE(j):		2.593E+00	2.585E+00	2.559E+00	2.509E+00	2.348E+00	1.862E+00	9.592E-01	3.019E+01
Th-230	U-234	1.000E+00	0.000E+00	2.415E-05	9.385E-05	2.312E-04	6.696E-04	1.993E-03	4.441E-03	6.928E-03
Th-230	U-238	1.000E+00	0.000E+00	7.879E-11	1.197E-09	7.311E-09	6.269E-08	5.972E-07	3.536E-06	1.220E-05
Th-230	∑DOSE(j):		0.000E+00	2.415E-05	9.385E-05	2.312E-04	6.697E-04	1.994E-03	4.445E-03	6.940E-03
Ra-226	U-234	1.000E+00	0.000E+00	6.476E-07	1.057E-05	6.558E-05	5.680E-04	5.486E-03	3.352E-02	2.047E-01
Ra-226	U-238	1.000E+00	0.000E+00	1.346E-12	8.882E-11	1.379E-09	3.564E-08	1.122E-06	1.919E-05	5.331E-04
Ra-226	∑DOSE(j):		0.000E+00	6.476E-07	1.057E-05	6.558E-05	5.680E-04	5.487E-03	3.354E-02	2.052E-01
Pb-210	U-234	1.000E+00	0.000E+00	5.436E-09	2.819E-07	3.975E-06	8.766E-05	1.867E-03	1.661E-02	3.973E-01
Pb-210	U-238	1.000E+00	0.000E+00	9.151E-15	1.838E-12	6.445E-11	4.327E-09	3.219E-07	8.774E-06	1.439E-03
Pb-210	∑DOSE(j):		0.000E+00	5.436E-09	2.819E-07	3.975E-06	8.767E-05	1.868E-03	1.662E-02	3.988E-01
U-235	U-235	1.000E+00	6.660E-01	6.638E-01	6.572E-01	6.443E-01	6.029E-01	4.779E-01	2.461E-01	1.230E+00
Pa-231	U-235	1.000E+00	0.000E+00	3.077E-04	1.256E-03	3.095E-03	8.710E-03	2.302E-02	3.549E-02	1.047E+00
Ac-227	U-235	1.000E+00	0.000E+00	2.653E-06	3.602E-05	2.002E-04	1.341E-03	6.574E-03	9.202E-02	3.371E+00
U-238	U-238	1.000E+00	1.075E+01	1.072E+01	1.061E+01	1.040E+01	9.732E+00	7.715E+00	3.972E+00	6.414E+01

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	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	3.050E+01	3.040E+01	3.010E+01	2.950E+01	2.761E+01	2.188E+01	1.126E+01	1.100E+00
U-234	U-238	1.000E+00	0.000E+00	1.927E-04	7.632E-04	1.870E-03	5.250E-03	1.387E-02	2.142E-02	6.986E-03
U-234	∑S(j):		3.050E+01	3.040E+01	3.010E+01	2.951E+01	2.761E+01	2.189E+01	1.128E+01	1.107E+00
Th-230	U-234	1.000E+00	0.000E+00	2.741E-04	1.091E-03	2.700E-03	7.838E-03	2.335E-02	5.203E-02	7.898E-02
Th-230	U-238	1.000E+00	0.000E+00	8.683E-10	1.380E-08	8.512E-08	7.330E-07	6.993E-06	4.143E-05	1.324E-04
Th-230	∑S(j):		0.000E+00	2.741E-04	1.091E-03	2.700E-03	7.839E-03	2.335E-02	5.207E-02	7.911E-02
Ra-226	U-234	1.000E+00	0.000E+00	5.935E-08	9.438E-07	5.827E-06	5.035E-05	4.859E-04	2.969E-03	1.023E-02
Ra-226	U-238	1.000E+00	0.000E+00	1.254E-13	7.967E-12	1.227E-10	3.161E-09	9.939E-08	1.699E-06	1.469E-05
Ra-226	∑S(j):		0.000E+00	5.935E-08	9.438E-07	5.827E-06	5.035E-05	4.860E-04	2.970E-03	1.025E-02
Pb-210	U-234	1.000E+00	0.000E+00	6.102E-10	3.794E-08	5.601E-07	1.262E-05	2.708E-04	2.414E-03	9.543E-03
Pb-210	U-238	1.000E+00	0.000E+00	9.666E-16	2.417E-13	8.986E-12	6.206E-10	4.664E-08	1.275E-06	1.346E-05
Pb-210	∑S(j):		0.000E+00	6.102E-10	3.794E-08	5.601E-07	1.262E-05	2.709E-04	2.416E-03	9.556E-03
U-235	U-235	1.000E+00	1.300E+00	1.296E+00	1.283E+00	1.258E+00	1.177E+00	9.328E-01	4.803E-01	4.704E-02
Pa-231	U-235	1.000E+00	0.000E+00	2.741E-05	1.086E-04	2.661E-04	7.467E-04	1.972E-03	3.039E-03	9.848E-04
Ac-227	U-235	1.000E+00	0.000E+00	4.311E-07	6.586E-06	3.760E-05	2.550E-04	1.255E-03	2.394E-03	8.299E-04
U-238	U-238	1.000E+00	6.820E+01	6.797E+01	6.730E+01	6.597E+01	6.174E+01	4.894E+01	2.520E+01	2.468E+00

BRF(i) is the branch fraction of the parent nuclide.



SITE1.RAD 10/13/99 13:09 Includes All Pathways

Attachment F

RESRAD Version 5.82 Code Run
(Residential Scenario, Building 611B Site Specific Parameters)

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

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	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(3)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	U-234	1.320E-01	1.320E-01	DCF2(6)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(7)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(8)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(3)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	U-234	2.830E-04	2.830E-04	DCF3(6)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(7)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(8)
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	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(6,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(6,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
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	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)

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) *	4.000E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m) *	2.500E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+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)	4.000E+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)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	3.050E+01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): U-235	1.300E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): U-238	6.820E+01	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(8)
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)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+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)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(6,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.655E-02	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(7,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.655E-02	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(8,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.655E-02	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
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	6.596E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.655E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.330E-02	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)

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 Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.899E-02	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(5,1
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.222E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
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
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)	1.600E+02	1.600E+02	---	DIET(1)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+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	0.200E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.200E+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
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)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	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
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:	4000.00 square meters
Thickness:	0.25 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
U-234	3.050E+01
U-235	1.300E+00
U-238	6.820E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	9.102E+00	8.857E+00	8.157E+00	6.918E+00	3.990E+00	5.673E-01	4.052E-02	1.344E+01
M(t):	3.034E-01	2.952E-01	2.719E-01	2.306E-01	1.330E-01	1.891E-02	1.351E-03	4.480E-01

Maximum TDOSE(t): 1.344E+01 mrem/yr at t = 1.000E+03 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)

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
U-234	7.003E-03	0.0008	2.344E-01	0.0258	0.000E+00	0.0000	5.223E-01	0.0574	2.025E-02	0.0022	5.131E-02	0.0056	2.363E-01
U-235	5.619E-01	0.0617	9.312E-03	0.0010	0.000E+00	0.0000	2.100E-02	0.0023	8.142E-04	0.0001	2.063E-03	0.0002	9.502E-03
U-238	5.192E+00	0.5705	4.686E-01	0.0515	0.000E+00	0.0000	1.110E+00	0.1220	4.303E-02	0.0047	1.091E-01	0.0120	5.022E-01
Total	5.761E+00	0.6330	7.124E-01	0.0783	0.000E+00	0.0000	1.653E+00	0.1817	6.409E-02	0.0070	1.624E-01	0.0178	7.480E-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
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	1.072E+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	6.046E-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	7.425E+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	9.102E+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+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
U-234	6.820E-03	0.0008	2.283E-01	0.0258	0.000E+00	0.0000	5.071E-01	0.0573	1.974E-02	0.0022	4.997E-02	0.0056	2.301E-01
U-235	5.472E-01	0.0618	9.070E-03	0.0010	0.000E+00	0.0000	2.046E-02	0.0023	8.054E-04	0.0001	2.009E-03	0.0002	9.261E-03
U-238	5.055E+00	0.5707	4.564E-01	0.0515	0.000E+00	0.0000	1.078E+00	0.1217	4.197E-02	0.0047	1.062E-01	0.0120	4.891E-01
Total	5.609E+00	0.6333	6.937E-01	0.0783	0.000E+00	0.0000	1.606E+00	0.1813	6.251E-02	0.0071	1.582E-01	0.0179	7.284E-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-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
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	1.042E+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	5.888E-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	7.226E+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	8.857E+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 = 4.000E+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
U-234	6.303E-03	0.0008	2.108E-01	0.0258	0.000E+00	0.0000	4.627E-01	0.0567	1.821E-02	0.0022	4.610E-02	0.0057	2.125E-01
U-235	5.053E-01	0.0619	8.383E-03	0.0010	0.000E+00	0.0000	1.886E-02	0.0023	7.771E-04	0.0001	1.854E-03	0.0002	8.575E-03
U-238	4.664E+00	0.5717	4.214E-01	0.0517	0.000E+00	0.0000	9.834E-01	0.1206	3.871E-02	0.0047	9.799E-02	0.0120	4.516E-01
Total	5.175E+00	0.6344	6.406E-01	0.0785	0.000E+00	0.0000	1.465E+00	0.1796	5.770E-02	0.0071	1.459E-01	0.0179	6.727E-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 = 4.000E+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
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	9.566E-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	5.437E-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	6.657E+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	8.157E+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+01 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
U-234	5.402E-03	0.0008	1.798E-01	0.0260	0.000E+00	0.0000	3.850E-01	0.0556	1.550E-02	0.0022	3.924E-02	0.0057	1.812E-01
U-235	4.308E-01	0.0623	7.166E-03	0.0010	0.000E+00	0.0000	1.602E-02	0.0023	7.190E-04	0.0001	1.578E-03	0.0002	7.358E-03
U-238	3.970E+00	0.5738	3.594E-01	0.0519	0.000E+00	0.0000	8.182E-01	0.1183	3.294E-02	0.0048	8.342E-02	0.0121	3.851E-01
Total	4.406E+00	0.6368	5.463E-01	0.0790	0.000E+00	0.0000	1.219E+00	0.1762	4.916E-02	0.0071	1.242E-01	0.0180	5.737E-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
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	8.061E-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	4.636E-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	5.649E+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	6.918E+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+01 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
U-234	3.366E-03	0.0008	1.058E-01	0.0265	0.000E+00	0.0000	2.076E-01	0.0520	9.052E-03	0.0023	2.294E-02	0.0057	1.066E-01
U-235	2.530E-01	0.0634	4.264E-03	0.0011	0.000E+00	0.0000	9.262E-03	0.0023	5.301E-04	0.0001	9.231E-04	0.0002	4.432E-03
U-238	2.315E+00	0.5803	2.113E-01	0.0530	0.000E+00	0.0000	4.411E-01	0.1105	1.924E-02	0.0048	4.877E-02	0.0122	2.265E-01
Total	2.572E+00	0.6446	3.214E-01	0.0805	0.000E+00	0.0000	6.579E-01	0.1649	2.882E-02	0.0072	7.264E-02	0.0182	3.375E-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
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	4.554E-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	2.724E-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	3.262E+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	3.990E+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+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
U-234	1.335E-03	0.0024	1.665E-02	0.0294	0.000E+00	0.0000	2.235E-02	0.0394	1.385E-03	0.0024	3.509E-03	0.0062	1.677E-02
U-235	3.849E-02	0.0678	6.978E-04	0.0012	0.000E+00	0.0000	1.225E-03	0.0022	1.349E-04	0.0002	1.412E-04	0.0002	7.539E-04
U-238	3.383E-01	0.5964	3.295E-02	0.0581	0.000E+00	0.0000	4.693E-02	0.0827	2.926E-03	0.0052	7.451E-03	0.0131	3.531E-02
Total	3.782E-01	0.6666	5.030E-02	0.0887	0.000E+00	0.0000	7.050E-02	0.1243	4.446E-03	0.0078	1.110E-02	0.0196	5.283E-02

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-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
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	6.200E-02
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	4.144E-02
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	4.639E-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	5.673E-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+02 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
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 = 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
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	3.749E-02	0.9251	1.441E-04	0.0036	0.000E+00	0.0000	2.879E-03	0.0710	3.183E-06	0.0001	7.005E-06	0.0002	4.052E-02
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	3.749E-02	0.9251	1.441E-04	0.0036	0.000E+00	0.0000	2.879E-03	0.0710	3.183E-06	0.0001	7.005E-06	0.0002	4.052E-02

*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		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
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+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
U-234	3.783E+00	0.2815	1.993E-03	0.0001	0.000E+00	0.0000	2.911E-01	0.0217	5.669E-03	0.0004	2.117E-02	0.0016	4.103E+00
U-235	6.784E-01	0.0505	1.693E-03	0.0001	0.000E+00	0.0000	5.219E-02	0.0039	2.922E-03	0.0002	9.228E-04	0.0001	7.361E-01
U-238	7.930E+00	0.5901	3.360E-03	0.0003	0.000E+00	0.0000	6.100E-01	0.0454	1.155E-02	0.0009	4.459E-02	0.0033	8.600E+00
Total	1.239E+01	0.9221	7.047E-03	0.0005	0.000E+00	0.0000	9.533E-01	0.0709	2.014E-02	0.0015	6.669E-02	0.0050	1.344E+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	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	3.513E-02	3.417E-02	3.136E-02	2.643E-02	1.491E-02	1.984E-03	0.000E+00	1.319E-01
U-234	Th-230	1.000E+00	0.000E+00	4.358E-07	1.651E-06	3.786E-06	8.705E-06	1.354E-05	0.000E+00	1.147E-06
U-234	Ra-226	1.000E+00	0.000E+00	1.422E-08	2.187E-07	1.243E-06	8.147E-06	3.175E-05	0.000E+00	5.582E-04
U-234	Pb-210	1.000E+00	0.000E+00	5.077E-11	2.550E-09	3.278E-08	5.234E-07	3.625E-06	0.000E+00	2.088E-03
U-234	∑DSR(j)		3.513E-02	3.417E-02	3.137E-02	2.643E-02	1.493E-02	2.033E-03	0.000E+00	1.345E-01
U-235	U-235	1.000E+00	4.651E-01	4.528E-01	4.180E-01	3.560E-01	2.084E-01	3.138E-02	0.000E+00	1.248E-01
U-235	Pa-231	1.000E+00	0.000E+00	6.977E-05	2.612E-04	5.488E-04	9.081E-04	3.592E-04	0.000E+00	1.051E-01
U-235	Ac-227	1.000E+00	0.000E+00	9.888E-07	1.277E-05	5.846E-05	2.056E-04	1.389E-04	3.117E-02	3.364E-01
U-235	∑DSR(j)		4.651E-01	4.529E-01	4.182E-01	3.566E-01	2.096E-01	3.188E-02	3.117E-02	5.663E-01
U-238	U-238	1.000E+00	1.089E-01	1.060E-01	9.761E-02	8.282E-02	4.783E-02	6.801E-03	0.000E+00	1.257E-01
U-238	U-234	1.000E+00	0.000E+00	9.686E-08	3.557E-07	7.492E-07	1.268E-06	5.625E-07	0.000E+00	3.744E-04
U-238	Th-230	1.000E+00	0.000E+00	6.243E-13	9.230E-12	5.137E-11	3.217E-10	1.156E-09	0.000E+00	2.298E-09
U-238	Ra-226	1.000E+00	0.000E+00	1.332E-14	8.161E-13	1.141E-11	2.116E-10	2.188E-09	0.000E+00	9.262E-07
U-238	Pb-210	1.000E+00	0.000E+00	3.797E-17	7.355E-15	2.324E-13	1.082E-11	2.200E-10	0.000E+00	3.401E-06
U-238	∑DSR(j)		1.089E-01	1.060E-01	9.761E-02	8.282E-02	4.783E-02	6.802E-03	0.000E+00	1.261E-01

*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 = 30 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	8.539E+02	8.780E+02	9.565E+02	1.135E+03	2.009E+03	1.476E+04	*6.245E+09	2.230E+02
U-235	6.451E+01	6.624E+01	7.173E+01	8.412E+01	1.432E+02	9.412E+02	9.625E+02	5.298E+01
U-238	2.755E+02	2.831E+02	3.073E+02	3.622E+02	6.272E+02	4.410E+03	*3.360E+05	2.379E+02

*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 = 1.000E+03 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
U-234	3.050E+01	1.000E+03	1.345E-01	2.230E+02	1.345E-01	2.230E+02
U-235	1.300E+00	1.000E+03	5.663E-01	5.298E+01	5.663E-01	5.298E+01
U-238	6.820E+01	1.000E+03	1.261E-01	2.379E+02	1.261E-01	2.379E+02

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

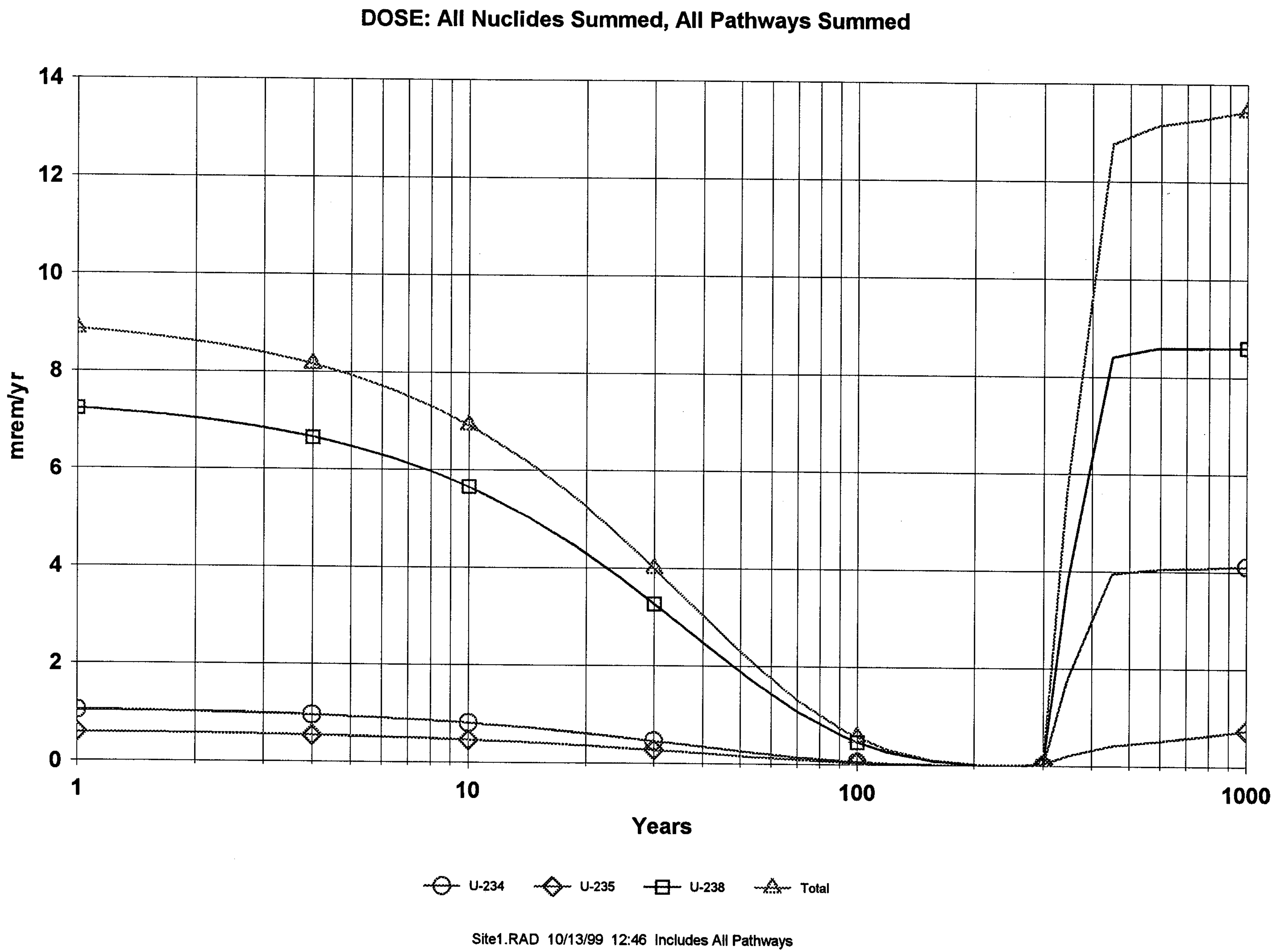
Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	1.072E+00	1.042E+00	9.566E-01	8.060E-01	4.549E-01	6.051E-02	0.000E+00	4.023E+00
U-234	U-238	1.000E+00	0.000E+00	6.606E-06	2.426E-05	5.109E-05	8.651E-05	3.836E-05	0.000E+00	2.554E-02
U-234	∑DOSE(j):		1.072E+00	1.042E+00	9.566E-01	8.060E-01	4.549E-01	6.054E-02	0.000E+00	4.048E+00
Th-230	U-234	1.000E+00	0.000E+00	1.329E-05	5.035E-05	1.155E-04	2.655E-04	4.130E-04	0.000E+00	3.499E-05
Th-230	U-238	1.000E+00	0.000E+00	4.258E-11	6.295E-10	3.503E-09	2.194E-08	7.885E-08	0.000E+00	1.567E-07
Th-230	∑DOSE(j):		0.000E+00	1.329E-05	5.035E-05	1.155E-04	2.655E-04	4.130E-04	0.000E+00	3.514E-05
Ra-226	U-234	1.000E+00	0.000E+00	4.336E-07	6.670E-06	3.790E-05	2.485E-04	9.685E-04	0.000E+00	1.703E-02
Ra-226	U-238	1.000E+00	0.000E+00	9.084E-13	5.566E-11	7.779E-10	1.443E-08	1.493E-07	0.000E+00	6.317E-05
Ra-226	∑DOSE(j):		0.000E+00	4.336E-07	6.670E-06	3.790E-05	2.485E-04	9.686E-04	0.000E+00	1.709E-02
Pb-210	U-234	1.000E+00	0.000E+00	1.549E-09	7.777E-08	9.998E-07	1.596E-05	1.106E-04	0.000E+00	6.370E-02
Pb-210	U-238	1.000E+00	0.000E+00	2.589E-15	5.016E-13	1.585E-11	7.379E-10	1.500E-08	0.000E+00	2.319E-04
Pb-210	∑DOSE(j):		0.000E+00	1.549E-09	7.777E-08	9.999E-07	1.596E-05	1.106E-04	0.000E+00	6.393E-02
U-235	U-235	1.000E+00	6.046E-01	5.887E-01	5.433E-01	4.628E-01	2.710E-01	4.079E-02	0.000E+00	1.622E-01
Pa-231	U-235	1.000E+00	0.000E+00	9.071E-05	3.395E-04	7.134E-04	1.180E-03	4.670E-04	0.000E+00	1.367E-01
Ac-227	U-235	1.000E+00	0.000E+00	1.285E-06	1.660E-05	7.599E-05	2.673E-04	1.806E-04	4.052E-02	4.373E-01
U-238	U-238	1.000E+00	7.425E+00	7.226E+00	6.657E+00	5.649E+00	3.262E+00	4.639E-01	0.000E+00	8.574E+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	4.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	3.050E+01	2.970E+01	2.743E+01	2.339E+01	1.375E+01	2.143E+00	1.058E-02	8.938E-11
U-234	U-238	1.000E+00	0.000E+00	1.883E-04	6.954E-04	1.483E-03	2.615E-03	1.359E-03	2.012E-05	5.674E-13
U-234	∑S(j):		3.050E+01	2.970E+01	2.743E+01	2.339E+01	1.375E+01	2.144E+00	1.060E-02	8.994E-11
Th-230	U-234	1.000E+00	0.000E+00	2.709E-04	1.042E-03	2.411E-03	5.675E-03	9.592E-03	1.025E-02	1.003E-02
Th-230	U-238	1.000E+00	0.000E+00	8.550E-10	1.298E-08	7.304E-08	4.688E-07	1.831E-06	2.443E-06	2.398E-06
Th-230	∑S(j):		0.000E+00	2.709E-04	1.042E-03	2.411E-03	5.675E-03	9.593E-03	1.025E-02	1.004E-02
Ra-226	U-234	1.000E+00	0.000E+00	5.857E-08	8.952E-07	5.110E-06	3.428E-05	1.514E-04	2.268E-04	2.241E-04
Ra-226	U-238	1.000E+00	0.000E+00	1.234E-13	7.481E-12	1.049E-10	1.991E-09	2.333E-08	5.316E-08	5.357E-08
Ra-226	∑S(j):		0.000E+00	5.857E-08	8.952E-07	5.110E-06	3.428E-05	1.514E-04	2.268E-04	2.242E-04
Pb-210	U-234	1.000E+00	0.000E+00	6.024E-10	3.604E-08	4.928E-07	8.640E-06	8.282E-05	1.578E-04	1.571E-04
Pb-210	U-238	1.000E+00	0.000E+00	9.542E-16	2.277E-13	7.742E-12	3.982E-10	1.123E-08	3.658E-08	3.754E-08
Pb-210	∑S(j):		0.000E+00	6.024E-10	3.604E-08	4.928E-07	8.641E-06	8.283E-05	1.578E-04	1.571E-04
U-235	U-235	1.000E+00	1.300E+00	1.266E+00	1.169E+00	9.968E-01	5.861E-01	9.136E-02	4.512E-04	3.820E-12
Pa-231	U-235	1.000E+00	0.000E+00	2.678E-05	9.893E-05	2.109E-04	3.719E-04	1.931E-04	2.855E-06	7.998E-14
Ac-227	U-235	1.000E+00	0.000E+00	4.164E-07	5.741E-06	2.684E-05	9.762E-05	7.419E-05	1.216E-06	3.524E-14
U-238	U-238	1.000E+00	6.820E+01	6.641E+01	6.133E+01	5.230E+01	3.075E+01	4.793E+00	2.367E-02	2.004E-10

BRF(i) is the branch fraction of the parent nuclide.


DOSE: All Nuclides Summed, All Pathways Summed
14
12
10
8
6
4
2
0
mrem/yr
1
10
100
1000
Years
U-234
U-235
U-238
Total
Site1.RAD 10/13/99 12:46 Includes All Pathways

BETWEEN:

License Fee Management Branch, ARM
and
Regional Licensing Sections

(FOR LFMS USE)
INFORMATION FROM LTS

Program Code: 11300
Status Code: 0
Fee Category: EX 2C
Exp. Date: 20010531
Fee Comments: NOT SHIELDING
Decom Fin Assur Reqd: Y

LICENSE FEE TRANSMITTAL

A. REGION

1. APPLICATION ATTACHED
   Applicant/Licensee: ARMY, DEPARTMENT OF THE
   Received Date: 19991202
   Docket No: 4006377
   Control No.: 127545
   License No.: SUB-348
   Action Type: Amendment

2. FEE ATTACHED
   Amount: ___/___
   Check No.: ___/___

3. COMMENTS

Signed R. J. Brown
Date ____________

B. LICENSE FEE MANAGEMENT BRANCH (Check when milestone 03 is entered /__/)

1. Fee Category and Amount: ____________

2. Correct Fee Paid. Application may be processed for:
   Amendment ____________
   Renewal ____________
   License ____________

3. OTHER ____________
   ____

Signed ____________
Date ____________

This is to acknowledge the receipt of your letter/application dated

11-29-99, and to inform you that the initial processing which includes an administrative review has been performed.

Amend SUB-348/40-06377

☒ There were no administrative omissions. Your application was assigned to a technical reviewer. Please note that the technical review may identify additional omissions or require additional information.

☐ Please provide to this office within 30 days of your receipt of this card

____.

A copy of your action has been forwarded to our License Fee & Accounts Receivable Branch, who will contact you separately if there is a fee issue involved.

Your action has been assigned **Mail Control Number** 127545.
When calling to inquire about this action, please refer to this control number.
You may call us on (610) 337-5398, or 337-5260.

NRC FORM 532 (RI)
(6-96)

Sincerely,
Licensing Assistance Team Leader