Nevada
Environmental
Restoration
Project

DOE/NV-446 - Rev. 1

Streamlined Approach for Environmental Restoration Plan for Corrective Action Unit 430, Buried Depleted Uranium Artillery Round No. 1, Tonopah Test Range

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Revision: 1

September 1996

MASTER

Environmental Restoration
Division

U.S. Department of Energy
Nevada Operations Office

DOE/NV--446

STREAMLINED APPROACH FOR ENVIRONMENTAL RESTORATION PLAN FOR CORRECTIVE ACTION UNIT 430, BURIED DEPLETED URANIUM ARTILLERY ROUND NO. 1, TONOPAH TEST RANGE

DOE Nevada Operations Office
Las Vegas, Nevada

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STREAMLINED APPROACH FOR ENVIRONMENTAL RESTORATION PLAN FOR CORRECTIVE ACTION UNIT 430, BURIED DEPLETED URANIUM ARTILLERY ROUND NO. 1, TONOPAH TEST RANGE

UNCONTROLLED

Approved by: Sabine Curtis Date: Sept. 30, 1996

Sabine Curtis, Subproject Manager
Industrial Sites Subproject

Approved by: David Shafer Date: September 30, 1996

David Shafer, Acting Project Manager
Environmental Restoration Project

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List of Acronyms and Abbreviations

Ac	Actinium
AIHC	American Industrial Health Council
Am	Americium
Be	Beryllium
Bq/Ci	Becquerel(s) per curie
CAU	Corrective Action Unit(s)
C_e	Evapotranspiration coefficient
CFR	Code of Federal Regulations
Ci	Curie(s)
CLP	Contract Laboratory Program
cm	Centimeter(s)
cm^3/g	Cubic centimeter(s) per gram
C_r	Runoff coefficient
Cs-137	Cesium-137
d	Days
d/yr	Day(s) per year
D	Decay products
DOE	U.S. Department of Energy
DOE/AL	U.S. Department of Energy, Albuquerque Operations Office
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DQO	Data Quality Objective(s)
DU	Depleted Uranium
EPA	U.S. Environmental Protection Agency
FFACO	Federal Facility Agreement and Consent Order
FIWP	Facility Investigation Work Plan
ETr	Evapotranspiration rate
ft	Foot (feet)
ft^2	Square foot (feet)
G	Glass
g	gram(s)
g/cm^3	Gram(s) per cubic centimeter
g/m^3	Gram(s) per cubic meter
g/yr	Gram(s) per year
ha	Hectare(s)
HASL	Health and Safety Laboratory

List of Acronyms and Abbreviations (Continued)

HE	High explosives
hrs/d	Hour(s) per day
hrs/y	Hour(s) per year
in.	Inch(es)
IRr	Irrigation rate
ITLV	IT Corporation, Las Vegas
JTA	Joint Test Assembly
keV	Kiloelectron volt
kg	Kilogram(s)
kg/yr	Kilogram(s) per year
km	Kilometer(s)
L	Liter(s)
L/day	Liter(s) per day
L/yr	Liter(s) per year
LANL	Los Alamos National Laboratory
m	Meter(s)
MB	Mass balance
m/s	Meter(s) per second
m/yr	Meter(s) per year
m^2	Square meter(s)
m^2/s	Square meter(s) per second
m^3/day	Cubic meter(s) per day
m^3/yr	Cubic meter(s) per year
mg/kg	Milligram(s) per kilogram
mg/L	Milligram(s) per liter
mi	Mile(s)
mL	Milliliter(s)
mrem/pCi	Millirem(s) per PicoCurie
mrem/yr	Millirem(s) per year
NA	Not applicable
NAS	National Academy of Science
ND	Nondispersion
NDEP	Nevada Division of Environmental Protection
Ni	Nickel

List of Acronyms and Abbreviations *(Continued)*

No.	Number
Np	Neptunium
NTS POC	*Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste*
Pa	Protactinium
Pb	Lead
pCi	PicoCurie(s)
pCi/g	PicoCurie(s) per gram
pCi/L	PicoCurie(s) per liter
PE	Polyethylene
Pr	Precipitation
PRG	Preliminary Remediation Goals
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
r	Radius
Ra	Radium
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactivity (computer code)
Rn	Radon
RPD	Relative percent difference
s/yr	Second(s) per year
SAFER	Streamlined Approach for Environmental Restoration
SNL	Sandia National Laboratories
SNM	Special Nuclear Material
sq ft	Square foot (feet)
SSHASP	Site-Specific Health and Safety Plan(s)
SVOC	Semivolatile organic compound(s)
TAL	Target Analyte List
Tbq	Tetrabecquerel(s)
TCLP	Toxicity Characteristic Leaching Procedure
Th	Thorium
TRU	Transuranic
TTR	Tonopah Test Range

List of Acronyms and Abbreviations *(Continued)*

U	Uranium
UXO	Unexploded ordnance
yr(s)	Year(s)
μg/L	Microgram(s) per liter
μm	Micrometer
%	Percent
%R	Percent recovery
°C	Degree(s) Celsius

1.0 Introduction

This plan addresses actions necessary for the restoration and closure of Corrective Action Unit (CAU) No. 430, Buried Depleted Uranium (DU) Artillery Round No. 1 (Corrective Action Site No. TA-55-003-0960), a buried and unexploded W-79 Joint Test Assembly (JTA) artillery test projectile with high explosives (HE) (Kessel, 1996), at the U.S. Department of Energy, Nevada Operations Office (DOE/NV) Tonopah Test Range (TTR) in south-central Nevada. It describes activities that will occur at the site as well as the steps that will be taken to gather adequate data to obtain a notice of completion from Nevada Division of Environmental Protection (NDEP). This plan was prepared under the Streamlined Approach for Environmental Restoration (SAFER) concept, and it will be implemented in accordance with the Federal Facility Agreement and Consent Order (FFACO) (FFACO, 1996) and the Resource Conservation and Recovery Act (RCRA) *Industrial Sites Quality Assurance Project Plan* (DOE/NV, 1994a).

The SAFER process is employed at CAUs where enough information exists about the nature and extent of contamination to propose an appropriate corrective action prior to implementing a Corrective Action Investigation. This process combines elements of the Data Quality Objective (DQO) process and the observational approach to help plan and conduct corrective actions. DQOs are used to identify the problem and define the type and quality of data needed to complete the investigation phase of the process. The observational approach provides a framework for managing uncertainty and planning decision making. The purpose of the investigation in the SAFER process is to document and verify the adequacy of existing information, such as process knowledge; to affirm the decision for clean closure, closure in place, or no further action; and to provide sufficient data to implement the corrective action.

The SAFER concept recognizes that technical decisions may be made based on incomplete, but sufficient, information and the experience of the decision maker. Any uncertainties are addressed by documented assumptions that are verified by sampling and analysis, data evaluation, and on-site observations as planned activities progress, and by contingency plans as necessary. The remediation and closure may proceed simultaneously with site characterization as sufficient data are gathered to confirm or disprove the assumptions made in selecting the closure method. If, at any time during the site closure, new information is developed that indicates that the closure method or underlying assumptions should be revised, the decision-makers will redirect the closure activities to more appropriately protect human health and the environment.

NDEP will be notified, and this plan will be amended. Following the completion of SAFER activities, a closure report will be prepared and submitted to the NDEP.

Adequate process knowledge currently exists to propose clean closure as the corrective action for the Buried DU Artillery Round No. 1 CAU. The process knowledge includes review of historical records, geophysical surveys, and interviews with project personnel. This process knowledge was used to determine the constituents of concern that will be present as well as the most appropriate SAFER methods.

Corrective action at the Buried DU Artillery Round No. 1 CAU will be achieved in three phases. The first phase will involve locating and assessing the projectile. The second phase involves destruction in place and removal of the projectile or its remaining components. Finally, the third phase will involve the remediation of radiological and chemical contamination, which includes collecting soil samples to verify clean closure. A decision diagram which shows the iterative process for each phase is presented in Figure 1-1.

This plan reflects the following assumptions. If, at any time during closure activities, information is developed that invalidates any assumption, this plan shall be amended, and amendments will be provided to NDEP for approval.

- The Buried DU Artillery Round No. 1 is located in one of three suspected locations south of Avenue 13.
- The Buried DU Artillery Round is believed to contain unexploded HE and depleted uranium.
- The Buried DU Artillery Round cannot be safely removed without first causing an explosion of the HE, so the projectile will be detonated in place.
- Depleted uranium (U-238) will be released to the subsurface in the vicinity of the projectile during detonation, resulting in localized contamination of the soil with depleted uranium.
- All potentially existing contamination is limited in extent to the immediate vicinity of the artillery round. Explosives residue (i.e., 2,4-Dinitrotoluene and Nitrobenzene) to be released during the detonation will be minor and only affect a small volume of soil near the detonation. All contamination that may result from detonating the round will be limited to the immediate vicinity of the round.

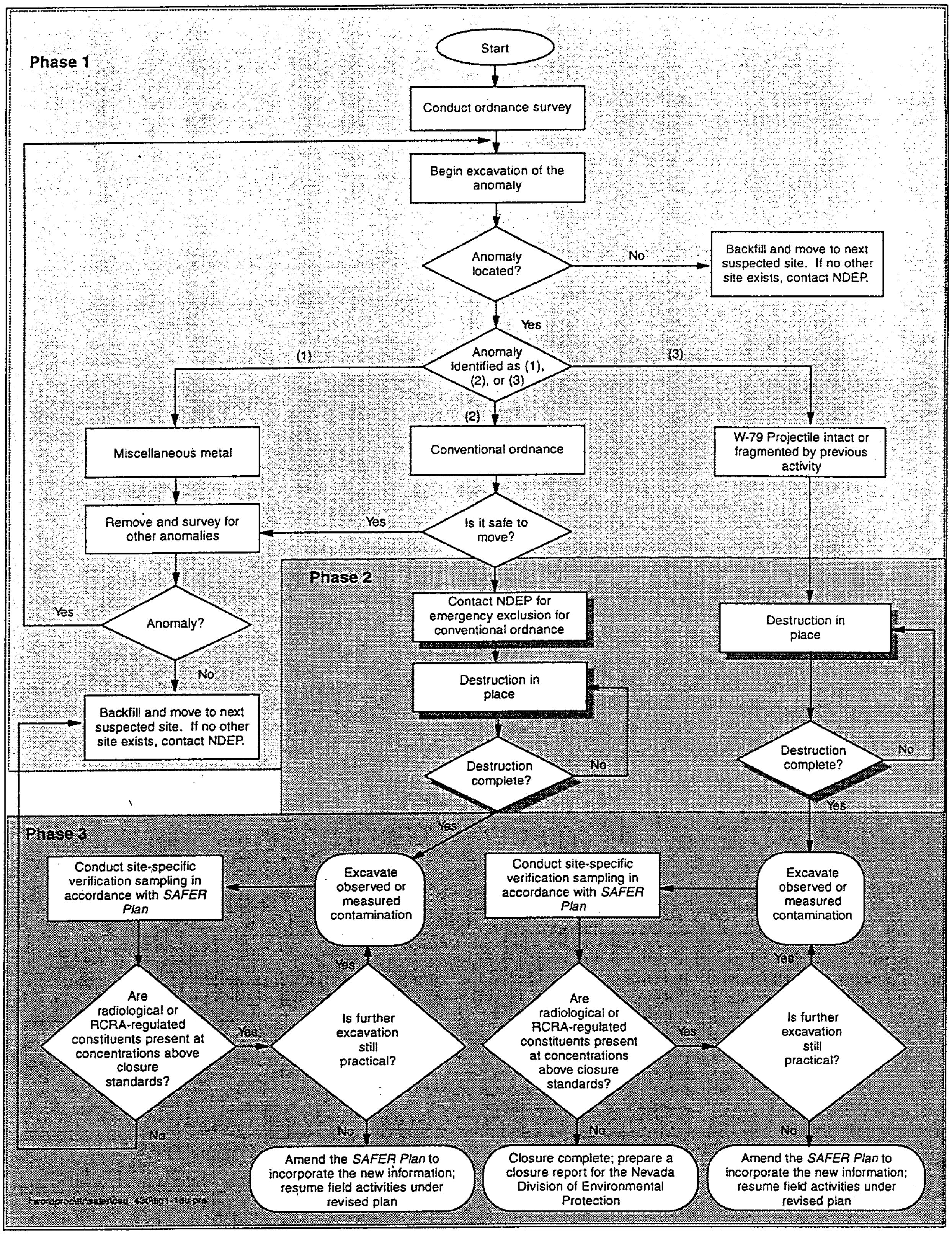


Figure 1-1
Closure Decision Diagram

- A small amount of mixed waste may be generated during the detonation of the projectile because of the simultaneous release of U-238 and regulated organic compounds in the explosive.

If any mixed waste is generated, it will be managed in accordance with the *Mutual Consent Agreement Between the State of Nevada and the Department of Energy for the Storage of Low-Level Land Disposal Restricted Mixed Waste*. Within nine months of the placement of mixed waste on the transuranic (TRU) mixed waste storage pad, DOE/NV will submit a plan for treatment and disposal of the waste to the Nevada Division of Environmental Protection.

2.0 Unit Descriptions and Closure Objectives

The Buried DU Artillery Round No. 1 (CAU No. 430) is located on the Tonopah Test Range, a U.S. Department of Energy (DOE) weapons test and research facility located in Nye County, Nevada, on the northern portion of the Nellis Air Force Range (Figure 2-1).

2.1 Tonopah Test Range

The TTR is approximately 255 kilometers (km) (140 miles [mi]) northwest of Las Vegas by air and approximately 64 km (40 mi) southeast of Tonopah by road. The nearest occupied community is Goldfield, Nevada, which is 42 km (26 mi) west of the western TTR boundary (ERDA, 1975).

The TTR occupies about 1,616 square kilometers (624 square miles). It is bordered on the south, east, and west by the Nellis Air Force Range and on the north by sparsely populated public land administered by the U.S. Bureau of Land Management and the U.S. Forest Service (DOE/NV, 1992a).

Since 1957, the TTR has been operated for the DOE Albuquerque Operations Office (DOE/AL) by Sandia National Laboratories (SNL) and used for weapon test-support activities varying from simple tests of hardware components or systems needing limited support to rocket launches or air drops of test vehicles requiring full range support for the U.S. Air Force, U.S. Army, and U.S. Navy operational and test groups as well as some defense contractors (ERDA, 1975). Through a Memorandum of Agreement with DOE/AL, primary responsibility for environmental restoration activities associated with TTR CAUs has been transferred to DOE/NV (Powers, 1996).

The TTR is divided into various areas (Figure 2-2). Areas 3 and 9 and an unnumbered Test Area along the flight line are under SNL control; Areas 3 and 9 are the main centers of SNL activities. Area 3 is also known as the Control Point Area and includes support facilities for maintenance and operations. Area 9 is the center for rocket and gun firings, ordnance storage, and related test support operations, with impact areas to the southeast. The Test Area is a series of dry lakes that begin at Main Lake near Area 9, continue south for about 21 km (13 mi), and end with Antelope Lake (ERDA, 1975). Area 10 and other remote parts of the range are under control of the U.S. Air Force.

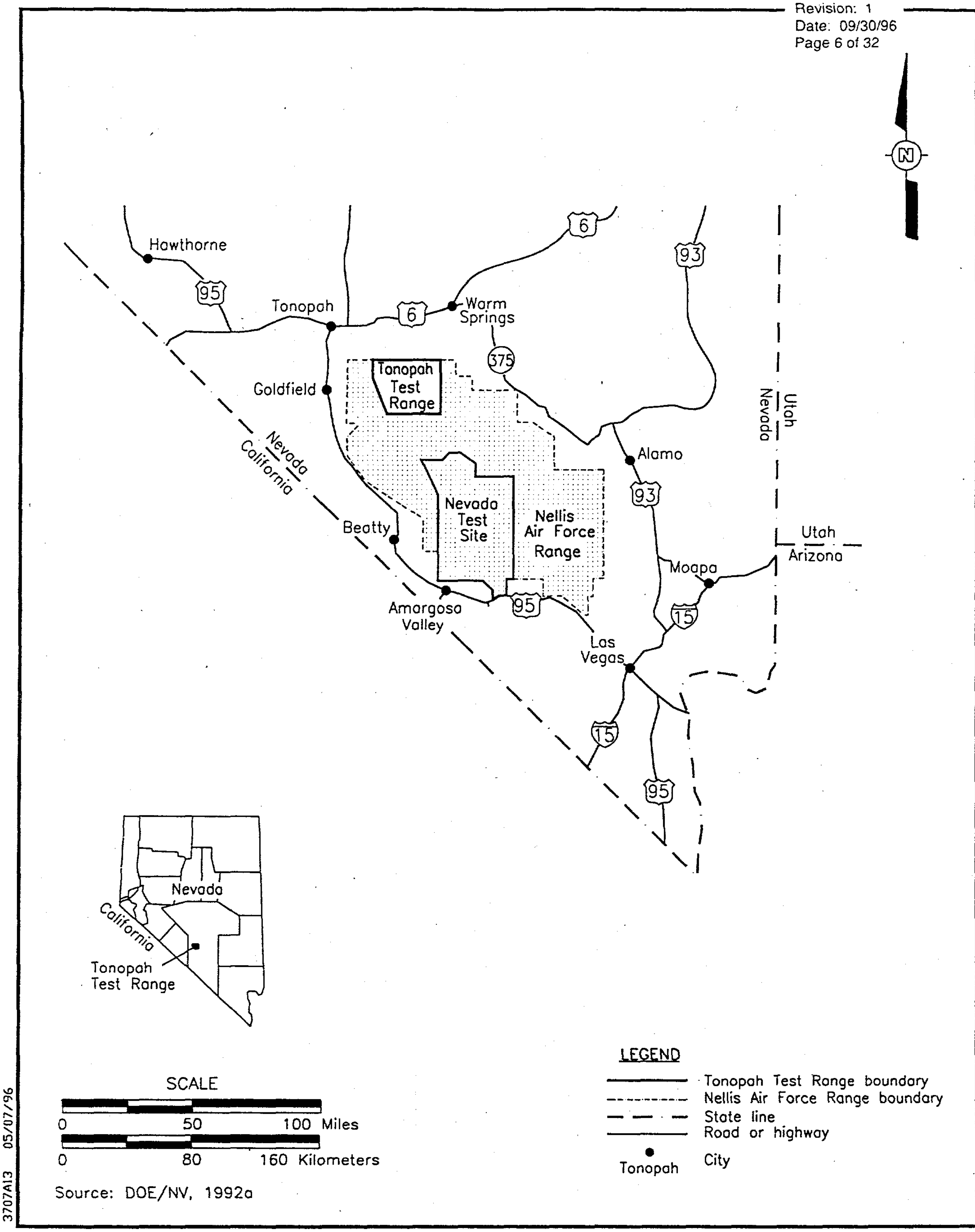
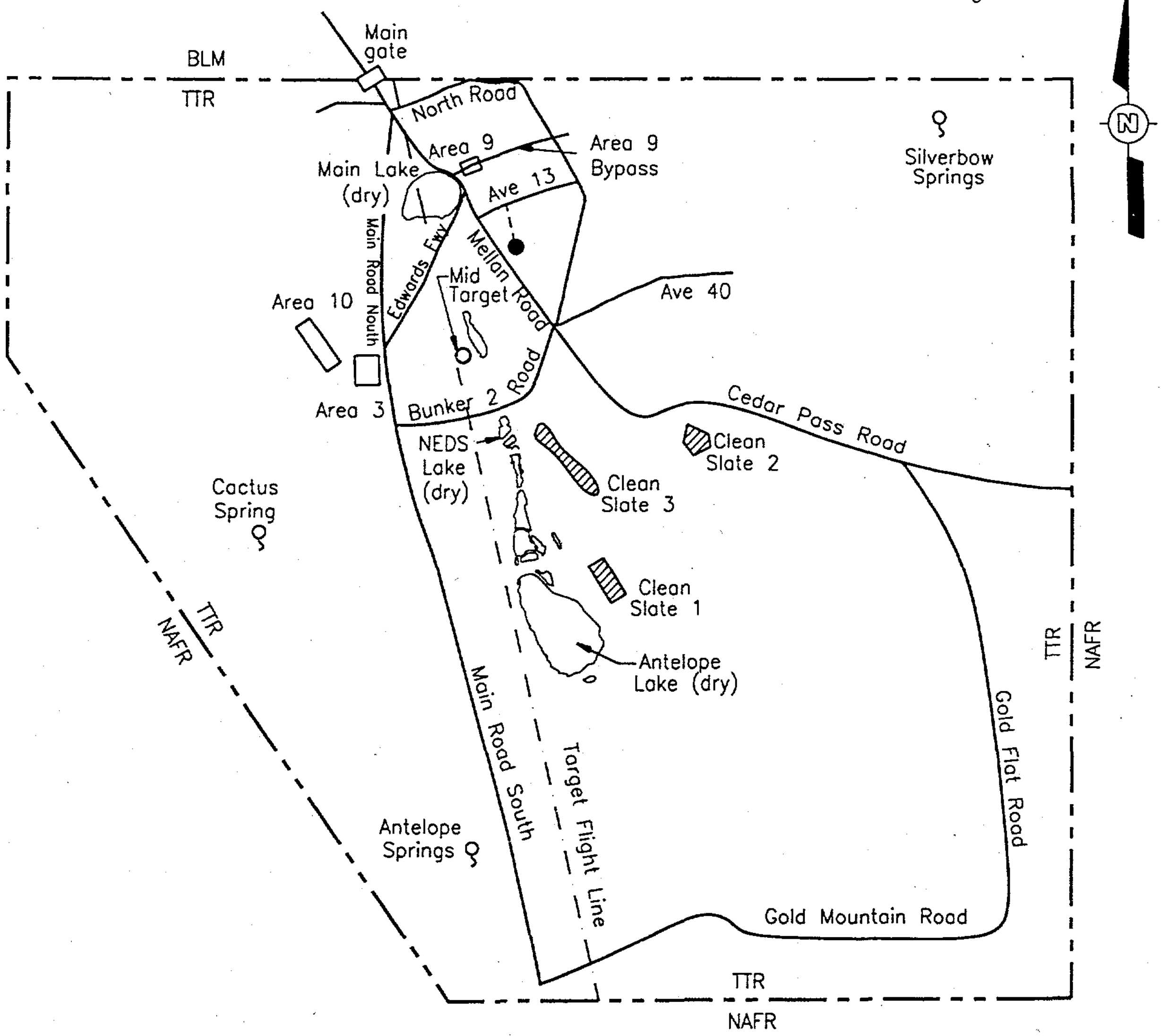


Figure 2-1
Tonopah Test Range Location Map



LEGEND

— - - —	Tonopah Test Range boundary
———	Primary roadway
●	Buried DU Artillery Round No. 1
▨	Operation Roller Coaster sites
▭	Area/gate
♀	Spring
BLM	Bureau of Land Management
NAFR	Nellis Air Force Range
TTR	Tonopah Test Range
- - - - -	Dirt road along orange barrels

SCALE

0 24,000 48,000 Feet

0 8,000 16,000 Meters

Source: Adapted from DOE/AL, 1992

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Figure 2-2
Tonopah Test Range Layout
Nye County, Nevada

2.2 Site Location and Description

The approximate location of Buried DU Artillery Round No. 1 is 1.1 km (0.7 mi) south of Avenue 13, south of Area 9 in the Test Area (Figure 2-2). The site consists of a potentially unexploded W-79 JTA test artillery projectile with HE. The projectile is reportedly buried in one pit, approximately 5 to 10 feet (ft) deep (Smith, 1993a; Smith, 1996; Quas, 1996). (Because the burial depth is not known, all exploratory excavations will be advanced past 10 feet to confirm the absence of the projectile.) The exact location of the pit is not known. There are three disturbed areas at the suspected site that have been identified via geophysical survey as possible locations of the test projectile (Figure 2-3).

Buried DU Artillery Round No. 1 had DU substituted for Special Nuclear Material (SNM) to prevent a nuclear explosion and yet retain the physical characteristics of uranium for ballistic and other mechanical tests. Even though the artillery projectiles used at TTR did not contain SNM, they did contain explosives and detonators; however, the detonators were not wired into the fire system (Smith, 1996). Explosives with detonators were used in the projectile recovery system, and these components may pose a health and safety risk.

The test procedure involved firing the projectile southward at an angle of 87° from an 8-inch (in.) artillery gun located in Area 9. A drogue parachute was scheduled to be deployed during the projectile's terminal phase of travel to facilitate recovery of the undamaged test projectile (Smith, 1993b). However, in this instance, the parachute failed to deploy, resulting in a "hard" landing. Due to damage that the projectile received upon landing, normal recovery operations were aborted. The projectile was retrieved and placed in a 5-foot-deep excavation for destruction. Approximately 6 pounds of C-4 explosive (C-4) were placed in an excavation adjacent to the projectile, and the excavation was backfilled (Smith, 1993a).

The detonation of the C-4 was planned to cause a sympathetic detonation of the HE contained within the buried projectile which could be inferred by a resultant "burp" (or release) of radiation (gamma radiation from U-238) at the ground surface. However, radiation from U-238 was not detected at the surface after the detonation (Smith, 1993a), which may indicate that the C-4 failed to cause a sympathetic detonation of the projectile. The area suspected of containing the projectile may also contain other unexploded ordnance (UXO) (i.e., inert projectiles) (Smith, 1996; Enlow, 1996).

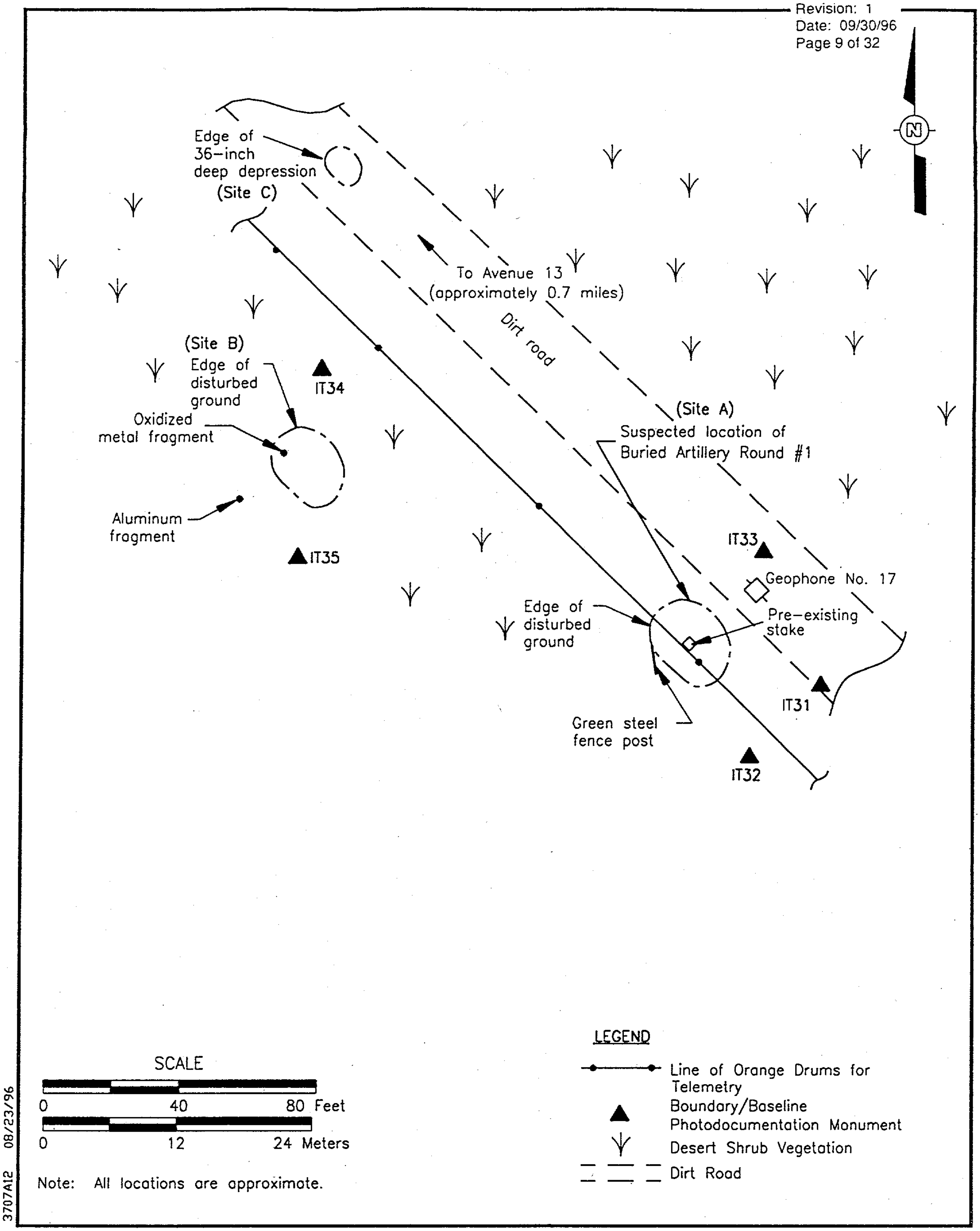

Figure 2-3
Site Location Map, Buried DU Artillery Round No. 1
Tonopah Test Range, Nye County, Nevada

2.3 Process Knowledge

Process knowledge is based on interviews of personnel involved with the project and a review of historical records, geophysical surveys, and associated activities. All unclassified process knowledge records are available for review at the IT Corporation office in Las Vegas.

Interviews and historical records used to compile process knowledge are referenced where applicable, are listed in Section 8.0 of this plan, and are available upon request to Kevin Cabble of DOE/NV Environmental Restoration Division.

2.3.1 Hazardous Components and Information

The internal specifications of a W-79 JTA projectile with HE are classified as Secret Restricted Data. There are two different configurations of the W-79 JTA artillery test projectile with HE. The only notable difference between the two configurations is the use of an inert vs. a live rocket motor. The configuration of the test projectile buried at this site may be documented in the Range Instrumentation Order, or test document. This information does not affect safety, but might be of concern with respect to identifying post-detonation residues (SNL, date unknown). The configuration is classified information.

The basic components of the projectile were DU and HE. The only mechanism of transport that will result in significant contamination will be the demolition that will be performed using C-4 explosive. The remediation will focus on remediating soil containing DU and explosive residue. Any other contaminants potentially present will be contained within the DU and explosive residue contaminated soil.

2.3.2 Constituents of Concern

Based on process knowledge, the constituents of concern for the Buried DU Round No. 1 are depleted uranium from components of the projectile and chromium, mercury, lead and the explosive compound hexahydro-1,3,5-trinitro-1,3,5-triazine, which are common components of the explosive C-4 used in the attempt to destroy the projectile. Other projectile constituents which may be present include beryllium, nickel, plutonium, and tritium.

2.4 Closure Standards

The site must have soil contaminant concentrations below NDEP regulatory action levels to be evaluated for closure. The proposed closure standards (action levels) are presented in Table 2-1. The particular soil action levels are the following:

Table 2-1
Suspected Constituents of Concern and Closure Standards for the Buried Depleted Uranium Artillery Round No. 1 Corrective Action Unit 430
(Page 1 of 2)

Parameter Group	Individual Constituents	Analytical Method[a]	Closure Standard	Source of Standard
TCLP Metals[b]	Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver	1311/ 6010A, 7470[c]	5 mg/L[d] 100 mg/L 1 mg/L 5 mg/L 5 mg/L 0.2 mg/L 1 mg/L 5 mg/L	Title 40 CFR 261.24 Table 1
TAL Total Metals	Beryllium Nickel	6010	0.14 mg/kg[e] 150 mg/kg	NDEP, 1992, and proposed RCRA Subpart S rule for corrective action, 55 FR 30796[f], 1990, and EPA Region 9 PRGs, August 1996
TCLP Semivolatile Organics	Nitrobenzene 2,4-Dinitrotoluene	1311/ 8270	2 0.13	Title 40 CFR 261.24 Table 1
Nitroaromatics & Nitroamines	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine Hexahydro-1,3,5-trinitro-1,3,5-triazine 1,3,5-Trinitrobenzene 1,3-Dinitrobenzene Methyl-2,4,6-trinitrophenylnitramine 2,4,6-Trinitrotoluene 4-Amino-2,6-dinitrotoluene 2-Amino-4,6-dinitrotoluene 2,6-Dinitrotoluene 3-Nitrotoluene 4-Nitrotoluene Nitrobenzene 2,4-Dinitrotoluene	8330	3000 mg/kg 4.0 mg/kg 3.3 mg/kg 6.5 mg/kg 650 mg/kg 15.0 mg/kg 0.65[g] mg/kg 0.65[g] mg/kg 65 mg/kg 650 mg/kg 650 mg/kg 130 mg/kg 18 mg/kg	NDEP, 1992, and proposed RCRA Subpart S rule for corrective action, 55 FR 30796, 1990, and EPA Region 9 PRGs, August 1996.
Isotopic Uranium	Uranium-238, -234 and -235/236	NAS-NS-3050[h]	1,044 pCi/g[i] U-238 for DU if no plutonium present	Calculated from the dose rate given in DOE Order 5400.5[j] and NTS POC
Isotopic Plutonium	Pu-238 Pu-239/240	NAS-NS 3058[k]	Pu-238 12.8 Pu-239/240 1,376	DOE Order 5400.5 and NTS POC
NA[l]	Tritium	EPA EERF H-01[m]	NA	NTS POC

Table 2-1
Suspected Constituents of Concern and Closure Standards for the Buried Depleted Uranium Artillery Round No. 1 Corrective Action Unit 430
(Page 2 of 2)

Parameter Group	Individual Constituents	Analytical Method[a]	Closure Standard	Source of Standard
Gamma emitting radionuclides	Analyze by gamma spectroscopy and report Cs-137 and any other radionuclide identified in library search	HASL 300 4.5.2.3[n]	Isotope-specific	NTS POC

[a]From SW-846 (EPA, 1986) unless otherwise specified.
[b]Title 40 CFR §261.24, Table 1
[c]Method for Mercury
[d]Milligrams per liter
[e]Milligrams per kilogram
[f]All RCRA Subpart S values from EPA, 1996. Methodology for use of Subpart S values is contained in the Contaminated Soil and Groundwater Remediation Policy (NDEP, 1992).
[g]Uses value for dinitrotoluene mixture per Art Gravenstein - State of Nevada (Deshler, 1996).
[h]National Academy of Science, Nuclear Science Series, 1962
[i]PicoCuries per gram
[j]DOE, 1990
[k]National Academy of Science, Nuclear Science Series, 1963
[l]Not applicable due to gaseous form
[m]U.S. Environmental Protection Agency Eastern Environmental Radiation Facility
[n]Environmental Measurements Laboratory Procedure Manual, HASL-300, U.S. Department of Energy, 1992

CFR = Code of Federal Regulations
Cs-137 = Cesium-137
DU = Depleted Uranium
HASL = Health and Safety Laboratory
NAS = National Academy of Science
NDEP = Nevada Division of Environmental Protection
NTS POC = *Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste*
PRG = Preliminary Remediation Goals
RCRA = Resource Conservation and Recovery Act
TAL = Target Analyte List
TCLP = Toxicity Characteristic Leaching Procedure

- Toxicity Characteristics Leaching Procedure (TCLP) concentration limits for defining hazardous waste characteristics of solids under RCRA (Title 40 *Code of Federal Regulation* [CFR] 261.24, Table 1) for semivolatile organic compounds (SVOCs), and inorganic compounds.

- Isotopic activities or total activities (e.g., total alpha, total gamma or total beta activities) above the *Nevada Test Site Performance Objective for Certification of Nonradioactive* (NTS POC) set forth by Bechtel Nevada (1995).

- For any parameters not covered in the above action levels, action levels will be taken from the concentration limits in the proposed RCRA Subpart S rule for corrective action (55 FR 30796).

Soil found to contain soil concentrations above the closure standard will be excavated, containerized, and managed appropriately as waste in accordance with Section 5.0 of this plan. Following excavation and removal, there will be additional sampling to verify that concentrations remaining in the soil are below closure standards. This process is described in more detail in Sections 3.1 and 3.2 of this plan.

2.5 Depleted Uranium and Plutonium Closure Standards

A site-specific radiological risk assessment was performed for CAU No. 430 to determine the guideline concentration in soil. The guideline is defined as a depleted uranium and plutonium concentration in soil, that given appropriate use scenarios and site parameters, will reasonably ensure that individual dose limits of 100 millirems per year (mrem/year) will not be exceeded. The DOE has established generic cleanup guidelines for radium and thorium in soil; cleanup guidelines for depleted uranium and plutonium must be derived on a site-specific basis.

2.5.1 RESRAD Risk Assessment Calculations

RESRAD is a microcomputer program which utilizes the dose assessment methodology recommended for use in deriving site-specific soil cleanup guidelines. The methodology and resultant code were adapted from a manual developed in 1989 for implementing DOE residual radioactive material guidelines.[1] The manual and the code are used widely by DOE and its contractors and, to some extent, by the U.S. Nuclear Regulatory Commission and licensing states. The program is issued by the Environmental Assessment Division of Argonne National Laboratory.

2.5.2 RESRAD Risk Assessment Methodology

Analysis of radiation exposure pathways is used to translate radiation dose guidelines, which are generally not directly measurable, into derived concentration guidelines, i.e., concentration of a radionuclide in soil. The primary objective is to establish the DU and plutonium concentration in soil that relates to a maximum effective dose equivalent of 100 mrem/year.

The pathways analysis relates DU and Pu concentration in soil to the 100 mrem/year dose guidelines for the maximum exposed dose receptor. The analysis requires:

- Development of scenarios that describe potential exposure modes

[1]The DOE guidelines were incorporated into DOE Order 5400.5 in February 1990 and were included in proposed Title 10, Part 834 of the *Code of Federal Regulations* (March 1993).

- Selection and use of mathematical models of radiation exposure and radionuclide transport
- Reasonable numeric values for parameters used in the mathematical models

Appendix B presents the site-specific and generic data used in calculating the depleted DU and Pu guideline concentrations, including all of the RESRAD input values and dose calculation output. In addition, Appendix B includes the methodology used in calculating site-specific input parameter values used as input to RESRAD. The dose contribution by individual radionuclides for each exposure pathway and the total dose contribution by each radionuclide and from each exposure pathway is also listed.

2.5.3 Summary and Recommendations for Depleted Uranium and Plutonium Closure Standards Using RESRAD

Using a conservative and limiting site resident exposure scenario, the radiological risk assessment was performed to ensure that the soil guideline concentration complies with the 100 mrem/yr basic dose requirement established in DOE Order 5400.5. The site-specific guideline concentrations for CAU No. 430 are listed in Table 2-2.

Table 2-2
Site-Specific Radionuclide Guideline Concentrations

Radionuclide	Guideline Concentration (pCi/g)
U-238	6.95E-2
U-235	1.13E-3
U-234	6.50E-3
Pu-238	1.28E+1
Pu-239	1.26+3
Pu-240	1.19E+2
Pu-241	1.97E+3
Pu-242	2.53E-3
Am-241	6.02E+1
Total	3,422

pCi/g = PicoCuries per gram
U = Uranium
Pu = Plutonium
Am = Americium

2.6 Clean Closure

The objective of the SAFER activities at the Buried DU Artillery Round No. 1 CAU is to remove contaminated material with concentrations above the closure standard and to gather adequate data to affirm the decision for clean closure. The first phase involves locating and exposing the test projectile, assessing its condition, and determining the appropriate method to destroy the device. The second phase includes destruction in place, removal of depleted uranium fragments, and removal of soil potentially contaminated with DU or explosive residues. The third phase of SAFER activities will be accomplished through sampling and analysis to verify adequacy, correctness, and completeness of process knowledge and remedial actions.

Verification samples will be collected and analyzed to determine if additional soil excavation and remediation are required. If each sample meets the standards described in Table 2-1, the site may be restored and clean-closed. If the verification samples indicate that constituents of concern are present in the soil above closure standards as presented in Section 2.4 of this plan, additional excavation will take place; the excavated soil will be stockpiled and managed as waste in accordance with Section 5.0 of this plan. Additional verification samples will be collected and analyzed; this sequence may be repeated as necessary until all areas are demonstrated to meet the closure standards presented in Table 2-1. All verification samples will be collected and managed in accordance with U.S. Environmental Protection Agency (EPA) quality protocols as reflected in Section 3.0 and in the *RCRA Industrial Sites Quality Assurance Project Plan* (QAPP) (DOE/NV, 1994a).

If conventional UXO (UXO containing high explosives without SNM or DU) is unearthed during the excavation of one of the three areas suspected of containing the Buried DU Artillery Round No. 1, and is found to be unsafe to move, it will be destroyed in place after notification and agreement with NDEP. Verification samples will be collected from the destruction pit and analyzed to determine if TCLP RCRA metals, or SVOCs, or explosives residue (nitroaromatics or nitroamines) are present above the closure standards presented in Table 2-1. If these constituents of concern are above closure standards, the impacted soil will be excavated, segregated from other soil stockpiles, and managed as waste. Additional verification samples will be collected and analyzed, and this sequence may be repeated as necessary until the area is demonstrated to meet closure standards. Sampling activities will parallel those given in Section 3.0 of this plan for the Buried DU Artillery Round No. 1 destruction pit.

3.0 Field Activities

Field activities to obtain clean closure of the Buried DU Artillery Round No. 1 CAU will be completed using the three-phase approach discussed in Section 2.9 (see Figure 1-1). This approach includes:

- Locating and exposing the projectile or remaining components of the projectile
- Destroying the projectile or remaining components in place
- Excavating contaminated soil from the destruction pit
- Using sampling and analyses of soil to verify that all soil contaminated above closure standards have been excavated and removed

Verification analyses for the Buried DU Artillery Round CAU will include all of the parameters listed in Table 2-1 (TCLP and total metals, TCLP SVOCs, nitroaromatics and nitroamines, isotopic uranium and plutonium, tritium, and gamma spectroscopy for other radionuclides). The sampling and analyses introduced in Table 2-1 is explained further in Tables 3-1 and 3-2.

If a conventional UXO is unearthed and requires detonation in place, or if evidence of unexpected non-radiological contamination is discovered through analysis, further soil removal, sampling, and analysis will be performed in accordance with Section 3.1 of this plan. Verification analyses for any conventional UXO destruction pit or non-radiological source will be for TCLP metals, SVOCs, and nitroaromatics and nitroamines. Radiological analyses will not be performed for any nonradiological source discovered. With the exception of the radiological analysis, the analytical requirements are the same as those given in Tables 3-1 and 3-2 for the Buried DU Artillery Round No. 1.

3.1 Sampling

After the Buried DU Artillery Round No. 1 projectile is located and destroyed in place, the soil from the destruction pit will be removed in 1-meter (m) (3-ft) layers, segregated according to radiological activity (based on field radiological screening results), stored on plastic sheeting, and sampled to determine if radioactive or hazardous constituents are present in the soil above closure standards. Surface soil around the pit that is contaminated through destruction activities will also be removed as appropriate.

Table 3-1
Analytical Requirements for the Buried Depleted Uranium Artillery Round No. 1 Corrective Action Unit 430

Parameter Group	Analytical Method[a]	Number of Verification Soil Samples	Number of Waste Profile Soil Samples	Number of Field Quality Control Samples[b]
TCLP[c] Metals (eight metals)	1311/6010A/7470	5	1	3
Total Metals (beryllium and nickel)	6010A	5	1	3
TCLP Semivolatiles (two compounds)	1311/8270	5	1	3
Gamma Emitting Radionuclides	HASL 300 4.5.2.3[d]	5	1	3
Isotopic Uranium	NAS-NS-3050[e]	5	1	3
Isotopic Plutonium	NAS-NS-3058[f]	5	1	3
Tritium	EPA-EERF H-01[g]	5	1	3
Nitroaromatics and Nitroamines (14 compounds)	8330	5	1	3

[a]From SW-846 (EPA, 1986) unless otherwise specified
[b]Duplicate, rinsate blank, and field blank samples. Duplicates and field blanks will be collected at a frequency of 1 per 20 environmental samples, One rinsate blank will be collected for each separate decontamination event.
[c]Title 40 CFR §261.24, Table 1
[d]Environmental Measurements Laboratory Procedure Manual, HASL-300, U.S. Department of Energy, 1992c
[e]National Academy of Science, Nuclear Science Series, 1962
[f]National Academy of Science, Nuclear Science Series, 1963

EPA = U.S. Environmental Protection Agency
HASL = Health and Safety Laboratory
NAS = National Academy of Science
TCLP = Toxicity Characteristic Leaching Procedure

Excavated soil will be sampled to profile the soil prior to selecting an appropriate waste disposal. Verification sampling will be conducted within the destruction pit and surrounding surface soil to verify that all contaminated soil has been removed.

All soil samples will be collected with a decontaminated trowel or equivalent. Discrete surface-soil samples and waste profile samples will be collected from 0 to 15 centimeters (cm) (0 to 6 in.) below the bottom of surface. All sampling activities and locations will be documented. The statistical calculation of the number of required verification samples is given in the following text. The analytical requirements for each sample are given in Table 3-1.

Table 3-2
Site Characterization and Closure Verification Analytical Chemical Requirements
(Page 1 of 3)

Parameter Group	Analytical Method	Sample Medium	Sample Container	Minimum Amount of Sample Required	Preservative	Holding Time	Analytes to be Analyzed and Reported	Minimum Detectable Concentration (mg/L)[a]	Regulatory Limit or Closure Standard for Soil	Acceptable Precision (RPD)[b]	Acceptable Accuracy (%R)[c]
Nitroaromatics and Nitroamines	8330	Water Soil	G[d], amber G, amber Teflon™-lined cap	2 x 1 liter 4-ounce wide-mouth jar	Cool with ice	7 days	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine Hexahydro-1,3,5-trinitro-1,3,5-triazine 1,3,5-Trinitrobenzene 1,3-Dinitrobenzene Methyl-2,4,6-trinitrophenylnitramine 2,4,6-Trinitrotoluene 4-Amino-2,6-dinitrotoluene 2-Amino-4,6-dinitrotoluene 2,6-Dinitrotoluene 2-Nitrotoluene 3-Nitrotoluene 4-Nitrotoluene 2,4-Dinitrotoluene Nitrobenzene	45 µg/L[e] (Water) 2.5 mg/kg (Soil)	3300 mg/kg[f, g] 4.0 mg/kg[g] 3.3 mg/kg[g] 6.5 mg/kg[g] 650 mg/kg[g] 15.0 mg/kg[g] 0.65 mg/kg[h] 0.65 mg/kg[h] 65 mg/kg[g] 650 mg/kg[i] 650 mg/kg[g] 650 mg/kg[g] 130 mg/kg[g] 18 mg/kg[g]	20 (Water) 30 (Soil)	53 to 133 (Water) 22 to 157 (Soil)
TCLP[j] Metals	1311/6010A[k] 7470[l]	Water Soil	PE[m] or G	1 liter 8-ounce wide-mouth jar	pH < 2, HNO_3[n] Cool with ice (Water) Cool with ice (Soil)	180 days to leaching; 180 days to analysis[o]	As Ba Cd Cr Pb Hg Se Ag	0.500 0.200 0.010 0.025 0.150 0.0002 0.500 0.020	5.0 mg/L 100.0 mg/L 1.0 mg/L 5.0 mg/L 5.0 mg/L 0.20 mg/L 1.0 mg/L 5.0 mg/L	20	80 to 120
TCLP Semivolatile Organics	1311/8270[k]	Water Soil	G, amber, Teflon™-lined cap	2 x 1 liter 8-ounce wide-mouth jar	Cool with ice	14 days to leaching; 7 days to extraction; 40 days to analysis	2,4-Dinitrotoluene Nitrobenzene	0.010 0.010	0.13 mg/L 2.0 mg/L	25	1 to 180

Refer to footnotes at end of table.

Table 3-2
Site Characterization and Closure Verification Analytical Chemical Requirements
(Page 2 of 3)

Parameter Group	Analytical Method	Sample Medium	Sample Container	Minimum Amount of Sample Required	Preservative	Holding Time	Analytes to be Analyzed and Reported	Minimum Detectable Concentration (mg/L)[a]	Regulatory Limit or Closure Standard for Soil	Acceptable Precision (RPD)[b]	Acceptable Accuracy (%R)[c]
Gamma Emitting Radionuclides	EPA 901.1[p]	Water	PE or G	1 liter	HNO_3 to pH<2	6 months	Report Cs-137 and any other radionuclide identified in library search	20 pCi/L[r]	DOE Order 5400.5[j] and NTS POC	±20	80 to 120
	HASL 300[q] 4.5.2.3	Soil		500 grams	None			0.2 pCi/g			
Isotopic Uranium	NAS-NS-3050[s]	Water	PE or G	1,000 mL[t]	HNO_3 to pH<2	6 months after collection	Uranium-238 Uranium-234 Uranium-235/236	1 pCi/L	500 pCi/g	±25	70 to 120
		Soil		50 grams	None			1 pCi/g			
Total Metals	6010	Water	PE or G	1 liter	pH<2, HNO_3 Cool to 4°C	180 days	Beryllium (Be) Nickel (Ni)	5 µg/L (Be) 40µg/L (Ni)	0.14 mg/kg (Be)	20	75 to 125
		Soil		8-ounce wide-mouth jar	Cool to 4°C			0.5 mg/kg (Be) 4 mg/kg (Ni)	150 mg/kg (Ni)		
Isotopic Plutonium	NAS-NS-3058	Water	PE or G	1 liter	HNO_3 to pH<2	6 months	Plutonium-238 Plutonium-239/240	1 pCi/L	Soil: Pu-238 = 12.8 pCi/g Pu-239/240 = 1,376 pCi/g Water: Pu-238 = 17 pCi/L Pu-239/240 = 15.5 pCi/L	25	75 to 125
		Soil		4 ounce	None			1 pCi/g			

Refer to footnotes at end of table.

Table 3-2
Site Characterization and Closure Verification Analytical Chemical Requirements
(Page 3 of 3)

Parameter Group	Analytical Method	Sample Medium	Sample Container	Minimum Amount of Sample Required	Preservative	Holding Time	Analytes to be Analyzed and Reported	Minimum Detectable Concentration (mg/L)[a]	Regulatory Limit or Closure Standard for Soil	Acceptable Precision (RPD)[b]	Acceptable Accuracy (%R)[c]
Tritium	EPA 906.0	Water	PE or G	250 mL	Cool to 4°C	6 months	Tritium	500 pCi/L	Not Applicable	20	80 to 120
	EPA EERF H-01	Soil	G	100 grams				1 pCi/g			

[a]Milligrams per liter, unless otherwise specified
[b]Relative percent difference
[c]Percent recovery
[d]Glass
[e]Micrograms per liter
[f]Milligrams per kilogram
[g]All RCRA Subpart S values from EPA, 1996
[h]Uses value for dinitrotoluene mixture per Art Gravenstein - State of Nevada (Deshler, 1996)
[i]Value is same as that calculated for 3-nitrotoluene and 4-nitrotoluene
[j]Toxicity Characteristic Leaching Procedure from Title 40 CFR §261.24, Table 1
[k]EPA Test Methods for Evaluating Solid Waste, 3rd Edition, Part 1-4, SW-846, 1986
[l]Method for mercury analysis
[m]Polyethylene
[n]Nitric acid
[o]Except mercury: 28 days to leaching, 28 days to analysis
[p]Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 1992
[q]*Environmental Measurements Laboratory Procedure Manual*, HASL-300, U.S. *Department of Energy, 1992*
[r]PicoCuries per liter
[s]National Academy of Sciences, Nuclear Science Series, September 1963
[t]Milliliter

°C = Degrees Celsius
CFR = Code of Federal Regulations
Cs-137 = Cesium-137
HASL = Health and Safety Laboratory
NTS POC = *Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste (Bechtel Nevada, 1995)*
RCRA = Resource Conservation and Recovery Act

Data quality objectives and quality assurance (QA) objectives, including precision, accuracy, representativeness, comparability, and completeness, have been established for the project to ensure that the data are sufficient and of adequate quality for their intended uses. The DQOs are included in Appendix A. The laboratory will provide Contract Laboratory Program (CLP)-like data packages for all analyses, and ten percent of all sample results will be validated by third-party data validators. The QA objectives are discussed in the *RCRA Industrial Sites QAPP* (DOE/NV, 1994a). Quality control requirements specific to these assessment activities include the following and are also discussed in detail in the *RCRA Industrial Sites QAPP*:

- One duplicate sample will be collected per 20 environmental samples collected.
- One rinsate blank will be collected per decontamination event. Dedicated trowels may be used to preclude decontamination between sample locations.
- One field blank will be collected per 20 environmental samples collected.

Statistical methods were used to determine the appropriate number of samples to collect and verify that constituents of concern are present below closure standard levels (Table 2-1). Equation Number 8 in Chapter 9 of SW-846 (EPA, 1986) gives the process for calculating the number of samples required to measure the sample mean, X, of the sampled area associated with a sample standard deviation of s, with an acceptably small probability of error, α, as:

$$n = (t_{1-\alpha/2,\ n-1}\ s/[RT-X])^2$$

Where:

$t_{1-\alpha/2,\ n-1}$ = the corresponding student t value for the appropriate probability and number of degrees of freedom (= n-1)

s = the sample standard deviation

RT = the regulatory threshold for the constituent of concern

X = the mean concentration of the constituent of concern

For the Buried DU Artillery Round No. 1 at the TTR, there is no preliminary information regarding the mean or standard deviation of the constituents of concern. In the absence of this information, the destruction pit and any other area of concern will be divided into equal grid spaces; and a systematic, random sampling pattern will be followed. The required number of samples will then be calculated from the analytical results using the above equation. If additional samples are required to demonstrate that the site meets closure standards, they will be collected at a later time. If the initial sampling effort shows that there are areas that are above the closure standard, the contaminated areas will be excavated and resampled. The data showing the presence of constituents of concern above the closure standard will be discarded for purposes of calculation, and Equation 8 of Chapter 9 of SW-846 (EPA, 1986) will be applied again, using the new data. This will confirm that an adequate number of samples was collected and analyzed to demonstrate that the site meets closure standard requirements.

3.1.1 Sample Locations

In the following sections, the sampling strategy for the destruction pit and the stockpiled soil are described.

Verification Sampling of the Destruction Pit and Surroundings

Sample locations will be determined by dividing the destruction pit into four quadrants of approximate equal size and then dividing each of these quadrants into four quadrants. The intersection of the lines that meet in the center of each subdivided quadrant mark the approximate sample locations. Actual sampling locations will be documented in the field.

In the event that the destruction in place is not fully contained, the sampling program will be adjusted to verify that the impacted area around the excavation was cleaned adequately. Radiological surveys and sampling will be carried out over that area by expanding the grid area that will be used within the excavation.

Characterization Sampling of the Stockpiled Soil

Waste characterization soil samples will also be collected from stockpiled soil having elevated field screening readings. There is a possibility that some uncontaminated soil may need to be excavated (e.g., initial excavation of the soil cover to be excavated when trying to locate the projectile); in such case, the uncontaminated soil (based on field screening) will not be characterized. Waste characterization will be guided by the *Waste Characterization Sampling and Analysis Plan for Tonopah Test Range: Corrective Action Units 400, 407, 426, 430, and the Wind Radar Antenna Pedestal*, (DOE/NV, 1996b). The piles will be divided into four quadrants. Five surface samples (0 to 6 in.) will be collected from the pile, one from the center of each quadrant and one from the center where the four quadrants meet. The five samples will be composited into a single sample and submitted for the same laboratory analysis as those samples collected from the destruction pit. Results from these samples will be used to characterize the piles of soil for disposal. Sampling locations will be documented in the field.

3.1.2 Analytical Parameters

At the Buried DU Artillery Round No. 1, all samples will be analyzed for TCLP and total metals, TCLP SVOCs, nitroaromatics and nitroamines, isotopic uranium and plutonium, tritium, and gamma spectroscopy analyses for other radionuclides, per Tables 2-1, 3-1 and 3-2. At all other nonradiological UXO that may be encountered, samples will be analyzed only for TCLP metals and SVOCs, and nitroaromatics and nitroamines.

The laboratory will provide CLP-like data packages for all analyses, and ten percent of all sample results will be validated by third-party data validators.

3.2 Field Screening and Field Surveys

Magnetometer and radiological field screening methods will be used to guide excavation activities. To ensure proper handling and shipping of potentially radioactive materials, all soil samples from this investigation will be screened for alpha, beta, and gamma radiation in accordance with the *NV/YMP Radiological Control Manual* (DOE/NV, 1994b) before being removed from the TTR.

The radiological surveys will be performed over a grid whose grid spacing will be selected appropriately to cover the area effected by the demolition. The survey will be performed using a Sodium Iodide detector to collect gamma activities and a Geiger-Mueller detector to collect alpha and beta activities.

3.3 Verification

Excavation activities will be stopped when field magnetometer and radiological surveys determine that sufficient soil has been removed. To verify that the excavation has been sufficient, the soil within potentially impacted areas (e.g., destruction pit or surface areas impacted by a release) will be sampled and analyzed in accordance with Section 3.1. If the analytical results meet the closure standards and no other constituents of concern are found, and if concurrence is obtained from NDEP, then no further action will be required and the site will be considered restored and closed. If contamination is detected at concentrations above closure standards, then additional excavation and soil sampling will be performed as described in Section 3.1. This process will be repeated, as necessary, until analyses indicate that the closure standards have been achieved.

3.4 Remediation

The excavation process will be performed using a backhoe or other means as directed by the UXO team. Excavated soil will be removed in 1-m (3-ft) layers. Each layer will be screened for radiological contamination prior to removal. Radiologically contaminated soil will be segregated from noncontaminated soil on the basis of field measurements, and the soil will be placed on heavy plastic sheeting and covered. All excavated soil will remain on site until sample analysis determines its disposition. If it is determined that excavation is no longer practical or cost-effective, work will be stopped; NDEP will be notified as soon as practical; and this plan will be amended (or a new plan written) to encompass a subsurface investigation.

3.5 Site Restoration

Upon confirmation that the site has met closure standards and upon receipt of a notice of closure from NDEP, all deep excavations will be filled with clean soil from existing borrow pits, and all shallow excavations will be graded. The landscape of the site will be recontoured to grade.

3.6 Schedule

All appropriate permits will be obtained prior to field work. Sampling will begin after the approval of this SAFER Plan by the NDEP. Upon approval of this plan, NDEP will be notified of the scheduled start date of field activities at least 10 working days prior to the start of field work. The expected schedule of completion dates (in working days) is as follows:

- Day 0: Begin location and assessment of Buried DU Artillery Round No. 1
- Day 10: Destruction in place of projectile or related components
- Day 85: Complete any required excavations and a second round of sampling if required. If not required, confirm site remediations are complete through analytical results and waste removal.

Factors beyond DOE/NV's control, such as weather, classified TTR activities, or delays in receipt of laboratory results, may delay field activities. If such delays occur, NDEP will be verbally notified.

Within six months of receipt of validated laboratory results from final field activities, a closure report will be submitted to NDEP as discussed in Section 4.0 of this plan.

4.0 Reports

Reports during field activities and after completion of the SAFER process will be provided to NDEP by DOE/NV.

Daily reports of field activities will be provided to NDEP while field activities are ongoing through informal fax transmittal. In addition, DOE/NV will verbally inform NDEP as soon as is practical of any substantial changes in scope or schedule. If it is determined that this plan requires significant amendments, NDEP will be notified as soon as practical; this plan will be amended; and NDEP's concurrence with the modified plan will be solicited.

If clean closure is achieved within six months of receipt of validated laboratory results from final field activities, DOE/NV will provide a written closure report to the NDEP documenting that closure was completed in accordance with this plan and will include all analytical results to verify that clean closure did occur. Both radiological and chemical laboratory analytical results, in addition to waste characterization and disposition information, will be included in the closure report. The report will describe the SAFER Plan activities for each unit and request a notice of completion from NDEP.

5.0 Waste Management

All waste generated through the performance of field activities at the Buried DU Artillery Round No. 1 CAU will be managed in accordance with existing federal and State of Nevada regulations, DOE waste minimization and pollution prevention objectives, waste management programs, and radiological control programs. The waste will be categorized (i.e., as sanitary, low-level, mixed, or hazardous waste) through application of process knowledge, field screening, and confirmatory sampling and analysis. Soil shown to be uncontaminated may be returned to the location from which it was excavated.

The absence or removal of radiological constituents will be demonstrated through laboratory analyses and the use of sufficiently sensitive radiological screening instruments. The instruments will be used for detecting alpha and beta/gamma activities. In addition, swipes will be collected on all sample containers prior to shipment off site for analysis. Off-site release limits for surface contamination listed in the *Radiological Control Manual*, Table 2-2 (DOE/NV, 1994b) will apply. Waste will be determined to be radioactive through sampling and analysis. As a waste minimization effort, the data will be evaluated to see if they meet the definition of nonradioactive waste as discussed in the *Nevada Test Site Performance Objective for Certification of Nonradioactive Hazardous Waste* (Bechtel Nevada, 1995). With the approval by the Bechtel Nevada Waste Management Program, waste meeting the requirements of the NTS POC may be disposed in a sanitary landfill. Radioactive waste that does not meet the NTS POC will be segregated and stored at the designated TTR Radioactive Material Area pending disposal at one of the Nevada Test Site's Radioactive Waste Management Sites according to NVO-325 requirements (DOE/NV, 1992b).

Hazardous waste is defined in Title 40 CFR Part 261. Hazardous waste will be managed in accordance with applicable federal and state regulations. Hazardous waste will be determined to be a mixed waste if analytical results do not meet the NTS POC for radioactivity. Mixed waste, if generated, will be shipped to the Nevada Test Site Area 5 Transuranic Waste Storage Pad, pending treatment and disposal. Nonradioactive hazardous waste to be disposed off of the TTR will be packed in containers that meet all EPA and U.S. Department of Transportation criteria for shipment and any additional criteria specified by the receiving disposal site. Hazardous wastes will be disposed of at an off-site commercial, permitted treatment, storage, and disposal facility or recycling facility. Hazardous waste may be shipped to the Nevada Test Site for storage at the permitted Area 5 Hazardous Waste Storage Site pending shipment to a commercial facility.

Nonrecyclable wastes that are nonhazardous and nonradioactive will be disposed of at an appropriate sanitary landfill. Generation of transuranic, high-level, or biological waste is not anticipated. In the event that one of these waste types is generated, work will stop; NDEP will be notified; and this plan will be amended to assure proper waste disposition.

If any mixed waste is generated, it will be managed in accordance with the *Mutual Consent Agreement Between the State of Nevada and the Department of Energy for the Storage of Low-Level Land Disposal Restricted Mixed Waste*. Within nine months of the placement of mixed waste on the TRU mixed waste storage pad, DOE/NV will submit a plan for treatment and disposal of the waste to the Nevada Division of Environmental Protection.

6.0 Site-Specific Health and Safety Plans

The health and safety protocols for the field activities related to the implementation of this SAFER plan will be delineated in a Site-Specific Health and Safety Plans (SSHASPs). This SSHASP, controlled separately from this SAFER plan, is not included as part of this plan, but will be available upon request prior to start of field activities. The SSHASP sets forth the specific requirements and procedures that will be followed while performing operations under this SAFER plan. The SSHASP includes the following information:

- Engineering and administrative protective measures
- Monitoring for site-specific chemical and radiological contaminants
- Personal protective equipment and its use
- Site control
- Emergency communications
- Emergency reporting protocol
- Decontamination
- Site characterization
- Training
- Excavation safety

All field activities will be performed in accordance with the applicable SSHASP, and all field personnel involved in these activities will be familiar with requirements of the SSHASP. All visitors to the work sites will be required to abide by these procedures.

The objective of the SSHASP is the protection of workers during SAFER plan activities. This will be accomplished through compliance with DOE Orders, Occupational Safety and Health Administration Regulations, and the DOE/NV *NV/YMP Radiological Control Manual* (DOE/NV, 1994b), as well as the SSHASPs. Many of the operations conducted under the DOE/NV Environmental Restoration Program are regulated under the DOE Orders and Title 29 of the *Code of Federal Regulations*.

Due to unique logistics, hazards, and site conditions, individual groups of sites and/or tasks require the production of a SSHASP. It is considered a living document, and as new information becomes available, changes will be made as appropriate, with concurrence and approval of the Subproject Manager.

7.0 Community Relations Plan

A *Public Involvement Plan* is being developed for environmental restoration activities at Nevada sites operated by DOE/NV. Under this plan, specific public-involvement activities will be outlined for the Environmental Restoration Project, including the TTR.

Until the *Public Involvement Plan* is developed, public-participation activities for the Environmental Restoration Project are referenced in the *Public Participation Plan for the ERWM Program, Nevada Operations Office* (DOE/NV, 1993). Any public-participation activities specifically relating to DOE/NV environmental restoration activities at the TTR will be publicly announced through press releases and/or newspaper advertisements.

A fact sheet, poster board, and video covering environmental restoration activities at the TTR also has been prepared. These and other public information materials can be obtained by writing to the following address:

U.S. Department of Energy
Nevada Operations Office
Public Affairs and Information Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

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Mr. Don Cox IT Corporation Las Vegas, NV 89103	1
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Ms. Stacey Sorg IT Corporation Las Vegas, NV 89103	1
Ms. Jeanne Wightman IT Corporation Las Vegas, NV 89103	1
Mr. Dave Madsen Bechtel Nevada	1
Ms. Karen Patton Bechtel Nevada	1
U.S. Department of Energy Office of Scientific and Technical Information 175 Oak Ridge Turnpike P.O. Box 62 Oak Ridge, TN 378831	2
DOE/Nevada Operations Office Technical Information Resource Center Post Office Box 98518 Las Vegas, NV 89193-8518	2

Appendix A

Data Quality Objectives

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A.1.0 Data Quality Objectives

The sampling objectives for the Buried DU Artillery Round No. 1 SAFER Plan were determined using the Data Quality Objective process outlined by the Environmental Protection Agency (EPA, 1994). DQOs are qualitative and quantitative statements that specify the quality and type of data required to support proposed potential courses of actions for the Buried DU Artillery Round No. 1 CAU. The DQOs were developed to clearly define the purpose(s) for which environmental data will be used and to design a data collection program that will satisfy these goals.

The DQO process is a planning process that provides a systematic approach to defining the criteria and objectives that data collection should satisfy. DQOs have been developed using the step-wise planning process outlined by the EPA. The DQOs are qualitative and quantitative statements derived from the step-wise process that clarify the study objective, define the most appropriate type of data to collect, determine the most appropriate conditions from which to collect the data, and specify tolerable limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision. The seven sequential steps of the DQO process are:

1. State the problem
2. Identify the decision
3. Identify inputs to the decision
4. Define the study boundaries
5. Develop a decision rule
6. Specify tolerable limits on decision errors
7. Optimize the design

Ultimately, the DQO process yields a thoughtfully designed study that has well-defined objectives, has obtainable objectives, is designed to meet objectives, and is sufficiently detailed to be defensible -- but not overly detailed to result in wasting resources. The following seven sections, A.1.2.1 to A.1.2.7, present the results of the seven step DQO planning process.

One tool used in the DQO process is the formulation of a site conceptual model.

A.1.1 Conceptual Model

A conceptual model has been developed to postulate potential exposure pathways from likely contaminant sources at the Buried DU Artillery Round No. 1 CAU (Figure A-1). The conceptual model is based on the historical information described in Section 2.0 of the main text. The following are assumptions that were considered regarding the projectile:

- The projectile is located in one of three areas suspected of containing the projectile.
- Some components of the projectile contain depleted uranium (U-238), chromium, mercury, and lead.
- The disposition of the projectile is unknown (i.e., whether the projectile is intact or not).
- The projectile is assumed to contain unexploded high explosive and must be destroyed in-place before it is safe to remove.

The following are assumptions that were considered regarding concerns caused by the destruction of the projectile:

- A portion of the DU will burn during the destruction of the projectile.
- Following in-place destruction of the projectile, the bulk of the contaminated soil will be confined to the disturbed soil around the projectile. The explosives will be placed on the projectile in such a way that the explosion is directed downward; therefore, the majority of the contamination will increase from the original elevation of the explosives towards the bottom of the pit (Figure A-2).
- Distribution of the contaminants after destruction of the projectile will be heterogeneous. Fragments or particles of DU (depending on size) will be found as radioactive hot spots through radiological field screening activities.
- The concentrations of the residual hazardous or radioactive materials from the destroyed projectile will be low.
- No other significant mechanisms (such as infiltrating fluids) exist that could drive the constituents significantly deeper than the zone of detonation in the time interval between detonation and remediation.
- Destruction of the projectile could result in surface contamination in the form of DU fragments or particles caused from a breach in the detonation containment. Hot spots will be located using radiological field screening.

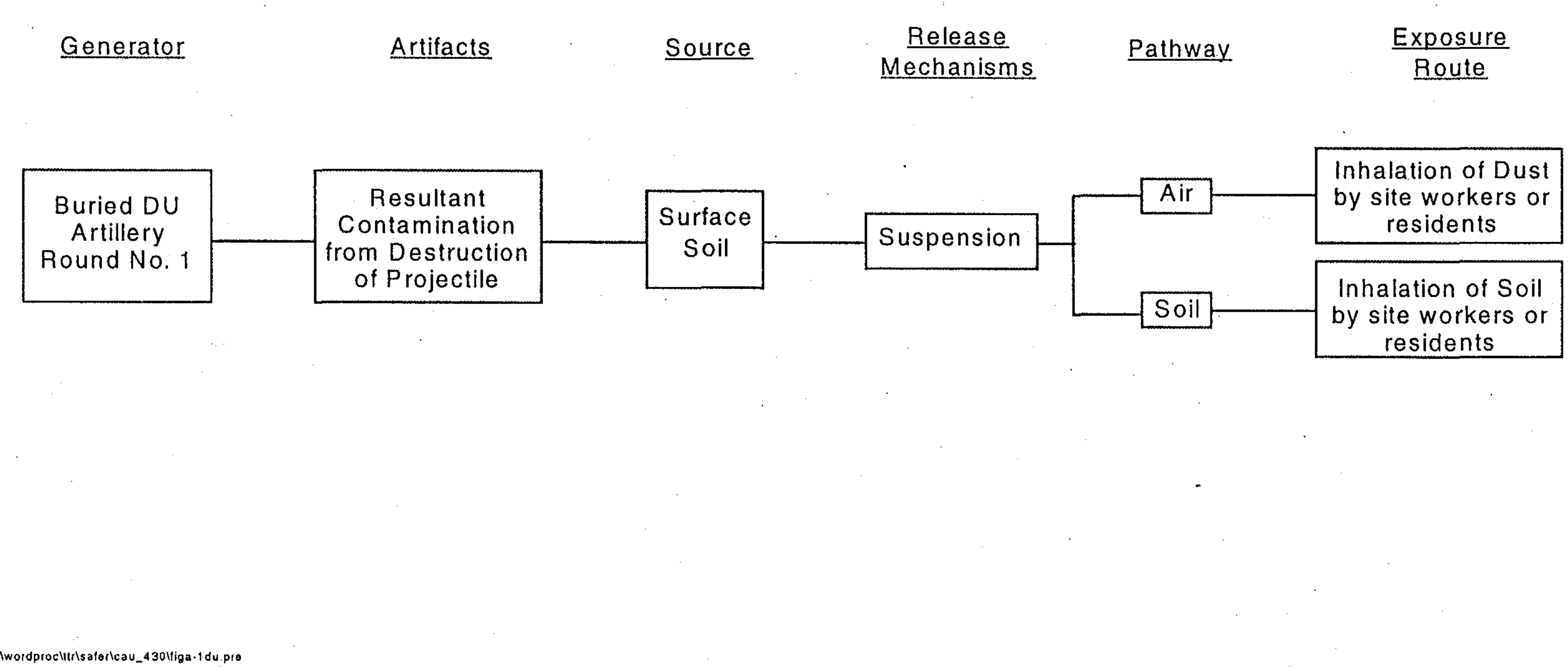

Figure A-1
Conceptual Model for the Buried Depleted Uranium Artillery Round No. 1 Corrective Action Unit

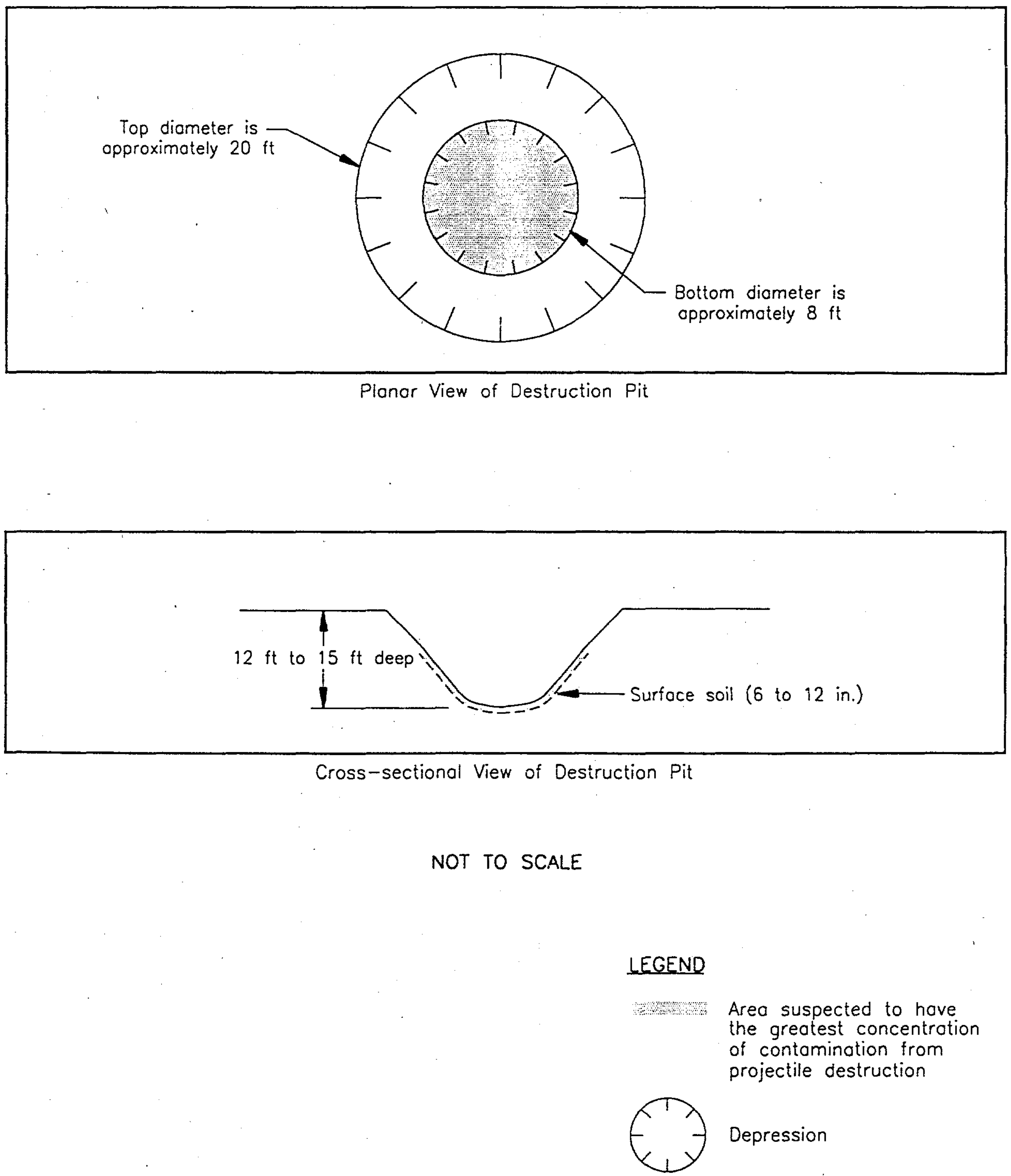

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Figure A-2
Planar and Cross-Sectional Views of the Area Affected by the Destruction of the Buried Depleted Uranium Artillery Round No. 1

- Hot spots will be detected within the top 0 to 15 cm (0 to 6 in.) of native soil within the pit and on the surface (if a breach occurred) because the majority will be removed with the excavation of the disturbed soil.

- A minor amount of mixed waste may be generated through a mixing during the detonation of DU with regulated metals or semivolatiles.

These factors were considered, and from them, a conceptual model was created. Based on these factors, it was determined that the primary contamination source of concern are fragments or particles of DU from the destruction of the projectile. These fragments will be located as hot spots with field radiological screening. It was also determined that the primary area impacted by DU fragments from the destruction of the projectile will be the lower portion of the destruction pit. Some surface contamination could occur if a breach of containment occurs during destruction of the projectile. Depleted uranium fragments or particles will be located only within the disturbed soil within the pit, or thin (6 in. deep) layer of undisturbed soil directly beneath the pit.

The conceptual model interprets that the destruction pit and potential additional surface area has only a shallow soil (< 30 cm [1 ft]) source after re-excavation. There would be two potential exposure routes: inhalation and ingestion of contaminated soil. The viable contamination release mechanism is the suspension of potentially contaminated surface soil to the air through either soil disturbance or high winds. If the surface soil is contaminated, inhalation or ingestion (or general consumption through the mouth) of dust or soil could be potentially harmful exposure routes. High winds and dust devils have been documented at the TTR (DOE/NV, 1996a). Both soil excavation activities and high winds could cause suspension of contaminated soil.

The amount of contamination will not exceed what was contained in the projectile. As such, the amount of contamination will not be great enough to impact groundwater. Environmental sample data will be used to determine when the site (destruction pit) or sites (destruction pit and additional areas of surface contamination) are cleaned up. If analytical results are below closure standards, the site(s) will be restored and clean closed. If analytical results indicate that contamination is present above closure standards, additional soil excavation and sampling will be performed. This will be repeated until all contamination has been removed and clean closure can be obtained.

A.1.2 Data Quality Objectives

The DQO process (EPA, 1994) is a systematic planning tool for establishing criteria for data quality and for developing data collection designs. It is a seven-step process which results in a design to collect the right type, quality, and number of data needed to support an environmental decision. The DQO process has been applied to proposed corrective action at the TTR Buried DU Artillery Round No. 1. Each step will be discussed in the following text.

A.1.2.1 Step 1: State the Problem

In this section, the problem is defined so that the focus of the study is unambiguous. The problem statement is based on the site history presented in Section 2.0 and the conceptual model presented in Section A.1.1.

The disposition and location of the Buried DU Artillery Round No. 1 is uncertain. It is known to contain depleted uranium and believed to contain RCRA characteristic constituents. This site must be closed. Closure of the site will require the location, assessment, and destruction of the projectile and remediation of the contamination caused by the destruction of the projectile and the explosives used to cause the destruction. Sampling and analysis will be required to verify that contaminated soil above action levels has been excavated.

A.1.2.2 Step 2: Identify the Decision

This step defines the study question that the study will attempt to address. Field screening instruments are needed to guide the excavation activities to ensure that excavation removes contaminated soil, but does not remove clean soil. Verification sampling must be used to verify that the excavation has removed all soil that exceeds action levels.

A.1.2.3 Step 3: Identify the Inputs to the Decision

The excavation of the contaminated soil will be guided by visual definition of impacted soil and field screening instruments which will be used to screen for metal debris and alpha and beta/gamma activities. The field screening is not a definitive tool for identifying soil contamination, so verification sampling with offsite analyses will be performed to ensure that all soil with concentrations or activities above action levels have been removed.

A.1.2.4 Step 4: Define the Boundaries of the Study

The temporal boundary of the study will be the time at which the SAFER plan is implemented. No follow-up study of the CAU is planned. The spatial boundaries of the remediation and verification sampling area will include the destruction pit and any surface area impacted by a release of contamination during destruction activities.

A.1.2.5 Step 5: Develop a Decision Rule

The results of the laboratory analytical data for the verification samples from the destruction pit and any other areas with potential contamination will determine whether the site is clean or not. Closure standards for the constituents of concern are discussed in Section 2.0 and listed in Table 2-1. If analytical data indicate that constituents of concern are not detected above the closure standards, the site will be declared closed. If not, remediation will continue until analytical data from resampling demonstrate the site to be clean.

Note that the null hypothesis (H_o) is that the site is contaminated. Only if statistically valid results prove that the analytical data is less than the closure standards will the site be considered "clean." Thus, the burden of proof is on the data to demonstrate that the site is clean.

A.1.2.6 Step 6: Specify Acceptable Limits on Decision Error

There are two types of decision errors possible in conducting the SAFER process. These errors are described as a Type I error (false positive," judging a clean area to be contaminated, referred to by statisticians as the "confidence level" or 1-α) and a Type II error ("false negative," judging a contaminated area to be clean, referred to by statisticians as the "power," or 1-β). This SAFER plan is designed to minimize both types of errors.

For a planned removal or remedial response operation involving potentially contaminated soil, Type I and Type II errors are of about equal significance and are usually established at 90 to 95 percent (EPA, 1989). For the purpose of this SAFER plan, the confidence level and power will both be assigned at 90 percent.

Because the collected data will be used to support a closure, all off-site analyses will be documented with CLP-like data packages, and 10 percent of the data will undergo data validation by a third party.

A.1.2.7 Step 7: Optimize the Design

The sampling and analysis plan has been presented in Section 3.1 of this report and considered all seven DQO steps. Soil will be removed from the projectile destruction pit in 3-ft layers until native fill beneath the projectile is reached and field screening results are negative. Each layer will be screened for metal debris and radiological contamination prior to excavation. Metal debris not radiologically contaminated will be removed and staged separately for disposal in a sanitary landfill. Soil and/or metal found to be radiologically contaminated will be staged separately pending soil sample results. Verification soil samples will be collected from native soil at the bottom of the pit. These analytical results will verify when all contamination (e.g., radiological or hazardous) has been removed and the site is "clean."

Appendix B

Guideline Concentration for Depleted Uranium and Plutonium

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INTERNATIONAL TECHNOLOGY CORPORATION

Memorandum

To: **Randy Dubiskas** Date: **September 5, 1996**

From: **Steve Adams** SRA **Project No. 764037.07010100**

Subject: **Letter Report: GUIDELINE CONCENTRATION FOR DEPLETED URANIUM AND PLUTONIUM AT CORRECTIVE ACTION UNIT 430, BURIED DEPLETED URANIUM ARTILLERY ROUND NO. 1**

B.1.0 Introduction

Corrective Action Unit (CAU) No. 430 is located 0.7 miles south of Avenue 13, south of Area 9 in the Test Area of the Tonopah Test Range (TTR). CAU No. 430 consists of a W-79 Joint Test Assembly (JTA) test artillery projectile. The projectile was reportedly buried at the site in May 1987, at a depth of approximately 5 to 10 feet deep. The buried projectile had depleted uranium (DU) substituted for most of the special nuclear material. Therefore, the projectile still contains a small amount of weapons grade plutonium (Pu). In addition, the W-79 projectile contained high explosives and tritium gas.

Because the W-79 projectile is believed to contain unexploded high explosives (HE), it cannot be safely removed because of the risk of causing the HE to explode. Therefore, the projectile will be detonated in place. Closure of CAU No. 430 includes destruction of the projectile in place and removal of the projectile fragments and soil potentially contaminated with DU, Pu, and explosives residue. The purpose of this letter report memorandum is to document an analysis performed to define the maximum residual concentration of DU and Pu in soil that will ensure compliance with the public dose limit established in the Department of Energy Order 5400.5 (DOE, 1993).

A guideline is required for residual concentration of DU and Pu in the soil at CAU No. 430. The guideline is defined as a DU and Pu concentration in soil that, given appropriate use scenarios and site parameters, will reasonably ensure that individual dose limits of 100 millirems per year (mrem/yr) will not be exceeded. The Department of Energy (DOE) has established generic cleanup guidelines for radium and thorium in soil; cleanup guidelines for DU and Pu must be derived on a site-specific basis.

This letter report memorandum presents the results of the guideline concentration calculations for DU and Pu in soil at CAU No. 430. In addition, it includes all of the site-specific and generic data used in calculating this guideline concentration. The DOE residual radioactive material guideline computer code, RESRAD, was used to calculate the guideline concentration (Yu et al., 1993a). The RESRAD computer program utilizes a dose assessment methodology for deriving

deriving site-specific soil guidelines. The dose assessment method and resultant code were adapted by DOE from a manual developed in 1989 for implementing DOE residual radioactive material guidelines (DOE, 1989). The RESRAD code and dose assessment methodology is established by reference in DOE Order 5400.5 (DOE, 1993) as the method to be used in calculating guideline concentrations in soil.

Section B.3.0 of this letter report memorandum lists the guideline concentrations for DU and Pu in soil at CAU No. 430. Table B-1 lists the dose contribution by individual radionuclide for each exposure pathway and the total dose contributed by each radionuclide and from each exposure pathway. Table B-2 lists all of the RESRAD code input parameter values. Attachment B-1 documents how the user-defined code input values were calculated and utilized in RESRAD. Section B.4.0 lists the references for this letter report memorandum and Attachment B-1.

Table B-1
Dose Contributions for Individual Radionuclides and Exposure Pathways at Corrective Action Unit No. 430 (mrem/year)[a]

Isotope	External Exposure	Inhalation	Radon	Plant Ingestion	Soil Ingestion	Total
Am-241	1.64	1.25	0.00	1.23	1.32	5.44
Pu-238	0.00	0.19	0.00	0.19	0.20	0.58
Pu-239	0.25	26.43	0.00	26.14	28.19	81.01
Pu-240	0.01	2.51	0.00	2.48	2.67	7.67
Pu-241	1.45	1.27	0.00	1.25	1.34	5.32
Pu-242	0.00	0.00	0.00	0.00	0.00	0.00
U-234	0.00	0.00	0.00	0.00	0.00	0.00
U-235	0.00	0.00	0.00	0.00	0.00	0.00
U-238	0.01	0.00	0.00	0.00	0.00	0.01
Total	3.35	31.64	0.00	31.28	33.73	100

[a]Doses are for the guideline concentration during the year of maximum dose, 33 years after environmental restoration. Doses in the table are rounded to the nearest 0.01 mrem. The total doses are calculated by summing the individual doses and then rounding to the nearest 0.01 mrem.

R. Dubiskas September 5, 1996

Table B-2
Parameters Used in the RESRAD Code for Calculating Guidance Concentrations for Corrective Action Unit No. 430, Tonopah Test Range
(Page 1 of 8)

Parameter	Unit	Value Resident	Reference
Dose Limit	mrem/yr.	100	DOE, 1993
Dose conversion factors for inhalation:	mrem/pCi		
Ac-227+D		6.72E+0	RESRAD default
Am-241		4.40E-1	RESRAD default
Np-237+D		5.40E-1	RESRAD default
Pa-231		1.28E+0	RESRAD default
Pb-210+D		2.32E-2	RESRAD default
Pu-238		3.92E-1	RESRAD default
Pu-239		4.29E-1	RESRAD default
Pu-240		4.29E-1	RESRAD default
Pu-241+D		8.25E-3	RESRAD default
Pu-242		4.11E-1	RESRAD default
Ra-226+D		8.60E-3	RESRAD default
Ra-228+D		5.08E-3	RESRAD default
Th-228+D		3.45E-1	RESRAD default
Th-229+D		2.16E+0	RESRAD default
Th-230		3.26E-1	RESRAD default
Th-232		1.64E+0	RESRAD default
U-233		1.35E-1	RESRAD default
U-234		1.32E-1	RESRAD default
U-235+D		1.23E-1	RESRAD default
U-236		1.25E-1	RESRAD default
U-238+D		1.18E-1	RESRAD default

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Table B-2
Parameters Used in the RESRAD Code for Calculating Guidance Concentrations for Corrective Action Unit No. 430, Tonopah Test Range
(Page 2 of 8)

Parameter	Unit	Value Resident	Reference
Dose conversion factors for ingestion:	mrem/pCi		
Ac27+D		1.48E-2	RESRAD default
Am-241		3.64E-3	RESRAD default
Np-237+D		4.44E-3	RESRAD default
Pa-231		1.06E-2	RESRAD default
Pb-210+D		7.27E-3	RESRAD default
Pu-238		3.20E-3	RESRAD default
Pu-239		3.54E-3	RESRAD default
Pu-240		3.54E-3	RESRAD default
Pu-241+D		6.85E-5	RESRAD default
Pu-242		3.36E-3	RESRAD default
Ra-226+D		1.33E-3	RESRAD default
Ra-228+D		1.44E-3	RESRAD default
Th-228+D		8.08E-4	RESRAD default
Th-229+D		4.03E-3	RESRAD default
Th-230		5.48E-4	RESRAD default
Th-232		2.73E-3	RESRAD default
U-233		2.89E-4	RESRAD default
U-234		2.83E-4	RESRAD default
U-235+D		2.67E-4	RESRAD default
U-236		2.69E-4	RESRAD default
U-238+D		2.69E-4	RESRAD default

Table B-2
Parameters Used in the RESRAD Code for Calculating Guidance Concentrations for Corrective Action Unit No. 430, Tonopah Test Range
(Page 3 of 8)

Parameter	Unit	Value Resident	Reference
Plant/Soil concentration ratio:	None		
Ac-227+D		2.50E-3	RESRAD default
Am-241		1.00E-3	RESRAD default
Np-237+D		2.00E-2	RESRAD default
Pa-231		1.00E-2	RESRAD default
Pb-210+D		1.00E-2	RESRAD default
Pu-238		1.00E-3	RESRAD default
Pu-239		1.00E-3	RESRAD default
Pu-240		1.00E-3	RESRAD default
Pu-241+D		1.00E-3	RESRAD default
Pu-242		1.00E-3	RESRAD default
Ra-226+D		4.00E-2	RESRAD default
Ra-228+D		4.00E-2	RESRAD default
Th-228+D		1.00E-3	RESRAD default
Th-229+D		1.00E-3	RESRAD default
Th-230		1.00E-3	RESRAD default
Th-232		1.00E-3	RESRAD default
U-233		2.5E-3	RESRAD default
U-234		2.5E-3	RESRAD default
U-235+D		2.5E-3	RESRAD default
U-236		2.5E-3	RESRAD default
U-238+D		2.5E-3	RESRAD default
Area of contaminated zone	m^2	1.82E+2	Calculated
Thickness of contaminated zone	m	4.57	Calculated
Length parallel to aquifer flow	m	1.52E+1	Calculated
Time since placement of material	years	0	Assumption
Times for calculation 10, 50, 100, 250, 500, 800, 1000, 5000, 10,000	years	NA	User assumption

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Table B-2
Parameters Used in the RESRAD Code for Calculating Guidance Concentrations for Corrective Action Unit No. 430, Tonopah Test Range
(Page 4 of 8)

Parameter	Unit	Value Resident	Reference
Initial principal radionuclide concentration in soil:	pCi/g		
Am-241		6.02E+1	Calculated
Pu-238		1.28E+1	Calculated
Pu-239		1.26E+3	Calculated
Pu-240		1.19E+2	Calculated
Pu-241		1.97E+3	Calculated
Pu-242		2.53E-3	Calculated
U-234		6.50E-3	Calculated
U-235		1.13E-3	Calculated
U-238		6.95E-2	Calculated
Concentration of radionuclides in groundwater:	pCi/L	not used	RESRAD calculates from input data
Cover depth	m	0	Conservative assumption
Density of contaminated zone	g/cm^3	1.5	RESRAD default
Contamination zone erosion rate	m/yr	1.442E-3	Calculated
Contaminated zone total porosity	-	0.30	RCRA FIWP for TTR DOE, 1994
Contaminated zone effective porosity	-	0.30	RCRA FIWP for TTR DOE, 1994
Contaminated zone hydraulic conductivity	m/yr	1000	Table 5.4, page 31 Yu et al., 1993b
Contaminated zone "b" parameter	-	4.05	Table 13.1, page 77 Yu et al., 1993b
Evapotranspiration coefficient	-	0.68	Calculated
Precipitation	m/yr	0.127	Culp and Howard, 1995
Irrigation	m/yr	1.53	Calculated
Irrigation mode	-	ditch	User assumption

Table B-2
Parameters Used in the RESRAD Code for Calculating Guidance Concentrations for Corrective Action Unit No. 430, Tonopah Test Range
(Page 5 of 8)

Parameter	Unit	Value Resident	Reference
Runoff coefficient	-	0.2	RESRAD default
Watershed area for pond	m^2	1.82E+2	not used
Accuracy for water/soil computations	None	1.00E-3	RESRAD default
Density of saturated zone	g/cm^3	1.5	RESRAD default
Saturated zone total porosity	-	0.3	RCRA FIWP for TTR DOE, 1994
Saturated zone effective porosity	-	0.3	RCRA FIWP for TTR DOE, 1994
Saturated zone hydraulic conductivity	m/yr	1.0E+3	Tables 5.4 page 31 Yu et al., 1993b
Saturated zone hydraulic gradient	-	1.00E-4	RCRA FIWP for TTR DOE, 1994
Saturated zone "b" parameter	-	4.05	Table 13.1 Yu et al., 1993b
Water table drop rate	m/yr	1.0E-4	RCRA FIWP for TTR DOE, 1994
Well pump intake depth (below water table)	m	10	RESRAD default
Well pumping rate	m^3/yr	279.6	Calculated
Model: nondispersion (ND) or mass balance (MB)	-	ND	ND
Number of unsaturated zones	-	1	1
Unsaturated zone thickness	m	80	RCRA FIWP for TTR DOE, 1994
Unsaturated zone density	g/cm^3	1.5	1.5

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Table B-2
Parameters Used in the RESRAD Code for Calculating Guidance Concentrations for Corrective Action Unit No. 430, Tonopah Test Range
(Page 6 of 8)

Parameter	Unit	Value Resident	Parameter
Unsaturated zone total porosity	-	0.3	RCRA FIWP for TTR DOE, 1994
Unsaturated zone effective porosity	-	0.3	RCRA FIWP for TTR DOE, 1994
Unsaturated zone "b" parameter	-	4.05	Table 13.1, Yu et al., 1993b
Unsaturated zone hydraulic conductivity	m/yr	1.0E+3	Table 5.4, Yu et al., 1993b
Distribution coefficient (all zones)			
Uranium isotopes	cm^3/g	35	Table 32.1 Yu et al., 1993B
Plutonium isotopes	cm^3/g	550	
Americium isotopes	cm^3/g	1900	
Actinium isotopes	cm^3/g	450	
Neptunium isotopes	cm^3/g	5	
Protactinium isotopes	cm^3/g	550	
Lead isotopes	cm^3/g	270	
Radium isotopes	cm^3/g	500	
Thorium isotopes	cm^3/g	3200	
Inhalation rate	m^3/yr	6,372	Calculated
Mass loading for inhalation	g/m^3	9.86E-6	Calculated
Dilution length for airborne dust inhalation	m	3	RESRAD default
Exposure duration	years	30	RESRAD default
Shielding factor, inhalation	-	1	Clayton, 1993
Shielding factor from external radiation	-	0.7	RESRAD default
Fraction of time spent indoors	-	6.792E-1	Calculated
Fraction of time spent indoors (on site)	-	2.797E-1	Calculated
Shape factor flag, external gamma	-	1	RESRAD default

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Table B-2
Parameters Used in the RESRAD Code for Calculating Guidance Concentrations for Corrective Action Unit No. 430, Tonopah Test Range
(Page 7 of 8)

Parameter	Unit	Value Resident	Reference
Soil ingestion rate	g/yr	36.5	Calculated
Fruit, vegetable, and grain consumption	kg/yr	49.49	Calculated
Leafy vegetable consumption	kg/yr	4.13	Calculated
Milk consumption from on-site livestock	L/yr	0	Not an exposure pathway
Meat consumption from on-site livestock	kg/yr	0	Not an exposure pathway
Fish consumption	kg/yr	0	Not an exposure pathway
Other seafood consumption	kg/yr	0	Not an exposure pathway
Drinking water intake	L/yr	511	Calculated
Contamination fraction of drinking, household, and irrigation water	-	1	RESRAD default
Contamination fraction of plant food	-	-1	RESRAD computes fraction based upon area of contamination
Mass loading for foliar deposition	g/m^3	3.656E-3	Calculated
Depth of soil mixing layer	m	0.0	Conservative assumption
Depth of roots	m	0.9	RESRAD default
Drinking, household, and irrigation, water fraction from groundwater	-	1	RESRAD default
Storage time for fruits, nonleafy vegetables, and grain leafy vegetables drinking water	 d d d	 14 1 0	 RESRAD default RESRAD default RESRAD default
Thickness of building foundation	m	0.15	RESRAD default

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Table B-2
Parameters Used in the RESRAD Code for Calculating Guidance Concentrations for Corrective Action Unit No. 430, Tonopah Test Range
(Page 8 of 8)

Parameter	Unit	Value Resident	Reference
Bulk density of building foundation	g/cm^3	2.4	RESRAD default
Total porosity of building foundation	-	0.1	RESRAD default
Volumetric water content of the foundation	-	3.0E-2	RESRAD default
Diffusion coefficient for radon gas in foundation material in contaminated zone soil	m/s	 3.0E-7 2.0E-6	 RESRAD default RESRAD default
Radon vertical dimension of mixing	m	2	RESRAD default
Average annual wind speed	m/s	3.4	Culp and Howard, 1995
Average building air exchange rate	per hour	0.5	RESRAD default
Height of the building (room)	m	2.5	RESRAD default
Building interior area factor	-	0.0	RESRAD default
Building depth below ground surface	m	-1	RESRAD default
Emanating power of radon gas Rn-222 gas Rn-220 gas	 - -	 0.20 0.15	 RESRAD default RESRAD default
Summary of pathways selected external gamma inhalation without radon plant ingestion drinking water soil ingestion radon	NA	NA	Scenario-dependent. Resident lives on the site and raises as much food as possible, but area not sufficient to raise livestock.

Ac = Actinium
Am = Americium
cm^3/g = Cubic centimeter(s) per gram
d = Day(s)
D = Decay product(s)
g/yr = Gram(s) per year
g/cm^3 = Gram(s) per cubic centimeter
kg/yr = Kilogram(s) per year
m = Meter(s)
m/yr = Meter(s) per year
m = Meter(s)
m^3/yr = Cubic meter(s) per year
MB = Mass balance
NA = Not applicable
ND = Nondispersion
Np = Neptunium
Pa = Protactinium
Pb = Lead
pCi/g = PicoCurie(s) per gram
pCi/g = PicoCurie(s) per liter
Pu = Plutonium
Ra = Radium
RCRA FIWP = Resource Conservation and Recovery Act Facility Investigation Work Plan
Rn = Radon
Th = Thorium
U = Uranium

R. Dubiskas September 5, 1996

B.2.0 Analysis

A resident exposure scenario was chosen for CAU No. 430. This resident scenario is a plausible, but unlikely, scenario. The assumption is that, at some time within the next 10,000 years, the area consisting of CAU No. 430 may be released for use following remediation without any radiological restrictions, and an individual (resident) will move onto the site.

B.2.1 Radiological Source Term

Calculating the dose to a member of the public from residual contamination requires definition of a contaminated zone. This is the region within which radionuclides are present in above-background concentrations, and it is the common source term and starting point for all exposure pathway analysis. The derivation of guideline concentrations is based upon an idealized contaminated region of cylindrical shape within which radionuclides are assumed to be uniformly distributed.

The tritium in the W-79 projectile was in a gaseous form which most likely escaped to the atmosphere when the projectile crashed to the ground. In the unlikely event that the tritium gas did not escape from the projectile when it crashed, it will escape into the atmosphere upon in-place detonation of the projectile. Tritium decays to stable helium, so there will be no radioactive decay products from the tritium to contaminate the soil upon detonation.

However, DU and Pu contamination may spread into the soil upon the in-place detonation of the W-79 projectile. For this analysis, it is conservatively assumed that the detonation may spread the contamination to the surface and 5 feet (ft) below the maximum expected depth of the projectile. The lateral spread of the contamination is expected to be 5 ft; for this analysis it is conservatively assumed to be 25 ft. Thus, the total area of contamination is 1,963.5 square feet (ft^2) (182.4 square meters [m^2]). The depth of contamination is assumed to be from the surface to 15 ft (4.57 m) below the surface. Thus, the DU and Pu contamination is assumed to be uniformly distributed in a right circular cylinder with an area of 1,963.5 ft^2 and a depth of 15 ft.

DU is a mixture of uranium-238, uranium-235, and uranium-234 (U-238, U-235, U-234). Decay products from these three uranium isotopes have been produced during the time period since the projectile was manufactured. Based upon the initial DU composition, the RESRAD code automatically calculates the concentrations of the uranium and its decay products in the soil and other environmental pathway media as well as the resultant dose contribution from each isotope. The initial assumed composition of the DU is that referenced in the *Health Physics Manual of Good Practices for Uranium Facilities* (Rich et al., 1988).

The actual amount of plutonium in the W-79 JTA projectile is classified information. The Pu source term is assumed to be weapons grade plutonium that has decayed for 10 years. In order to calculate the dose to the hypothetical resident, the amount of Pu in the W-79 projectile has to be defined (estimated). Even if the amount of Pu is a very small fraction of the DU mass, its contribution to the total radioactivity will dominate the contribution from the DU. This is because the activity of a radionuclide is directly proportional to the inverse of its half-life, the time it takes for half of its radioactivity to decay. The shorter the half-life, the more radioactivity per unit mass. The uranium isotopes that compose the DU have half-lives that are five orders of magnitude greater than the half-lives of the weapons-grade plutonium isotopes. Given the same mass of DU and Pu, the radioactivity of the uranium isotopes is five orders of magnitude less than the activity of the weapons-grade plutonium isotopes. For example, if the Pu mass is only 0.01 percent of the DU mass, the radioactivity from the Pu will contribute 97.8 percent of the total radioactivity, while the DU mass will contribute only 2.2 percent of the total radioactivity (see Attachment B-1, pages B-5 through B-7 on how the radioactivity contribution from the Pu and DU is calculated). As the mass fraction of the Pu varies from 0.01 percent to 10 percent, its contribution to the total radioactivity varies from 97.8 to greater than 99.99 percent.

The dose to the hypothetical resident is directly proportional to the radioactivity to which that person is exposed. The inhalation and ingestion dose conversion factors for uranium are approximately an order of magnitude less than plutonium. Given the same intake of radioactivity for both DU and Pu to the hypothetical resident, the dose from DU will be about 10 percent of the dose from Pu. To ensure that the chosen radiological source term chosen provides sufficient protection to the hypothetical resident, the amount of Pu in the W-79 projectile was chosen to be 10 percent by mass. For each gram of DU, there is assumed to be 0.1 gram of weapons-grade plutonium. Though the mass contribution of weapons-grade plutonium is only 10 percent, the radioactivity contributed by the Pu is significantly greater than the DU. The Pu will contribute greater than 99.99 percent to the total radioactivity present in the W-79 round. The methodology used in calculating the contribution of each DU and Pu isotope to the total radioactivity is shown in Attachment B-1, on pages B-5 through B-6. The results are listed in Table B-3.

B.2.2 Exposure Scenario and the Parameter Values

This section examines the exposure pathways for the hypothetical resident living on the CAU No. 430 site. An exposure pathway is a route of intake to the resident from the radioactivity associated with the DU- and Pu-contaminated soil. For example, ingestion of vegetables, fruits, and grains grown on contaminated soil would be an exposure pathway. The dose to the hypothetical resident is calculated by summing up the doses from all exposure pathways. The calculations are performed using RESRAD.

The exposure pathways used in calculating the dose to the hypothetical resident include:

- External gamma irradiation
- Inhalation of resuspended soil
- Ingestion of plants grown on contaminated soil and irrigated with contaminated water

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Table B-3
DU and Pu Isotope Contribution to Total Radioactivity

Isotope	Abundance by Mass (g[a] isotope/g total mass)	Abundance by Radioactivity (pCi[b] of isotope per pCi of total activity)
U-238	9.07E-1	2.03E-5
U-235	2.23E-3	3.29E-7
U-234	4.54E-6	1.9E-6
Pu-238	3.26E-6	3.73E-3
Pu-239	8.84E-2	3.67E-1
Pu-240	2.29E-3	3.49E-2
Pu-241	8.38E-5	5.76E-1
Pu-242	2.82E-6	7.4E-7
Am-241	7.68E-5	1.76E-2

[a]Gram(s)
[b]PicoCurie(s)

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil
- Inhalation of radon and radon daughter products

The hypothetical resident resides on the site and is exposed to radiation emitted from the DU, the Pu, and their decay products. The resident does not have to contact the contamination directly to receive an external radiation exposure. The hypothetical resident receives external radiation exposure both while indoors and outside. This person breathes air that is contaminated with resuspended contaminated soil, radon gas, and radon decay products. The hypothetical resident raises, to the extent possible, his food in a garden located on contaminated soil. All of the water used for drinking, cooking, and irrigation comes from a well located on site. In addition, the hypothetical resident is assumed to ingest contaminated soil.

The hypothetical resident is assumed to live on the site 350 days per year (EPA, 1991). He is assumed to raise food in a garden irrigated with water from a well located at the downgradient edge of the decontaminated area. This location will ensure that the water from the well receives the maximum amount of contamination from the site. All drinking and cooking water is obtained from this well. The resident drinks 1.4 liters (L) of well water per day, 490 L per year (AIHC, 1994). He raises, to the extent possible, all of his own fruits, vegetables, and grains. The amount of food raised is limited due to the area of the contaminated soil, 0.0182 hectares (ha) (0.045 acres). The fraction of his food that is raised on the contaminated soil is calculated internally by RESRAD. The code assumes that it takes 2,000 square miles (m^2) to raise all of an individual's vegetables, fruits, and grains. This assumption is conservative given the climate and soil conditions on the Tonopah Test Range. The hypothetical resident is assumed not to raise any livestock for beef or milk or poultry for meat or eggs on the contaminated land. The area of contamination is not sufficiently large to raise any feed animals. The consumption rate of all food items is based upon a 10-county lifestyle survey relevant to rural areas and towns of fewer than 25,000 residents in the arid and semi-arid western United States (Whicker et al., 1990).

The inhalation rate for the hypothetical resident is for a reasonable worst case. This case is defined for an individual who spends 8 hours per day sleeping and, during the remaining day, spends 25 percent of his time at a resting activity level, 60 percent at a light activity level, 10 percent at a moderate activity level, and 5 percent at a heavy activity level (Yu et al., 1993b). The concentration of resuspended soil in the air is based upon the activities assumed for the hypothetical resident and site-specific measurements performed at the Tonopah Test Range and the Nevada Test Site. The hypothetical resident is assumed to spend 24 hours per year rototilling and cultivating his garden (EG&G, 1986). During this time, the concentration of contaminated dust in the air is assumed to increase by a factor of 150 (Shinn et al., 1986). In addition, for 8 hours per day, 150 days per year, the resident performs other outdoor activities associated with maintaining his garden, orchards, and property. During these activities, the concentration of contaminated dust in the air is assumed to increase by a factor of two (Shinn et al., 1986).

The total time spent indoors and outside is based upon a study of nine lifestyles of individuals living near the Nevada Test Site (Henderson and Smale, 1990). On the average, the hypothetical resident is assumed to spend 4 hours per day outdoors on site, 350 days per year. While outside, he is exposed to an external radiation rate that is 3.33 times greater than while indoors. The RESRAD default value of 0.7 was used to describe the amount of shielding from the external exposure rate while the resident is indoors. The concentration of contaminated dust in the air indoors is assumed to be the same as outdoors (Clayton et al., 1993). No dust is assumed to be filtered by the heating, cooling, or ventilation system in the home or other buildings. The radon inhalation dose is calculated by assuming the residential building foundation depth is set at one meter and the effective radon diffusion coefficient is 3×10^{-7} square meters per second (m^2/s) (Yu et al., 1993b). These parameter values are RESRAD default values.

Other assumptions used in this analysis include the following:

- No cover is assumed to be placed over the decontaminated area after remedial action is completed.

- The surface soil, unsaturated zone, and saturated zone soil are assumed to be sandy alluvium. This medium has an effective and total porosity of 0.3 (McWorter and Sunada, 1977) and a hydraulic conductivity of 100 meters per year (m/yr) (DOE, 1994).

- Climatography data were obtained from the *1993 Site Environmental Report for the Tonopah Test Range* (Culp and Howard, 1995). This document contains temperature, precipitation, and wind velocity data for TTR. The climatography data are put directly in RESRAD and are also used in calculating other parameter values, such as the evapotranspiration coefficient.

- Data on the food consumption rate and lifestyle habits of the hypothetical resident were adapted from articles in the November 1990 Special Issue of the *Health Physics Journal*, "Evaluation of Environmental Radiation Exposures from Nuclear Testing in Nevada" (Gesell and Voilleque, 1990).

- The leach rates of the DU, Pu, and their decay products from the soil by precipitation and irrigation water are calculated by RESRAD by using the distribution coefficients listed for sandy soil, Table 32.1, *RESRAD Data Collection Handbook* (Yu et al., 1993b).

The parameter values used in the RESRAD code for calculating the guideline concentrations are listed in Table B-2. Attachment B-1 includes the methodology on how the user-defined, site-specific data were calculated and utilized in RESRAD. The results of the analysis are discussed in the next section.

B.3.0 Analytical Results

A radiological risk assessment was performed in order to determine the relationship between the concentration of DU and Pu in the soil at CAU No. 430 and the dose to a hypothetical resident. The analysis demonstrates that given a conservative and limiting exposure scenario for the site resident, a concentration of 3,422 pCi/g of Pu would be required to obtain a dose of 100 mrem/yr. This concentration is the sum of the Pu-238, 239, 240, 241, and americium (Am)-241. Survey instruments used to confirm cleanup concentrations are often calibrated for Pu-239/240 using the 59.5 kiloelectron volt (keV) photon emission rate from Am-241 and the assumed Pu-239/240/Am-241 radioactivity ratio. The Pu-239/240 activity at this Pu concentration is 1,376 pCi/g . The concentration of the Am-241 is 60.3 pCi/g. The ratio of Pu-239/240 radioactivity to Am-241 is 22.8. All of these concentrations are equivalent and are representative of the concentration that could result in a 100 mrem/yr dose to a hypothetical resident. Listed in Table B-4 are the concentrations of the source radionuclides that will result in a 100 mrem/yr dose rate to a resident on CAU No. 430. The maximum annual dose rate of 100 mrem/yr occurs in 33 years, the year 2029.

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Table B-4
Concentration of Source Radionuclides Resulting in a 100 mrem/yr Residential Dose Rate for CAU No. 430

Radionuclide	Guideline Concentration (pCi/g)
U-238	6.95E-2
U-235	1.13E-3
U-234	6.50E-3
Pu-238	1.28E+1
Pu-239	1.26E+3
Pu-240	1.19E+2
Pu-241	1.97E+3
Pu-242	2.53E-3
Am-241	6.02+1

mrem/yr = Millirem(s) per year
pCi/g = PicoCurie(s) per gram

The dose contribution from each isotope for each exposure pathway and the total dose from each isotope and each exposure pathway are listed in Table B-1. The Pu-239/240 contributes 88.7 percent of the total dose to the hypothetical resident. Approximately 31 percent of the dose is received from the ingestion of Pu-239/240-contaminated soil and dust. Inhalation of resuspended soil contaminated with Pu-239/240 contributes 29 percent of the dose, as does the ingestion of Pu-239/240-contaminated food grown on site. Am-241 and Pu-241 contribute about 5 percent each to the dose. No other isotope contributes greater than 0.6 percent of the dose. The uranium isotopes contribute 0.01 percent of the total dose.

A radiological risk assessment has been performed to ensure that the chosen soil guideline criteria would not present a risk exceeding the basic dose limit in DOE Order 5400.5 (DOE, 1993). The guideline concentrations stated above and listed in Table B-2 will result in the hypothetical resident receiving less than 100 mrem/yr.

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B.4.0 References

AIHC. See American Industrial Health Council.

DOE. See U.S. Department of Energy.

EG&G. See EG&G Idaho.

EPA. See U.S. Environmental Protection Agency.

RCRA FIWP. See U.S. Department of Energy, 1994.

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Attachment B-1

Parameter Values Used as RESRAD Input for CAU No. 430 Buried DU Artillery Round

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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Parameter:		Source:	
Dose Conversion Factors		RESRAD default values	
Food Transfer Factors		RESRAD default values	
Bioaccumulation factors, fresh water		not applicable, not used	
Area of contamination		*Calculated*	
	Assumption is that area is a 25 ft radius around the projectile		
	Area = pi x r**2 =	1963.494	sq. ft.
	Area =	182.4153	m**2
thickness of contaminated zone		15 ft =	4.572 m
length parallel to aquifer flow		50 ft =	15.24
basic radiation dose limit (mrem/yr)		100	mrem/yr
time since placement of material		9	years (May 1987)
times for calculations		0, 10, 50, 100, 250, 500, 800, 1000, 5000, 10 000 yrs	
	note - 0 used in RESRAD input for activity is calculated for 1996; RESRAD assumes equilibrium		
Initial principal radionuclides		U-234 = 84.2 pCi/g	
		U-235 = 14.6 pCi/g	
		U-238 = 901.3 pCi/g	
		total = 1,000 pCi/g	
	note - source term modified in accordance with LANL/SNL guidance, see pages B-5, B-6 of Attachment B-1		
concentration in groundwater		0 pCi/L for all 3 radionuclides	
cover depth (m)		0	
soil density of contaminated zone		1.5 g/cm**3 (RESRAD default)	
contaminated zone erosion rate (m/yr)		1.44E-03	a calculated value described below
	Erosion rate = average resuspension factor (1E-11 per second [Shinn, et al, 1986]) x		
	3.154E+7 s/yr x 4.572 m contaminated zone thickness		
	Contaminated zone erosion rate =	0.001442	(m/yr)
contaminated zone total porosity =		0.3 (RCRA FIWP for TTR [DOE, 1994])	
contaminated zone effective porosity =		0.3 (RCRA FIWP for TTR [DOE, 1994])	
contaminated zone hydraulic conductivity =		1000 (Yu, et al., 1993b, Table 5.4, page 31, sandy soil)	
contaminated zone b parameter =		4.05 (Yu, et al., 1993b, Table 13.1, page 77, sandy soil)	
evapotranspiration coefficient =		0.679125	is calculated value
	Ce = ETr/((1-Cr)Pr + IRr) where		
	Ce = Evapotranspiration coefficient		
	ETr = evapotranspiration rate, Fig. 12-1, pg 72, Yu et al., 1993b =	1.11	m/yr
	Cr = runoff coefficient, Table 10.1, pg 66, Yu et al., 1993b (default)	0.2	
	Pr = precipitation from (Culp and Howard, 1995) =	0.127	m/yr
	IRr = irrigation rate = assumming a 70% irrigation efficiency =	1.532857	m/yr
	Ce = 0.679125		
precipitation rate =		0.127 m/yr (Culp and Howard, 1995)	
irrigation rate =		1.53 m/yr is a calculated value	
	IRr = 1.2 -.127/ 0.7 where		
	1.2 = water required per year to raise garden (m/yr)		
	.127 = average precipitation (m/yr) at TTR (Culp and Howard, 1995)		
	.7 is the assumed irrigation efficiency, mid-range (pg 68, Yu et al., 1993b)		
	IRr = 1.532857		

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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irrigation mode =				ditch				
runoff coefficient =				.2 (Table 10.1, pg 66, Yu et al., 1993b)				
watershed area for nearby stream or pond =				182.4153	m**2			
	note - the area of contamination is the minimum area that RESRAD will accept and							
	still execute, even if no water pathways are chosen							
accuracy for water/soil computation =				.001 (RESRAD default)				
saturated zone total porosity =				0.3 (RCRA FIWP for TTR [DOE, 1994])				
saturated zone effective porosity =				0.3 (RCRA FIWP for TTR [DOE, 1994])				
saturated zone hyraulic conductivity =				1000 (Table 5.4, pg 31, Yu et al., 1993b)				
saturated zone hydraulic gradient =				1E-4 (RCRA FIWP for TTR [DOE, 1994])				
saturated zone b parameter =				4.05 (Table 13.1, pg 77, Yu et al., 1993b)				
water table drop rate (m/yr) =				1E-4 (RCRA FIWP for TTR [DOE, 1994])				
well pump intake depth =				10 m below the water table, RESRAD default value				
Model: nondispersion or mass balance				ND (nondispersion, RESRAD default value)				
well pumping rate (m**3/yr) =				279.6165	m**3/yr			
	calculated = area x irrigation rate							
number of unsaturated zone strata =				1	(RCRA FIWP for TTR, [DOE, 1994])			
unsaturated zone thickness =				80	m (RCRA FIWP for TTR [DOE, 1994])			
unsaturated zone soil density =				1.5	g/cm**3 (RCRA FIWP for TTR [DOE, 1994])			
unsaturated zone total porosity =				0.3	(RCRA FIWP for TTR [DOE, 1994])			
unsaturated zone effective porosity =				0.3	(RCRA FIWP for TTR [DOE, 1994])			
unsaturated zone b parameter =				4.05	(Table 3.2, pg 23, Yu et al., 1993b)			
unsaturated zone hydraulic conductivity =				1000	(m/yr) (Table 5.4, pg 31, Yu et al., 1993b)			
distribution coefficients:								
	element	distribution coefficient (cm**3/g) from (Table 32.1, p 105, sandy soil, Yu, 1993b)						
	U	35						
	Th	3200						
	Pa	550						
	Ra	500						
	Pb	270						
Inhalation rate =				6372	m**3/yr			
	value calculated using the following methodology:							
								Occupancy
Activity		Percent	hours/day	(m**3/hr)	m**3/day	days/yr	m**3/yr	corrected
sleeping		33.33	8	0.4095	3.276	350	1146.6	1195.74
light work/resting		56.67	13.6008	0.611	8.310089	350	2908.531	3033.182
moderate work		6.666	1.59984	1.625	2.59974	350	909.909	948.9051
very heavy work		3.333	0.8	4.088	3.2704	350	1144.64	1193.696
total		99.999	24.00064				6109.68	6371.524
	where:							
	breathing rates from (Table 7, pg. 33, averaged by sex and age group, Layton, 1993)							
	percent of time performing different activities from reasonable worst case, (Yu et al, 1993b)							
	350 days per year, (EPA, 1991)							

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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exposure duration =	30	yrs (RESRAD default value)
shielding factor, inhalation =	1 (Clayton et al., 1993)	
mass loading for inhalation =	9.86E-06	g/m**3
this is a calculated value based upon the following:		
mass loading =x ={(1 x 150 x .1 x 1.36E-5) + (8/24 x 150 x 2 x .1 x 1.36E-5) + (90 x .1 x 3E-5) +		
[(350-90-(8 x 150/24) - 1) x 1.36E-5]} / 350		where
1 = days per year that the resident is rototilling or cultivating (EG&G, 1986)		
150 = increase in the mass loading during rototilling/cultivation (Shinn et al., 1986)		
0.1 = correcting mass loading for fraction of 5.7 um particles reaching pulmonary lung (Shinn, 1986)		
1.36E-5 (g/m**3) = average annual mass loading at TTR (Shinn et al., 1994)		
8 (hrs/d) = rate resident is performing garden chores, not rototilling/cultivation (Lindicotte et al., 1978)		
150 (d/yr) = days per year resident is performing agricultural chores (Lindicotte et al., 1978)		
2 = increase in the mass loading due to agricultural chores when not rototilling/cultivation		
90 = days per year of maximum mass loading, but not during rototilling/cultivation		
3E-5= maximum natural mass loading during the above stated 90 days(g/m**3)		
350 = days resident is assumed to be on the contaminated site		
x =	9.86E-06	g/m**3
dilution length for airborne dust =	3	m (RESRAD default value)
exposure duration =	30	yrs (RESRAD default value)
shielding factor (inhalation) =	1	(Clayton et al, 1993)
shielding factor, (external gamma) =	0.7	(RESRAD default value)
fraction of time spent indoors on site =	0.679224	calculated value
fraction of time indoors on site = 17 (hrs/d) x 350 (d/yr)/ 8760 (hrs/yr)		
fraction of time spent outdoors =	0.27968	calculated value
fraction of time outdoors = 7 (hrs/d) x 350 (d/yr) /8760 (hrs/yr)		
occupancy factor = fraction of time onsite =	0.958904	
note - RESRAD corrects dietary consumption, soil ingestion, inhalation inputed by the		
user by multiplying the input by the occupancy factor, calculated inputs have to		
be corrected by dividing by the occupancy factor, dietary intakes do not have		
to be corrected if area <1000m**2 and contamination fraction = -1		
shape factor flag, external gamma =	1	(RESRAD default value)
consumption of fruits, vegetables, grains =	49.49	kg/yr is a calculated value
consumption of fruits, vegetables, grains per year from table 1 (Whicker et al., 1993)		
other vegetables & fruits = .282 kg/d for males, 0.269 kg/d for females		
grains = 0.90 kg/d for males, 0.066 for females		
total ={ [(.282 +.269)/2]+[(.09 +.066)/2] }x350 days/year x 0.4 =	49.49	kg/yr
0.4 is the EPA guideline for maximum fraction of homegrown vegetables, fruits, grains		
RESRAD corrects production by area if conta amination fraction = -1, area/2000 m**2		
consumption of leafy vegetables =	4.13	kg/yr calculated value
consumption of leafy vegetables, Table 1, pg 649 (Whicker et al., 1990)		
total = (.03+.029)/2 x 350 days/year x 0.4 =	4.13	
RESRAD corrects production if cc ontamination fraction = -1, correction = area/2000m**2		
milk, meat, fish, & seafood consumption =	0	no cattle or cows raised on-site, no ponds
soil ingestion rate = 0.1 g/d x 350 d/yr =	35	g/yr
correct for occupancy factor =	36.5	g/yr for RESRAD input
occupancy factor = 365/350		

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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drinking water intake =	511	L/day is a calculated value
drinking water intake = 1.4 L/d x 350 d/yr / occupancy factor		
consumption rate is from AIHC, 1994, pg. 6.36, Table 21		
contamination fraction of all food =	-1	corrects for small area of site
mass loading for foliar deposition =	0.003656	g/m**3 is a calculated value
mass loading =x ={(1 x 150 x .1 x 1.36E-5) + (8/24 x 150 x 2 x .1 x 1.36E-5) + (90 x .1 x 3E-5) +		
[(365-90-(8 x 150/24) - 1) x 1.36E-5 0]}		where
1 = days per year that the resident is rototilling or cultivating (EG&G, 1986)		
150 = increase in the mass loading during rototilling/cultivation (Shinn et al., 1986)		
0.1 = correcting mass loading for fraction of 5.7 um particles reaching pulmonary lung (Shinn, et al, 1986)		
1.36E-5 (g/m**3) = average annual mass loading at TTR (Shinn et al., 1994)		
8 (hrs/d) = rate resident is performing gardon chores, not rototilling/cultivation (Lindicotte et al., 1978)		
150 (d/yr) = days per year resident is performing agricultural chores (Lindicotte et al., 1978)		
2 = increase in mass loading due to agricultural chores when not rototilling/cultivation (Shinn et al, 1986)		
90 = days per year of maximum mass loading, but not during rototilling/cultivation (Shinn et al, 1986)		
3E-5= maximum natural mass loading during the above stated 90 days(g/m**3) (Shinn et al, 1994)		
x =	0.003656	g/m**3
depth of soil mixing layer =	0	m assumes no mixing from clean areas
depth of roots =	0.9	m (RESRAD default value)
fraction of drinking water fraction from groundwater =	1	assumes all water from onsite well
household water fraction from groundwater =	1	assumes all water from onsite well
irrigation fraction from groundwater =	1	assumes all water from onsite well
contamination fraction for livestock fodder, water, soil		
meat, milk =	0	not applicable to this analysis
		resident not consuming meat or milk from
		cattle, cows raised on-site
storage time of contaminated foodstuffs (days)		
fruits, non-leafy vegetables, grains =	14	RESRAD default value
leafy vegetables	1	RESRAD default value
well water	1	RESRAD default value
meat, milk, fish, animal fodder =	na	not applicable to this analysis
		resident not consuming any meat from
		animals raised on-site
thickness of building foundation (m)	0.15	RESRAD default value
bulk density of building foundation =	2.4	(g/cm**3) RESRAD default value
total porosity of the building foundation =	0.1	RESRAD default value
volumetric water content of the foundation =	0.3	RESRAD default value
diffusion coefficient for radon gas (m/s)		
in foundation material =	3.00E-07	RESRAD default value
in contaminated zone soil =	2.00E-06	RESRAD default value
radon vertical dimension of mixing (m) =	2	RESRAD default value
average annual wind speed (m/s) =	3.4	(Culp and Howard, 1995)
average building air exchange rate (1/hr) =	0.5	RESRAD default value
height of the building (m) =	2.5	RESRAD default value

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building interior area factor =	0	RESRAD default value
building depth below ground surface (m) =	-1	RESRAD default value
emanating power of Rn-222 gas	0.25	RESRAD default value
emanating power of Rn-220 gas	0.15	not applicable to the source term

Note - On September 5, 1996, LANL/Sandia Labs notified ITLV that the W-79 projectile contained Pu. The source term must be modified to include the contribution from the plutonium. The mass of the Pu, mixture of isotopes, ratio of activity to DU is classified. For this analysis, it will be assumed that the mass of the Pu is 10% of the DU and that the Pu is composed of weapons grade plutonium.

isotope	U-234	U-235	U-238	Total
activity (pCi/g)	84.2	14.6	901.3	1000.1
activity fraction	0.084192	0.014599	0.90121	1
mass	1.35E-08	6.75E-06	0.002689	0.002696
mass fraction	5E-06	0.002505	0.99749	1

Mass of DU per g of soil = .002696 g, the assumed mass of Pu = 0.00027

The isotopic distribution of activity (curies) in weapons grade Pu after 10 yrs decay is described below:

isotope	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242	Am-241	Total
activity	0.002771	0.273024	0.025946	0.428554	5.50E-07	0.013097	0.743393
fraction	0.003728	0.367268	0.034902	0.576484	7.4E-07	0.017618	1

conversion of activity (Ci) to mass (grams) is performed using the following expression:
Ci x 3.7E+10 (Bq/Ci) x 1E-12 (TBq/Bq) x (1/ TBq/g) where TBq/g is from Table 8.4.1 (Shleien, 1992)

	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242	Am-241	Total
mass	0.000162	4.392125	0.113879	0.004162	0.00014	0.003816	4.514284
fraction	3.58E-05	0.97294	0.025226	0.000922	3.1E-05	0.000845	

The total mass of Pu + Am in the W-79 per g of soil is assumed to be 0.00027 g. Then the mass contribution from each isotope is calculated by mass fraction x .00027 g.

	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242	Am-241	Total
mass	9.66E-09	0.000262	6.8E-06	2.49E-07	8.36E-09	2.28E-07	0.00027
pCi	165496.3	16306195	1549609	25595131	32.84842	782210.5	44398675

Even at 1% of the mass, the activity from the Pu+Am exceeds U activity by 44,400 !

Distribution Coefficients, dose conversion factors, food transfer factors, bioaccumulation for Pu+D:

Element	Dist. Coef.	DCF INH	FTF	Bisaccum.
Plutonium	550	default	default	default
Americium	1900	default	default	default
Neptunium	5	default	default	default

Distribution Coefficients are from Table 32.1, p. 105 (Yu et al., 1993b) for sand soil types
Default values are the RESRAD default values for each radionuclide for each element

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Calculations of RESRAD source terms:

Assume the Pu-239/240 activity = 500 pCi/g, the activity of all isotopes is calculated as follows:

The activity in the Pu+Am mix = 500 g/(fraction of total due to Pu-239/240) = 1243.256

The activity for all other Pu+Am isotopes can be calculated from their fraction of the Pu+Am mix.

If the Pu-239/240 activity is 200 pCi/g, the same method is used, Pu+Am activity = 497.3024

Then each isotope in the Pu+Am mix can be calculated by multiplying its fraction by the total pCi

e.g. for Pu-238, if the total activity when Pu-239/240 = 500 pCi/g is 1243.256 pCi, the Pu-238

activity is .003728 x 1243.256= 4.634244 pCi/g of soil

The U isotopic activity = (Pu+Am fraction/total Pu+Am) x total U x isotopic U activity fraction.

If Pu239/240 = 500 pCi/g, then Pu+Am fraction = 500 pCi/g + Pu-238.241,242, + Am = 1243.256

e.g., U-234 activity = (1243 pCi/g/4.4E+7 pCi/g) x 1000 pCi/g x .084192 = 0.002358

If Pu-239/240 activity fraction = 200 pCi/g, then the total Pu+Am activity = 497.3024

The U-234 activity = (497.3024/4.4E+7) x 1000 x .084192 = 0.000943

Pu-239/240 is emphasized because in-situ monitoring is based upon Am-241/Pu-239/240 activity ratios using the 59.5 keV Am-241 photon. For the W-79 project in-situ monitoring may not be used, but if it is used it will be helpful to have the guideline in terms of Pu-239/240 or Am-241.

principal Isotope	isotopic activity if the Pu-239/240 activity = 500 pCi/g	isotopic activity if the Pu-239/240 activity is 200 pCi/g
U-234	0.002358	0.000943
U-235	0.000409	0.000164
U-238	0.025238	0.010095
Pu-238	4.634244	1.853698
Pu-239	456.6077	182.6431
Pu-240	43.39231	17.35693
Pu-241	716.7174	286.687
Pu-242	0.00092	0.000368
Am-241	21.90354	8.761414
Total	1243.284	497.3136

Calculate the activity and mass fraction of each isotope for Table B-1 in Appendix B:

isotope	mass fraction	activity fraction	guideline concentration (pCi/g)
U-234	4.55E-06	1.9E-06	6.50E-03
U-235	0.002277	3.29E-07	1.13E-03
U-238	0.90681	2.03E-05	6.95E-02
Pu-238	3.26E-06	0.003727	1.28E+01
Pu-239	0.088449	0.367259	1.26E+03
Pu-240	0.002293	0.034901	1.19E+02
Pu-241	8.38E-05	0.576471	1.97E+03
Pu-242	2.82E-06	7.4E-07	2.53E-03
Am-241	7.68E-05	0.017617	6.02E+01

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Parameter Values Used as RESRAD Input for CAU No. 430
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Calculation of isotopic mass and activity fractions when mass fractions of Pu = 0.0001

Isotope	Mass fraction if Pu mass fraction = .0001	specific activity (TBq/g)	activity per 100 g (pCi)	activity fraction
U-234	0.0005	2.31E-04	3123027	0.001854
U-235	0.250427	8.00E-08	541522.5	0.000322
U-238	99.73907	1.24E-08	33429745	0.019851
Pu-238	3.58E-07	0.6341	6139937	0.003646
Pu-239	0.009729	2.30E-03	6.05E+08	0.359178
Pu-240	0.000252	8.43E-03	57481664	0.034133
Pu-241	9.22E-06	3.81	9.49E+08	0.563786
Pu-242	3.1E-07	1.45E-04	1218.489	7.24E-07
Am-241	8.45E-06	0.127	29015546	0.01723
Total	100		1.68E+09	1

Pu-239/240 % of the total activity when total Pu is 0.01% of the mass =	39.33109
Pu percent of the total activity when Pu is 0.01% of the mass =	97.79729
When DU is 99.99% of the mass its percent of the total activity =	2.202706

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Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61      T" Limit = 0.5 year        09/10/96  16:26    Page    1
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376   pCi/g Pu-239/240
File    : W79_DU_5.DAT
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Part I: Mixture Sums and Single Radionuclide Guidelines

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RESRAD, Version 5.61   T½ Limit = 0.5 year   09/10/96 16:26   Page 2
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

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

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(3)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(4)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(5)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(6)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(7)
B-1	Pu-240	4.290E-01	4.290E-01	DCF2(8)
B-1	Pu-241+D	8.250E-03	8.250E-03	DCF2(9)
B-1	Pu-242	4.110E-01	4.110E-01	DCF2(11)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(12)
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(13)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(14)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(15)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(16)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(17)
B-1	U-233	1.350E-01	1.350E-01	DCF2(18)
B-1	U-234	1.320E-01	1.320E-01	DCF2(19)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(20)
B-1	U-236	1.250E-01	1.250E-01	DCF2(21)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(22)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(3)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(4)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(5)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(6)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(7)
D-1	Pu-240	3.540E-03	3.540E-03	DCF3(8)
D-1	Pu-241+D	6.850E-05	6.850E-05	DCF3(9)
D-1	Pu-242	3.360E-03	3.360E-03	DCF3(11)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(12)
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(13)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(14)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(15)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(16)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(17)
D-1	U-233	2.890E-04	2.890E-04	DCF3(18)
D-1	U-234	2.830E-04	2.830E-04	DCF3(19)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(20)
D-1	U-236	2.690E-04	2.690E-04	DCF3(21)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(22)
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)

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Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 3
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

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

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(3,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(3,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(4,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(4,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(5,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(5,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(5,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(6,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(7,3)
D-34				
D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(8,3)
D-34				
D-34	Pu-241+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(9,1)
D-34	Pu-241+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(9,2)
D-34	Pu-241+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(9,3)
D-34				
D-34	Pu-242 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(11,1)
D-34	Pu-242 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(11,2)
D-34	Pu-242 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(11,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(12,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(12,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(12,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(13,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(13,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(13,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(14,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(14,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(14,3)
D-34				

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Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

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

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(15,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(15,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(15,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(16,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(16,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(16,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(17,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(17,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(17,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(18,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(18,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(18,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(19,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(19,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(19,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(20,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(20,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(20,3)
D-34				
D-34	U-236 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(21,1)
D-34	U-236 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(21,2)
D-34	U-236 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(21,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(22,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(22,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(22,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(3,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(4,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(5,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(5,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(6,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(6,2)

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 5
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

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

Menu	Parameter	Current Value	Default	Parameter Name
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(7,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(7,2)
D-5				
D-5	Pu-240 , fish	3.000E+01	3.000E+01	BIOFAC(8,1)
D-5	Pu-240 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(8,2)
D-5				
D-5	Pu-241+D , fish	3.000E+01	3.000E+01	BIOFAC(9,1)
D-5	Pu-241+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(9,2)
D-5				
D-5	Pu-242 , fish	3.000E+01	3.000E+01	BIOFAC(11,1)
D-5	Pu-242 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(11,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(12,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(12,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(13,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(13,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(14,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(14,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(15,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(15,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(16,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(16,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(17,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(17,2)
D-5				
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(18,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(18,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(19,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(19,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(20,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(20,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(21,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(21,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(22,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(22,2)

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61   T½ Limit = 0.5 year   09/10/96 16:26   Page 6
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

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)	1.820E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	4.572E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.524E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.000E+02	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+01	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+01	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+02	1.000E+01	---	T(4)
R011	Times for calculations (yr)	2.500E+02	3.000E+01	---	T(5)
R011	Times for calculations (yr)	5.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	8.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	5.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	1.000E+04	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Am-241	6.023E+01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Pu-238	1.276E+01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.256E+03	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): Pu-240	1.194E+02	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): Pu-241	1.971E+03	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): Pu-242	2.530E-03	0.000E+00	---	S1(11)
R012	Initial principal radionuclide (pCi/g): U-234	6.500E-03	0.000E+00	---	S1(19)
R012	Initial principal radionuclide (pCi/g): U-235	1.130E-03	0.000E+00	---	S1(20)
R012	Initial principal radionuclide (pCi/g): U-238	6.947E-02	0.000E+00	---	S1(22)
R012	Concentration in groundwater (pCi/L): Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): Pu-240	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): Pu-241	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): Pu-242	not used	0.000E+00	---	W1(11)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(19)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(20)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(22)
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)	1.442E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	3.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	6.800E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.270E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	1.530E+00	2.000E-01	---	RI
R013	Irrigation mode	ditch	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.824E+02	1.000E+06	---	WAREA

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 7
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	3.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	3.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.000E-04	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-04	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)	2.796E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	8.000E+01	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	3.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	3.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.050E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Am-241				
R016	Contaminated zone (cm**3/g)	1.900E+03	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.900E+03	2.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.900E+03	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.007E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.384E-04	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.384E-04	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for Pu-240				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.384E-04	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 8
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Pu-241				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.384E-04	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for Pu-242				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.384E-04	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCC(19)
R016	Unsaturated zone 1 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(19,1)
R016	Saturated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCS(19)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.169E-03	ALEACH(19)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(19)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCC(20)
R016	Unsaturated zone 1 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(20,1)
R016	Saturated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCS(20)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.169E-03	ALEACH(20)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(20)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCC(22)
R016	Unsaturated zone 1 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(22,1)
R016	Saturated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCS(22)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.169E-03	ALEACH(22)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(22)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	4.500E+02	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	4.500E+02	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	4.500E+02	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.691E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	5.000E+00	-1.000E+00	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+00	-1.000E+00	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	5.000E+00	-1.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.492E-02	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 9
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

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 Pa-231				
R016	Contaminated zone (cm**3/g)	5.500E+02	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	5.500E+02	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.384E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.819E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.522E-04	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.522E-04	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(14)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(14,1)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(14)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.379E-05	ALEACH(14)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(14)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.379E-05	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(16)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(16,1)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.379E-05	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T" Limit = 0.5 year 09/10/96 16:26 Page 10
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-232				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(17)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(17,1)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(17)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.379E-05	ALEACH(17)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(17)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCC(18)
R016	Unsaturated zone 1 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(18,1)
R016	Saturated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCS(18)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.169E-03	ALEACH(18)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(18)
R016	Distribution coefficients for daughter U-236				
R016	Contaminated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCC(21)
R016	Unsaturated zone 1 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(21,1)
R016	Saturated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCS(21)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.169E-03	ALEACH(21)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(21)
R017	Inhalation rate (m**3/yr)	6.372E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	9.860E-06	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	1.000E+00	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.792E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.797E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	1 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(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 11
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	4.949E+01	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	4.130E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.110E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.910E-01	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	3.656E-03	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	0.000E+00	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	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
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
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 12
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	not used	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	not used	2.000E+01	---	STOR_T(4)
STOR	Fish	not used	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	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	not used	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	1.500E-01	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	1.000E-01	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	3.000E-02	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	3.000E-07	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	5.000E-01	5.000E-01	---	REXG
R021	Height of the building (room) (m)	2.500E+00	2.500E+00	---	HRM
R021	Building interior area factor	0.000E+00	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	-1.000E+00	-1.000E+00	code computed (time dependent)	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	1.500E-01	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	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	active

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 13
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

Contaminated Zone Dimensions	
Area:	182.00 square meters
Thickness:	4.57 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Am-241	6.023E+01
Pu-238	1.276E+01
Pu-239	1.256E+03
Pu-240	1.194E+02
Pu-241	1.971E+03
Pu-242	2.530E-03
U-234	6.500E-03
U-235	1.130E-03
U-238	6.947E-02

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 100 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+01	5.000E+01	1.000E+02	2.500E+02	5.000E+02	8.000E+02	1.000E+03	5.000E+03	1.000E+04
TDOSE(t):	9.809E+01	9.920E+01	9.973E+01	9.824E+01	9.352E+01	8.708E+01	8.083E+01	7.727E+01	2.743E+01	1.166E+01
M(t):	9.809E-01	9.920E-01	9.973E-01	9.824E-01	9.352E-01	8.708E-01	8.083E-01	7.727E-01	2.743E-01	1.166E-01

Maximum TDOSE(t): 9.993E+01 mrem/yr at t = 32.92 þ 0.03 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 = 32.92 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	fract
Am-241	1.634E+00	0.0164	1.249E+00	0.0125	0.000E+00	0.0000	1.227E+00	0.0123	0.000E+00	0.0000	0.000E+00	0.0000	1.323E+00	0.013
Pu-238	1.049E-03	0.0000	1.893E-01	0.0019	7.164E-08	0.0000	1.852E-01	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	1.997E-01	0.002
Pu-239	2.452E-01	0.0025	2.641E+01	0.2643	0.000E+00	0.0000	2.612E+01	0.2614	0.000E+00	0.0000	0.000E+00	0.0000	2.817E+01	0.281
Pu-240	1.229E-02	0.0001	2.505E+00	0.0251	1.398E-15	0.0000	2.478E+00	0.0248	0.000E+00	0.0000	0.000E+00	0.0000	2.672E+00	0.026
Pu-241	1.448E+00	0.0145	1.266E+00	0.0127	0.000E+00	0.0000	1.247E+00	0.0125	0.000E+00	0.0000	0.000E+00	0.0000	1.344E+00	0.013
Pu-242	2.265E-07	0.0000	5.101E-05	0.0000	1.915E-20	0.0000	4.999E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.390E-05	0.000
U-234	1.716E-06	0.0000	3.940E-05	0.0000	1.242E-06	0.0000	2.266E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.092E-05	0.000
U-235	5.200E-04	0.0000	6.522E-06	0.0000	0.000E+00	0.0000	4.174E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.868E-06	0.000
U-238	5.599E-03	0.0001	3.762E-04	0.0000	4.088E-10	0.0000	2.302E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.108E-04	0.000
Total	3.348E+00	0.0335	3.162E+01	0.3164	1.314E-06	0.0000	3.126E+01	0.3128	0.000E+00	0.0000	0.000E+00	0.0000	3.370E+01	0.337

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61   T½ Limit = 0.5 year   09/10/96 16:26   Page 14
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 32.92 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.433E+00	0.0544
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.752E-01	0.0058
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.094E+01	0.8100
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.667E+00	0.0767
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.305E+00	0.0531
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.551E-04	0.0000
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	7.594E-05	0.0000
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	5.326E-04	0.0000
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	6.316E-03	0.0001
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	9.993E+01	1.0000

*Sum of all water independent and dependent pathways.

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Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T½ Limit = 0.5 year 09/10/96 16:26 Page 15
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

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-	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	fract.
Am-241	1.725E+00	0.0176	1.318E+00	0.0134	0.000E+00	0.0000	1.295E+00	0.0132	0.000E+00	0.0000	0.000E+00	0.0000	1.397E+00	0.0142
Pu-238	1.367E-03	0.0000	2.466E-01	0.0025	0.000E+00	0.0000	2.413E-01	0.0025	0.000E+00	0.0000	0.000E+00	0.0000	2.602E-01	0.0027
Pu-239	2.466E-01	0.0025	2.655E+01	0.2707	0.000E+00	0.0000	2.627E+01	0.2678	0.000E+00	0.0000	0.000E+00	0.0000	2.832E+01	0.2887
Pu-240	1.239E-02	0.0001	2.525E+00	0.0257	0.000E+00	0.0000	2.498E+00	0.0255	0.000E+00	0.0000	0.000E+00	0.0000	2.693E+00	0.0275
Pu-241	2.448E-02	0.0002	8.015E-01	0.0082	0.000E+00	0.0000	7.964E-01	0.0081	0.000E+00	0.0000	0.000E+00	0.0000	8.601E-01	0.0088
Pu-242	2.276E-07	0.0000	5.125E-05	0.0000	0.000E+00	0.0000	5.022E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.415E-05	0.0000
U-234	1.740E-06	0.0000	4.229E-05	0.0000	0.000E+00	0.0000	2.433E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.172E-05	0.0000
U-235	5.580E-04	0.0000	6.850E-06	0.0000	0.000E+00	0.0000	3.991E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.922E-06	0.0000
U-238	6.013E-03	0.0001	4.040E-04	0.0000	0.000E+00	0.0000	2.472E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.190E-04	0.0000
Total	2.016E+00	0.0206	3.145E+01	0.3206	0.000E+00	0.0000	3.110E+01	0.3170	0.000E+00	0.0000	0.000E+00	0.0000	3.353E+01	0.3418

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-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.735E+00	0.0585
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.494E-01	0.0076
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.139E+01	0.8297
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.729E+00	0.0788
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.482E+00	0.0253
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.559E-04	0.0000
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	8.008E-05	0.0000
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	5.708E-04	0.0000
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	6.783E-03	0.0001
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	9.809E+01	1.0000

*Sum of all water independent and dependent pathways.

R. Dubiskas September 5, 1996

Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
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RESRAD, Version 5.61 T" Limit = 0.5 year 09/10/96 16:26 Page 16
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

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-	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	fract.
Am-241	1.697E+00	0.0171	1.297E+00	0.0131	0.000E+00	0.0000	1.274E+00	0.0128	0.000E+00	0.0000	0.000E+00	0.0000	1.374E+00	0.0138
Pu-238	1.261E-03	0.0000	2.276E-01	0.0023	2.134E-09	0.0000	2.226E-01	0.0022	0.000E+00	0.0000	0.000E+00	0.0000	2.401E-01	0.0024
Pu-239	2.462E-01	0.0025	2.651E+01	0.2672	0.000E+00	0.0000	2.622E+01	0.2643	0.000E+00	0.0000	0.000E+00	0.0000	2.827E+01	0.2850
Pu-240	1.236E-02	0.0001	2.519E+00	0.0254	4.118E-17	0.0000	2.492E+00	0.0251	0.000E+00	0.0000	0.000E+00	0.0000	2.687E+00	0.0271
Pu-241	7.270E-01	0.0073	1.038E+00	0.0105	0.000E+00	0.0000	1.027E+00	0.0104	0.000E+00	0.0000	0.000E+00	0.0000	1.107E+00	0.0112
Pu-242	2.273E-07	0.0000	5.118E-05	0.0000	1.669E-22	0.0000	5.015E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.407E-05	0.0000
U-234	1.712E-06	0.0000	4.139E-05	0.0000	1.171E-07	0.0000	2.381E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.147E-05	0.0000
U-235	5.461E-04	0.0000	6.729E-06	0.0000	0.000E+00	0.0000	4.037E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.900E-06	0.0000
U-238	5.884E-03	0.0001	3.954E-04	0.0000	1.179E-11	0.0000	2.419E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.165E-04	0.0000
Total	2.690E+00	0.0271	3.159E+01	0.3185	1.192E-07	0.0000	3.124E+01	0.3149	0.000E+00	0.0000	0.000E+00	0.0000	3.368E+01	0.3395

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-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.641E+00	0.0569
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.915E-01	0.0070
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.125E+01	0.8191
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.710E+00	0.0777
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.900E+00	0.0393
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.556E-04	0.0000
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	7.850E-05	0.0000
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	5.588E-04	0.0000
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	6.638E-03	0.0001
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	9.920E+01	1.0000

*Sum of all water independent and dependent pathways.

R. Dubiskas September 5, 1996

Attachment B-1
Parameter Values Used as RESRAD Input for CAU No. 430
(Page 24 of 24)

RESRAD, Version 5.61 T" Limit = 0.5 year 09/10/96 16:26 Page 17
Summary : Dose to Resident, CAU 430, 0.77 pCi/g DU, 1376 pCi/g Pu-239/240
File : W79_DU_5.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 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	fract.
Am-241	1.589E+00	0.0159	1.214E+00	0.0122	0.000E+00	0.0000	1.193E+00	0.0120	0.000E+00	0.0000	0.000E+00	0.0000	1.286E+00	0.0129
Pu-238	9.148E-04	0.0000	1.650E-01	0.0017	2.400E-07	0.0000	1.614E-01	0.0016	0.000E+00	0.0000	0.000E+00	0.0000	1.741E-01	0.0017
Pu-239	2.445E-01	0.0025	2.633E+01	0.2641	0.000E+00	0.0000	2.605E+01	0.2612	0.000E+00	0.0000	0.000E+00	0.0000	2.808E+01	0.2816
Pu-240	1.224E-02	0.0001	2.495E+00	0.0250	3.991E-15	0.0000	2.468E+00	0.0247	0.000E+00	0.0000	0.000E+00	0.0000	2.660E+00	0.0267
Pu-241	1.617E+00	0.0162	1.305E+00	0.0131	0.000E+00	0.0000	1.284E+00	0.0129	0.000E+00	0.0000	0.000E+00	0.0000	1.384E+00	0.0139
Pu-242	2.260E-07	0.0000	5.089E-05	0.0000	1.001E-19	0.0000	4.987E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.377E-05	0.0000
U-234	1.777E-06	0.0000	3.798E-05	0.0000	2.821E-06	0.0000	2.185E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.052E-05	0.0000
U-235	5.015E-04	0.0000	6.407E-06	0.0000	0.000E+00	0.0000	4.289E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.854E-06	0.0000
U-238	5.395E-03	0.0001	3.626E-04	0.0000	1.402E-09	0.0000	2.218E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.068E-04	0.0000
Total	3.470E+00	0.0348	3.151E+01	0.3160	3.062E-06	0.0000	3.115E+01	0.3124	0.000E+00	0.0000	0.000E+00	0.0000	3.359E+01	0.3368

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Am-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.283E+00	0.0530
Pu-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.014E-01	0.0050
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.071E+01	0.8093
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.635E+00	0.0766
Pu-241	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.591E+00	0.0561
Pu-242	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.548E-04	0.0000
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	7.495E-05	0.0000
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	5.141E-04	0.0000
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	6.086E-03	0.0001
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	9.973E+01	1.0000

*Sum of all water independent and dependent pathways.