Nevada
Environmental
Restoration
Project

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Clean Slate 1 Corrective Action Plan

Revision 0

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Environmental Restoration
Division

U.S. Department of Energy
Nevada Operations Office

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CLEAN SLATE 1

CORRECTIVE ACTION PLAN

Bechtel Nevada Project No. ER 211-9701

**Prepared for the U.S. Department of Energy
Nevada Operations Office
under Contract No. DE-AC08-96NV11718**

Revision 0

April 1997

MASTER

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**CLEAN SLATE 1
CORRECTIVE ACTION PLAN**

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ACRONYMS and ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
AGL	Above Ground Level
Am	Americium
ATV	All Terrain Vehicle
BN	Bechtel Nevada
CADD	Corrective Action Decision Document
CAIP	Corrective Action Investigation Plan
CAP	Corrective Action Plan
CAU	Corrective Action Units
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
cm	centimeters
CS	Clean Slate
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy/Nevada Operations Office
DOT	U.S. Department of Transportation
DRI	Desert Research Institute
EDE	Effective Dose Equivalent
EEEC	Energy and Environmental Engineering Center
EPA	U.S. Environmental Protection Agency
EPP	Environmental Protection Plan
EZ	Exclusion Zone
FFACO	Federal Facility Agreement and Consent Order
ft	feet
ft/min	feet per minute
ft/s	feet per second
Ge	germanium
GPS	Global Positioning System
GZ	Ground Zero
HPD	Health Physics Department
in	inches
km	kilometers
keV	kilovolt
μCi	microcuries
m	meters
MDA	Minimum Detectable Activity
MEI	Maximum Exposed Individual
mi	miles
mil	millimeter

ACRONYMS and ABBREVIATIONS (Continued)

mph	miles per hour
mrem/year	millirem per year
m/s	meters per second
MSDS	Material Safety Data Sheet
NaI	sodium iodide
NAFR	Nellis Air Force Range
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NTS	Nevada Test Site
NTSWAC	Nevada Test Site Waste Acceptance Criteria
PA	Performance Assurance
PAMP	Performance Assurance Management Plan
pCi/g	picocuries per gram
PDT	Pacific Daylight Time
PM	Project Manager
PM ₁₀	particulate matter nominally 10 μ m or less
PTS/PMS	Performance Tracking System/Performance Measurement System
Pu	plutonium
QA/QC	Quality Assurance/Quality Control
RADCON	Radiation Control
RSL	Remote Sensing Laboratory
RWAP	Radioactive Waste Acceptance Program
RWMS	Radioactive Waste Management Site
RWP	Radiological Work Permit
SAP	Sampling and Analysis Plan
SHSO	Site Health and Safety Officer
SNL	Sandia National Laboratories
SSHASP	Site-Specific Health and Safety Plan
TCLP	Toxicity Characteristic Leachate Procedure
TTR	Tonopah Test Range
USAF	U.S. Air Force
yd	yard

CLEAN SLATE 1

CORRECTIVE ACTION PLAN Bechtel Nevada Project No. ER 211-9701

1.0 INTRODUCTION

This Corrective Action Plan (CAP) has been prepared to meet the requirements specified in the Federal Facility Agreement and Consent Order (FFACO, 1996). A Corrective Action Decision Document (CADD) (DOE, 1997) was submitted to the Nevada Department of Environmental Protection (NDEP) January 31, 1997 for the Clean Slate 1 (CS-1) Site in accordance with the Corrective Action Investigation Plan (CAIP) (DOE, 1996) and the Soils Media Operable Unit Quality Assurance Project Plan (DOE, 1995). The FFACO lists CS-1 as Corrective Action Unit (CAU) number 412.

Operation Roller Coaster was a series of four non-nuclear destruction experiments of nuclear devices which were detonated at Double Tracks and CS-1, Clean Slate 2 (CS-2), and Clean Slate 3 (CS-3). These experiments were a joint exercise among the United Kingdom, the U.S. Department of Defense (DoD), and the U.S. Atomic Energy Commission (AEC), predecessor to the U.S. Department of Energy (DOE) (AEC, 1964). The objectives of Operation Roller Coaster were to:

- Collect physical and biological data on plutonium (Pu) airborne particulates to assess the acute inhalation hazard.
- Measure the distribution of Pu on the ground to permit detailed accountability of the amount dispersed.
- Evaluate the effectiveness of storage structures with varying thickness of earth cover, for reducing the radiologic hazard from a real accident.
- Obtain data of special importance in forecasting the hazard arising from a real accident (cloud models).

Residual radiologic contamination remaining at the Operation Roller Coaster sites require that some form of site corrective action be undertaken. The Double Tracks site was characterized and interim corrective actions were completed in August 1996. Many lessons were learned during the Double Tracks characterization and corrective action which have been implemented into the CS-1 CAP. The CS sites are located in the central portion of the Tonopah Test Range (TTR). The TTR is in the northwest portion of the Nellis Air Force Range (NAFR) and is located north of the Nevada Test Site (NTS). The general locations of the TTR, NTS, and CS-1 site are shown in Figure 1-1.

The CS-1 site is located in the central portion of the TTR, in Nye County, Nevada. The approximate location of the site within the TTR is shown on Figure 1-1. The CS-1 site is located approximately 224 kilometers (km) (130 miles [mi]) northwest of Las Vegas and approximately 64 km (40 mi) southeast of Tonopah, Nevada.

The site is located within the high desert region of south-central Nevada. CS-1 is located in a broad valley known as Cactus Flat with an approximate elevation of 1,640 meters (m) (5380 feet [ft]) above mean sea level. The soils beneath the site are alluvial in origin. No permanent surface water, streams, or lakes are present in the area, although several dry stream channels and lake beds do retain and transport surface water after heavy rains (Leavitt, 1974).

During the spring of 1996, site characterization activities were performed at the site. The details of this study and a summary of previous studies are provided in the *Clean Slate 1 Corrective Action Decision Document* (DOE, 1997). This site characterization study revealed that, except for the area near the ground zero (GZ), contamination was limited to a depth of 3 to 5 centimeters (cm) (1 to 2 inches [in]) within the contaminated zone and is the basis for the approved corrective action alternative.

1.1 Corrective Action Plan Document Purpose

The purpose of this CAP is to provide the plan for implementing the recommended corrective action alternative discussed in the CADD. This corrective action will be undertaken to remediate the site to an extent that it may be released for unrestricted use.

Figure 1-1. Location map showing TTR, NTS, and CS-1.

1.2 Scope of Work

The scope of work for this project consists of the following activities:

- Mobilize personnel and equipment to the site.
- Remove soil with a total transuranic activity greater than 200 picocuries per gram (pCi/g) using heavy equipment. Load the soil into lined end-dump trailers, and transport to the NTS for disposal at the Area 3 Radioactive Waste Management Site (RWMS).
- Provide information for independent verification that the remaining surface soil on-site averages a total transuranic activity of less than 200 pCi/g.
- Stabilize and revegetate the site to conditions consistent with future use.
- Decontaminate equipment to unrestricted release limits or store them in a radioactive material area.
- Demobilize personnel and equipment.

The total soil radioactivity of each transported load will be counted to ensure compliance with U.S. Department of Transportation (DOT) regulations for shipment of radioactive materials. The characterization, handling, shipping, and certification of the radioactive contaminated soil will be conducted according to the waste profile developed for the soil under the guidelines of the *Nevada Test Site Waste Acceptance Criteria* (NTSWAC) (DOE, 1996) and the *Bechtel Nevada Waste Certification Program Plan for Radioactive Waste Storage or Disposal* (Bechtel Nevada, 1996). Radioactive contaminated soil control and certification activities will be subject to a DOE/NV Radioactive Waste Acceptance Program (RWAP) approval process.

1.3 Corrective Action Plan Contents

This document has been divided into the following sections:

- Section 1.0 - Introduction
- Section 2.0 - Detailed Statement of Work
- Section 3.0 - Schedule
- Section 4.0 - Post Closure Care
- Section 5.0 - References

1.3.1 Project Plans/Deliverables

The following documents have been or will be prepared:

1.3.1.1 *Site-Specific Health and Safety Plan*

A Site-Specific Health and Safety Plan (SSHASP) has been prepared and is on file at the Bechtel Nevada (BN) Environmental Restoration and Health and Safety Division offices in Las Vegas, NV. The original document will be kept in the office trailer at the work site. A copy of the SSHASP will be available on-site for review and signature by all workers prior to beginning work at the site. The SSHASP provides a detailed, job-specific plan covering protection against accidents or exposure of workers to contamination. It also discusses weather/air monitoring, accident reporting, emergency procedures, and physical and environmental hazards. The work will also be performed in accordance with the DOE Nevada Environmental Restoration Project Health and Safety Plan and the Bechtel Nevada Environmental, Safety, Security, and Health Manual. In addition, the material safety data sheets (MSDS) file will be maintained by the Health and Safety Officer and will also be available on-site.

1.3.1.2 *Environmental Protection Plan*

An Environmental Protection Plan (EPP) describing the methods and rationale used to protect the environmental resources at the CS-1 Site is included as Appendix A. No National Environmental Policy Act (NEPA) documentation was performed specifically for this action. However, the NTS Environmental Impact Statement/Record of Decision (DOE, 1996), which included this action, resulted in a Finding of No Significant Impact.

1.3.1.3 *Performance Tracking System/Performance Measurement System (PTS/PMS)*

The PTS/PMS includes technical progress reports and the cost performance reports. Information will be updated at least weekly, and will be reviewed monthly at a minimum.

1.3.1.4 *Transportation Plan*

The contaminated soil will be transported by a subcontractor licensed to haul low-specific activity radioactive material. A copy of the Transportation Plan is included as Appendix B.

1.3.1.5 *Air Monitoring Plan*

Air monitors will be deployed at the perimeter of the exclusion zone to monitor airborne particulate matter during excavation operations. The Desert Research Institute (DRI) air monitoring plan is included as Appendix C.

1.3.1.6 *Radiological Work Permit*

Radiological work permits (RWPs) are developed and approved to inform workers of the specific personnel protective equipment necessary to perform their tasks. The worker is required to read the permit and acknowledge their understanding of the requirements before entry into the exclusion zone (EZ). The RWPs are maintained by the radiological control personnel at the access station.

1.3.1.7 *Emergency Response Procedures*

The Emergency Response Procedure provides guidance for the response to, mitigation of, and recovery from the potential consequences of an emergency situation at the CS-1 site. Emergency situations include significant accidents, incidents, events, or natural phenomena which seriously degrade the safety or security of the CS-1 project. A copy of the procedures will be kept on-file in the office trailer at the CS-1 worksite.

1.3.1.8 Daily Field Reports

As negotiated under the FFACO, daily field reports will be submitted to the DOE and the Nevada Division of Environmental Protection. These reports will summarize daily activities and will be faxed to the receiving organizations by the end of each work day. Submittal will begin the first day of excavation and end on the last day of transport of soil to the NTS.

1.3.1.9 Revegetation Plan

The revegetation plan (Bechtel Nevada, 1996) is a reclamation plan for short-term and long-term stabilization of land disturbed by activities associated with cleanup at the CS-1 site. The plan provides general reclamation practices and procedures that will be followed during restoration of the cleanup site. Reclamation demonstration plots were established near the Double Tracks cleanup site in the fall of 1994 to evaluate the performance of several native species and to evaluate different irrigation strategies. Results of that study, and the results from numerous studies conducted at other sites (Area 11 and Area 19 of the Nevada Test Site [NTS]), have been summarized and incorporated into the final reclamation plan for the cleanup of the CS-1 site. The plan also contains procedures for monitoring both short-term and long term reclamation.

2.0 DETAILED STATEMENT OF WORK

2.1 Approved Alternative Implementation

The following describes how the approved alternative for the remediation of CS-1 Test Site will be carried out.

2.1.1 Mobilization and Field Setup

BN will mobilize the necessary equipment and personnel to the CS-1 Test Site to be entirely self-reliant, with the exception of fuel, water, billeting, messing, and miscellaneous minor logistics support which are available at the TTR either from the U.S. Air Force (USAF) 99th Range Squadron Detachment 2 or Sandia National Laboratories (SNL). BN will mobilize equipment and personnel from the NTS. Some additional equipment will be mobilized from the Double Tracks site.

2.1.1.1 Preplanning

Prior to commencing field activities, several meetings were held both on- and off-site with personnel involved with the corrective action. The meetings included discussions to develop an understanding of the administration of the health and safety program, submittals, permitting, and approach and execution of the CAP.

2.1.1.2 Equipment

All equipment and the basic supplies needed for the project will be obtained from the NTS or the Double Tracks site.

2.1.1.3 Personnel

The following individuals will serve as primary contacts for this project:

Project Manager–Department of Energy	Monica Sanchez (702) 295-0160
Project Manager–BN	David Cowser (702) 295-1632
Assistant Project Manager–BN	Mike Shotton (702) 295-1165
	TTR Project Office (702) 295-8346
Site Health and Safety–BN	Craig Lyons (702) 295-0781
	TTR Project Office (702) 295-8346

An organizational chart is presented in Figure 2-1. Table 2-1 describes the responsibilities of the key project personnel assigned to the project.

As equipment is being mobilized, BN will concurrently mobilize personnel to be on-site to unload and stage the arriving equipment. BN will mobilize personnel, both from the NTS and its North Las Vegas facilities, who will travel either by personal vehicle or government vehicle to the main gate of the TTR. From the main gate forward, transportation will be limited to nonprivately owned vehicles only. Unless otherwise approved by the 99th Range Squadron Detachment 2 security officer, all personal vehicles will be stored in the parking area outside of the main gate.

Mobilization personnel will be responsible for the unloading of equipment, the staging and set-up of the processing equipment, and the setup of the support facilities outside of the EZ. The peak number of personnel on site during the soil excavation, processing, and packaging

Figure 2-1. Project Organization Chart.

Table 2-1 Key Bechtel Nevada Personnel Responsibility and Authority.

Key Positions	Responsibility	Authority
Project Manager	<ul style="list-style-type: none"> ● Receive, administer, and manage applicable Task Agreement Plans. ● Ensure effective program communication. ● Provide program-wide continuity for the technical direction of projects. ● Plan and schedule work. ● Manage project-wide costs, quality control, and contractual requirements. ● Provide information to DOE Project personnel. ● Fulfill administrative and financial contractual reporting requirements. ● Serve as part of the Technical Staff on Projects as necessary. ● Ensure Project Teams are established with properly trained personnel. ● Support job planning and execution. ● Monitor Task Agreement Plan progress. ● Maintain awareness of all applicable regulatory requirements for each Task Agreement Plan. ● Supervise procurement activities. ● Serve as Corrective Action Manager for BN. 	<ul style="list-style-type: none"> ● Commit corporate resources to accomplish project objectives. ● Resolve work load conflicts on a project-wide basis. ● Negotiate and execute Task Agreement Plans. ● Negotiate and execute Change Control. ● Select Assistant Project Managers. ● Approve project policies and procedures. ● Approve all expenditures. ● Negotiate and approve subcontract agreements. ● Select Technical Staff. ● Review and approve all deliverables.
Assistant Project Manager	<ul style="list-style-type: none"> ● Provide input to project cost engineer for cost and performance reports. ● Manage funds for labor and materials procurement. ● Provide information to DOE Project personnel. ● Recommend Change Orders to Project Manager. ● Review technical aspects of all task deliverables. ● Provide technical leadership. ● Review remediation technology design, testing, and QA plans. ● Manage permit applications and approvals. ● Maintain regular contact with Project Manager and report progress. ● Comply with applicable permitting and regulatory requirements. ● Develop and/or modify critical path project tracking. ● Prepare specifications for subcontractor and equipment procurement. ● Interface with SHSO to ensure compliance with SSHASPs. ● Interface with senior project technical staff on relevant issues and methods of resolution. ● Implement the Work Plan, PAMP, SAP, and SSHASP. 	<ul style="list-style-type: none"> ● Approve remediation technology design, testing, and QA plans. ● Allocate budget among work elements as identified in the Work Plan. ● Approve/disapprove all labor, materials, equipment, and subcontractor charges to the Project. ● Establish and enforce work element milestones for timely completion of Task Agreement Plan. ● Authorize assignment of field operations personnel to the Project. ● Approve/disapprove any technical deliverable for each work element. ● Communicate daily with Project Control as to day-to-day progress and direct all technical activities. ● Select technical staff.

Table 2-1 (continued)

Key Positions	Responsibility	Authority
Site Superintendent	<ul style="list-style-type: none"> Schedule and commit resources for all operational work efforts. Supervise the conduct of construction field operations. Ensure adherence to PAMP, SSHASP, and SOPs. Communicate daily with PM and Assistant PM. Report daily labor and equipment charges. Prepare daily activity logs, including volumes of soils or water removed, treated, or disposed. Coordinate logistics between excavation and treatment operations and other operations such as sampling or disposal. Ensure adequacy of equipment, supplies, and personnel. Direct supervision of field personnel. Recommend corrective action to Assistant PM in event of problems in subcontractor performance. Execute items required in critical path schedule. 	<ul style="list-style-type: none"> Resolve site problems and inform Assistant PM of difficulties and support requirements. Immediate shutdown of operation because of observed safety hazard or failure to comply with PAMP. Immediate dismissal of any contractor personnel for failure to comply with SSHASP, PAMP, SAP, or SOPs. Select equipment to conduct operation in accordance with SOPs and Work Plan. Approve/disapprove all materials and labor costs for site operations.
Performance Assurance (PA) Representative	<ul style="list-style-type: none"> Monitor/audit field and laboratory operations to ensure compliance with PAMP procedures. Review all project field/laboratory data. Ensure that adequate QC documentation is provided. Ensure that QC problems are resolved in an expeditious manner and are identified to Project Superintendent and PM. Develop and implement QC plans and inspection system. 	<ul style="list-style-type: none"> Conduct unannounced audits of field/laboratory procedure. Approve/disapprove all field/laboratory data. Immediately stop field/laboratory operations which are not in compliance with PAMP. Communication with DOE project personnel regarding matters of data validation and other PAMP considerations.
Waste Minimization and Control Section	<ul style="list-style-type: none"> Characterize radioactive soil. Quantify via the radio assay system mounted on the conveyor the radionuclide activity of each package of soil. Package and prepare packages of soil for shipment. Ship soil for disposal. 	<ul style="list-style-type: none"> Develop waste characterization documents for CS-1 Waste Stream. Complete waste packaging and traceability documentation. Complete shipping documentation. Immediate shut down of operations because of observed problems with radio assay detection system.
Waste Certification Official	<ul style="list-style-type: none"> Certify all waste packages. Certify waste shipments. 	<ul style="list-style-type: none"> Immediate shutdown of operations of observed deficiencies in any characterization, packing, handling and shipping activities that could adversely impact certification of waste or shipments. Perform oversight of all waste characterization /quantification, handling, packing, and shipping activities.

Table 2-1 (continued)

Key Positions	Responsibility	Authority
Site Health and Safety Officer	<ul style="list-style-type: none"> • Monitor field/laboratory procedures to ensure compliance with SSHASP and corporate HSP. • Brief all field/laboratory personnel regarding special hazards that may be associated with project operations. • Monitor the labeling, shipping, and control of hazardous or potentially hazardous samples. • Monitor field/laboratory safety procedures. • Coordinate site health and safety requirements with Project Superintendent or Assistant PM. • Ensure maintenance of all health and safety monitoring and personnel protective equipment. • Collect all required air and personnel monitoring data. • Report all health and safety monitoring results to CIH. • Maintain MSDS file. • Prepare RWPs. 	<ul style="list-style-type: none"> • Immediately shut down field/laboratory operations if a violation to SSHASP or unsafe condition exists. • Conduct unscheduled safety audits.

operations will be approximately 25. BN will certify that all personnel who will be performing work under this CAP, or who will have access to facilities and information for which BN is responsible, are citizens of the United States.

Housing and meals on the TTR for BN personnel will be available at the main camp dormitories and the main cafeteria, respectively. The USAF has agreed to direct-bill BN for these services and they will be paid for with project funds.

2.1.1.4 *Temporary Facilities*

A temporary field construction office and support camp will be established outside the exclusion zone during mobilization activities. The location of the trailers and equipment has been predetermined. A sign will be placed on the site office trailer providing the business phone number, contact person, and emergency phone number. Facilities will be appropriately anchored. Electricity will be provided through on-site generators and distribution system. Potable water will be brought in daily. Phone lines for voice and data transmission will be laid to the site from the nearest trunk line. Phone lines both for telephone and facsimile will also be available in a support building (TTR Area 3 Building 3-78) located in the SNL compound.

2.1.1.5 *Site Preparation*

A road approximately 0.8 km (0.5 mi) long will be constructed of a minimum thickness of 20 cm (8 in) stabilized gravel to provide access to the site. A work pad for the base camp outside the EZ will be constructed by removing the upper few inches of soil, stockpiling it in an area outside of the EZ for use during revegetation, and placing and compacting a layer of pit-run gravel. A work pad inside the EZ will be constructed in a similar manner. The pit-run material will be hauled from the SNL quarry which is located approximately eight miles from the project site.

A radioactive material area will be designated within the EZ that contains the two drums of radioactive metal fragments collected from the Double Tracks and CS sites. These drums were moved from the Double Tracks site and will eventually be moved to the CS-2 site when work is completed at CS-1.

2.1.1.6 *Decontamination Stations*

A mobile personnel decontamination station consisting of a hand wash station will be set up near the personnel site entry access gate. This station will be used by personnel after exiting the EZ. Personnel will be thoroughly screened for radioactive contamination prior to exiting the EZ.

A lined decontamination pad will be constructed inside the EZ near the vehicle exit gate to decontaminate equipment and vehicles. Decontamination of equipment and vehicles will consist of pressure washing. The volume of contaminated water will be reduced using a water recycling unit designed to filter out contaminants. The collected decontamination water will be tested for radionuclides prior to discharge to plastic liners for evaporation or to the ground surface.

2.1.1.7 *Air Monitors*

As outlined in the air monitoring plan (Appendix C), air monitors will be deployed by DRI at the perimeter of the EZ to monitor airborne particulate matter during the field operations.

The BN Environmental Surveillance Group will also collect ambient airborne particles for radioactivity analysis. A solar-powered air sampling station is positioned at the north end edge of the project site. The flow rate of the sampler will be in the range of 0.08 m³/min to 0.14 m³/min (3 ft³/min to 5 ft³/min) and will collect approximately 850 to 1,400 m³ of air per week. Air filter samples will be collected weekly and counted for gross alpha/beta and gamma radiation. This air monitoring station has been in operation since August 8, 1996. The collected data will be incorporated in the NTS Annual Site Environmental Monitoring Report.

2.1.2 *Excavation*

The areas with a total transuranic activity greater than 200 pCi/g will be excavated. These areas include the circular mound area at GZ and the linear plume area which extends south from GZ (Figure 2-2). These areas were previously defined during site characterization. Survey markers will be placed at the boundaries of the plume and the GZ mound prior to excavation.

During site characterization, *in situ* contamination depth measurements were made at twenty locations. These measurements indicated that at all but two locations, the contamination was between

See Inserted Map

Figure 2-2. Total Transuranic Isotope Activity of Clean Slate 1 Soil (based on 1995 EG&G Ground Survey).

3 and 5 cm (1 and 2 in.) deep. The anomalously deep areas of contamination may represent disturbed areas, or incorrect usage of detection equipment during characterization, and not plume deposition. Based on this data, it is believed that the contamination can be removed by excavating the area to a depth of approximately $7.5 \text{ cm} \pm 3 \text{ cm}$ ($3 \text{ in.} \pm 1 \text{ in.}$). The soil will be removed by excavating layers approximately 3.75 cm (1.5 in.) thick using a motor grader. Periodic radiological surveys of the excavated area will then be conducted to determine if the proposed cleanup level of 200 pCi/g has been achieved. If the radiological activity level remains above 200 pCi/g, additional layers of soil will be removed until the proposed cleanup level has been achieved. If it is determined that only small areas require additional excavation, such as the deeper contaminated areas, this may be accomplished using a front-end loader. This process of removing the soil in layers will minimize the volume of soil to be processed and disposed.

Following the periodic radiological surveys of the excavated area, the remaining *in situ* soil will be disced. Once the soil has been disced, a final radiological survey will be performed to ensure that the radiological activity level is below 200 pCi/g and will be the survey which verifies that the cleanup level has been achieved.

Approximately $4,130 \text{ m}^3$ ($5,370 \text{ yd}^3$) of soil will be excavated. Expansion of the soil volume, estimated to be 22 percent based on experience at Double Tracks, will occur during soil processing. Therefore the net volume of soil to be packaged and shipped as waste will be on the order of $5,000 \text{ m}^3$ ($6,500 \text{ yd}^3$).

A schematic depicting the planned excavation process is shown in Figure 2-3. Prior to excavating, the ground surface will be wetted to reduce dust. Because of the fine-grained nature of the soils, a surfactant will be applied to improve wetting. Soil will be bladed into windrows using a motor grader. Windrowed soil will be picked up and moved to the stockpile area using a paddle-wheel scraper. The soil will be mounded into a stockpile with the assistance of a front-end loader. This stockpiled soil will be kept moist to reduce dust by spraying the stockpile with water. An application of Agri-lock™, a synthetic chemical soil stabilizer, will be sprayed on the completed stockpile to mitigate blowing dust from the stockpile and to mitigate the reduction in soil moisture due to evaporation. At the conclusion of excavation, Agri-lock™ will also be applied to the excavated plume and GZ areas.

LEGEND

- GROUND ZERO
- OUTER PERIMETER FENCE
- INNER PERIMETER FENCE

TOTAL TRANSURANIC ACTIVITY

	— 50 PC1/G
50	— 100 PC1/G
100	— 200 PC1/G
200	— 400 PC1/G
400	— 800 PC1/G
800	— 1600 PC1/G
1600	— 3200 PC1/G

NOTE: TRANSURANIC ACTIVITY BASED ON 1996 *IN SITU* RADIATION MEASUREMENTS

SCALE

0 50 100 150 Meters

0 200 500 Feet

FIGURE 2.2
TOTAL TRANSURANIC ISOTOPE ACTIVITY OF CLEAN SLATE 1 SOIL

Figure 2-3. Soil excavation schematic.

Site characterization activities revealed that the cement slab at GZ is probably not intact (DOE, 1997). Large pieces of the cement slab will be cut into smaller pieces with a concrete saw and containerized as bulk material.

During the excavation phase, BN will have captive, in the EZ, a motor grader, a scraper, a water pull, and a front-end loader. During camp setup, BN will locate both the fuel source and process water sources so the captive equipment can be serviced with these products without having to decontaminate the equipment and leave the EZ each time service is required.

2.1.3 Soil Processing and Loading

The equipment needed to process and load the excavated soil is identified in the State of Nevada Air Quality Permit. This permit is on file at the BN Environmental Compliance office and a copy will be posted on-site in the office trailer.

A schematic depicting the planned production packaging system is shown in Figure 2-4. Production packaging will be accomplished by conveyors that deposit soil into end-dump trailers. The trailers will be lined with 18-20 mil thickness polypropylene liners (known as burrito wrappers) that match the inside dimensions of the end-dump trailer. The flaps of the liner will overlap so that the wrapper will completely enclose the soil.

The soil-processing system will be fed by a front-end loader from the stockpile of excavated soil. Dust control will be accomplished by keeping the stockpiled material moist. BN does not anticipate using water sprays on the conveyors or transfer points. The processing system will segregate soil particles which are greater than 1.9 cm (0.75-inch) in diameter. This segregated soil will be discharged into B-12 boxes (metal boxes 1.2 m [4 ft] wide x 1.8 m [6 ft] long x 0.6 m [2 ft] high) for disposal at the Area 3 RWMS. The procedure for monitoring the amount of radioactivity in the B-12 boxes is provided in Appendix D.

A sodium iodide (NaI) detector system will be used to monitor the amount of radioactivity contained in each end-dump trailer. The detector will be mounted on the conveyor system transporting soil to the end-dump trailers and will record the americium-241 (^{241}Am) activity level in each trailer as the trailer is being filled. The Pu activity can be calculated based on the Am:Pu ratio which was measured during site characterization. The NaI detector system is described in more detail in Appendix E.

Figure 2-4. Soil processing and loading schematic.

Once the end-dump trailer has been filled, the trailer will be moved from the soil-loading area to a holding area where waste control personnel will complete documents which detail the total radioactivity level in the filled trailer. The burrito wrapper will be closed by BN personnel, the load tarped, and the outside of the trailer swipec surveyed to determine if there is any external contamination. If radioactivity levels for the trailer and its load are deemed acceptable, the trailer will be moved to a holding area outside the EZ to await transport to the NTS Area 3 RWMS. If it is deemed unacceptable, it will be decontaminated then resurveyed. The location of the processing equipment, the decontamination pad, control trailer, office trailer, Health Physics Department (HPD) trailer, counting van, and other associated equipment are depicted on Figure 2-5.

2.1.4 Transportation

Transportation will be accomplished by a licensed radiological waste carrier in accordance with DOT regulations. The route from the CS-1 site will be via 0.5 miles of dirt road to Brownes Lake Road; then approximately 3 miles on Brownes Lake Road to Main Road; then 15 miles on Main Road to the Main Gate of the TTR. The carrier will then proceed north on State Route 504 to U.S. Highway 6, west to U.S. Highway 95, and south to the Mercury entrance of the NTS as shown on the transportation route (Figure 2-6). The carrier will enter the NTS via the Mercury gate and, once cleared to proceed, will continue north to the Area 3 RWMS, approximately 35 miles from the entry point.

The loads transported by the subcontracted waste carrier will consist of end-dump trailers containing radioactively contaminated soil. The soil typically will be classified as low-specific activity radiological waste. One Sealand® container containing bulk material such as broken concrete and B-12 boxes containing the larger radioactively contaminated soil will be transported by NTS personnel. The Sealand® containers, B-12 boxes, and end-dump trailers will be off-loaded at the NTS Area 3 RWMS. After off-loading, the trucks and trailers will be checked for contamination by BN personnel and all required paperwork will be completed.

In the event of a spill, the carrier is ultimately responsible for cleanup. However, if requested to assist either by an official from the carrier or by an appropriate emergency management person, BN

See Inserted Map

Figure 2-5. Site layout plan.

Figure 2-6. Transportation route from CS-1 to the NTS.

1 ALL AREAS TO BE STABILIZED SHALL HAVE THE TOP 6" OF SOIL REMOVED AND COMPACTED TO 90% OF MAX DRY DENSITY PER ASTM D1557. ALL ROADS SHALL HAVE A MIN OF 6" BORON PITT MATERIAL PLACED ON SUBGRADE AND COMPACTED TO 90% OF MAX DRY DENSITY PER ASTM D1557. ALL OTHER INDICATED AREAS SHALL HAVE A MIN OF 6" BORON PITT MATERIAL PLACED ON SUBGRADE AND COMPACTED TO 90% OF MAX DRY DENSITY PER ASTM D1557.

LOCATION MAP
SCALE: 1" = 300'

SITE PLAN

NO	DATE	REVISIONS	☒ ☒ ☒ ☒ ☒	
<p align="center">U.S. DEPARTMENT OF ENERGY</p>				
Nuclear Operations Office		LAS VEGAS, NEVADA		
REVISIONS	<p align="center">NEVADA TEST SITE</p>		<p align="center">AREA 52</p>	
REVISION	<p align="center">TONOPAH TEST RANGE</p>			
DATE	<p align="center">CLEAN SLATES #1</p>			
DATE	<p align="center">LOCATION MAP & SITE PLAN</p>			
QUANTITIES (SPECIATED) EST. SHEET		DATE		
<p align="center"><small>IN DOLLAR VALUES</small></p>		<p align="center"><small>SECT OF CLEANING PLAN</small></p>	<p align="center"><small>APPROVAL, BLOCK</small></p>	
<p align="center">Bechtel Nevada</p>		<p align="center"><small>P.O. NO.</small></p>	<p align="center"><small>MARKING NUMBER</small></p>	
<p align="center"><small>P.O. BOX 90001 LAS VEGAS, NV 89163-0001</small></p>		<p align="center"><small>REVISIONS</small></p>	<p align="center"><small>DATE</small></p>	
<p align="center"><small>TEL. 702-795-1000</small></p>		<p align="center"><small>5420-0088</small></p>	<p align="center"><small>SK-052-97-C101</small></p>	
<p align="center"><small>TELETYPE 702-795-1000</small></p>		<p align="center"><small>1700-1177</small></p>	<p align="center"><small>REVISION</small></p>	
<p align="center"><small>TELEFAX 702-795-1000</small></p>		<p align="center"><small>1</small></p>	<p align="center"><small>1</small></p>	

personnel will respond (on a cost-reimbursable basis) to assist with preliminary cleanup in accordance with the Emergency Response Procedure. A copy of the Emergency Response Procedure will be kept on-site in the office trailer.

The carrier will return to the project site with the empty trailers where they will be put in holding to await refilling and subsequent shipment. The carrier will transport previously filled end-dump trailers back to the NTS Area 3 RWMS. Appropriate paperwork including completed shipping papers and placarding will be provided by BN. This sequence will continue until all processed material is removed. Once BN determines the end-dump trailers are being used for their final trip, the transporter will take them (after they are off-loaded at the Area 3 RWMS) to the Area 6 Decontamination Facility where BN will decontaminate them before they are released back to the transportation subcontractor. BN construction personnel will transport the one Sealand® container of bulk low-level radioactively contaminated material (primarily broken concrete) to the Area 6 Decontamination Facility. The route will be the same as above, with the exception of the final destination. The Transportation Plan is included in Appendix B.

2.1.5 Waste Disposal

The excavated, processed soil will be removed from the CS-1 site and transported to the NTS Area 3 RWMS for disposal as low-level radioactive waste in accordance with the NTSWAC (DOE, 1996). Approximately one Sealand® container of bulk material (primarily broken concrete) will be transported to the Area 3 RWMS for disposal. In addition, bags of compactable radioactive waste, such as booties, gloves, and filters, will be turned over to BN health physics personnel for disposition in the appropriate waste storage area. The waste must meet the characterization, packaging, and shipping waste acceptance criteria established in the NTSWAC (DOE, 1996). In order to meet the NTSWAC (DOE, 1996), the soil must be characterized, handled, packaged, shipped, and certified according to the BN Application to Transfer Radioactive Waste at the Nevada Test Site and the BN Waste Certification Program Plan for Radioactive Waste Storage or Disposal.

The methods that will be used to characterize the waste (count the radioactivity level in each end-dump trailer and B-12 box) are discussed in Section 2.1.3 and Appendices D and E.

BN Waste Minimization and Control Section will prepare characterization documents (e.g., Material Evaluation Form and NTSWAC waste profile) to demonstrate that the radioactive contaminated soil meets the NTSWAC (DOE, 1996).

The BN Waste Certification Office personnel will review the waste characterization documentation and observe all handling, packaging, and shipping activities in order to certify waste packages and shipments.

Prior to full-scale processing, the DOE/NV Waste Management RWAP personnel may perform an on-site surveillance of all contaminated soil handling, surveying, loading, shipping, and certification activities. Prior to full-scale operations, the DOE/NV Field Manager must approve the waste for shipment to NTS.

2.1.5.1 *Hydrocarbon Spills*

The excavation equipment and the electrical generators will be fueled on-site with diesel; therefore, there is the potential for accidental hydrocarbon spills. Accidental spills of petroleum hydrocarbons will be handled according to BN Company Procedure No. 4.2.9, "Response to Spills of Known Substances," a copy of which will be located on-site. Hydrocarbon-stained soil will be cleaned up so that no visible stain remains. The stained soil will be placed in plastic-lined 55-gallon drums for shipment to the NTS Area 6 Decontamination Pad to await future disposal.

2.1.6 Decontamination

Equipment which is involved with the handling and processing of the contaminated soil will be radiologically surveyed, decontaminated, and cleared in accordance with the Radiation Control (RADCON) manual. If there is surface contamination on the equipment, it will be cleaned with water using a mobile decontamination truck. Decontamination water will be collected and processed through a water recycler. Any equipment that cannot be cleaned to unrestricted release limits will be cleaned to the point that it can be safely transported back to the NTS Decontamination Pad in Area 6, where a more thorough decontamination will be conducted.

2.1.7 Demobilization

Once the project is complete and the area has been declared radiologically acceptable, the equipment and remaining supplies will be returned to the NTS in approximately the same order they arrived on-site. If there is a possibility that some of the equipment will be targeted for future CS remediation projects, a radioactive material area will be established within the CS-2 exclusion fence for interim storage of equipment.

2.2 Quality Control/Performance Assurance

The company document that establishes BN's commitment to apply the requirements of DOE Order 5700.6C, *Quality Assurance Program*, to BN activities is the Performance Assurance Management Plan (PAMP), No. B-A20/96.01. The requirements of the PAMP are to be satisfied by the implementation of this Project/Facility Management Plan.

Specific performance assurance activities to be implemented relative to this Corrective Action Plan include:

- Internal management assessment of actual project operation to determine the effectiveness of implementation of the Project/Facility Management Plan with respect to the requirements of the PAMP, and,
- Development of a comprehensive records and documents management program to create a complete history of the project.

2.3 Waste Management

The only waste that is currently present is the low-level radioactive soil. Wastes that may be generated during the remediation activities are compactable radioactive waste (booties, gloves, filter), bulk waste (concrete pad and oversized material), decontamination water, and packaged contaminated soil.

The contaminated soil, concrete pad, and oversize material will be packaged and disposed of in accordance with this plan as outlined in Section 2.1. Compactable radioactive waste will be turned

over to BN health physics personnel for final disposition in the appropriate waste disposal area. Decontamination water which results from the washing of the equipment will be processed and filtered through a recycler. The water will be tested for radioactive contamination prior to evaporation or release to the ground surface.

2.4 Clean-up Verification

The closure of this site will be predicated on the state of Nevada approving completion of the required corrective action.

2.4.1 Postexcavation Radiological Surveys

Postexcavation radiological surveys will be accomplished in accordance with the Remote Sensing Lab Radiological Verification Plan included as Appendix F. BN will conduct both periodic and final radiological surveys inside the fenced boundary of the site to assess levels of activity still remaining. If BN discovers areas of total transuranic activity greater than 200 pCi/g during periodic surveys, additional soil excavation in the noncompliant areas will be conducted. After confirmation by the final survey following disking of the soil, the equipment and crews will be released.

2.4.2 Postexcavation Documentation

BN will write a formal closure report describing the final radiological survey results. The closure report should be submitted to the State of Nevada within 6 months after the initial revegetation work is completed.

2.5 Permitting

2.5.1 Air Quality Operating Permit

The state of Nevada will issue an Air Quality Operating Permit for the CS-1 environmental restoration project. In addition, a State of Nevada Surface Disturbance Permit and Change of Location Forms will also be issued. Copies of these permits are on file at the BN Environmental Compliance offices and will be posted on-site in the office trailer.

2.5.1 National Emission Standards for Hazardous Air Pollutants

Requirements for controlling the release of radionuclides through the air borne exposure pathway during operations are established under the National Emission Standards for Hazardous Air Pollutants (NESHAPs) of the U.S. Environmental Protection Agency (EPA) under 40 CFR Part 61.106, subpart H (EPA, 1989). This rules requires the following:

The dose to the maximum exposed individual (MEI) due to the release of air borne radionuclides shall not exceed an effective dose equivalent (EDE) of 10 mrem/year.

An application for approval of the modification of a NESHAP source is required if the EDE to the MEI exceeds 0.1 mrem/year.

According to 40 CFR Part 61.96(b), the EDE to the MEI must be calculated using the source term as derived using 40 CFR Part 61 appendix D as guidance. Other methods may be used to estimate the radionuclide source term only after receiving prior approval from EPA for their use.

Continuous air monitoring of radionuclides sources is required if the calculated EDE to the MEI exceeds 0.1 mrem/year. For sources with an EDE to the MEI of less than 0.1 mrem/year periodic or confirmatory measurements are required.

SNL calculated the EDE to the MEI during remediation of CS-1 as $3.03\text{E-}3$ mrem/year. The data input parameters used in the calculations are the same as those used in preparing the 1996 NESHAPS Annual Report for TTR (Hwang, 1997). An application for approval of the modification to the CS-1 NESHAP source is not required. Continuous air monitoring during remediation for ensuring compliance with 40 CFR Part 61, subpart H is not required. However, confirmatory air monitoring of the CS-1 area is required during remediation activities.

3.0 SCHEDULE

A schedule of major activities and milestones for the approved corrective action is provided in Figure 3-1.

4.0 POST CLOSURE CARE

Once excavation is complete, short-term soil stabilization will be accomplished via soil stabilizing agents. Long-term stabilization will be accomplished via revegetation in accordance with a revegetation plan (Bechtel Nevada, 1997).

No additional post closure care will be necessary following revegetation. The site is currently fenced and posted with radiological control signs. The fence will initially be required to support revegetation efforts. In the long term, the fencing and signs will be posted in order to meet, at a minimum, established internal and external policies and regulations. It is assumed that the CS-1 site will remain under the institutional control of a federal agency.

Figure 3-1. Proposed Field Schedule.

Figure 3-1 (continued). Proposed Field Schedule.

5.0 REFERENCES

AEC, see U.S. Atomic Energy Commission.

Bechtel Nevada. 1996. *Waste Certification Program Plan for Radioactive Waste Storage or Disposal at the Nevada Test Site*, B-A20/96.03, Revision 1. Las Vegas, NV.

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Federal Facilities Agreement and Consent Order (FFACO) of 1996. Prepared by Nevada Division of Environmental Protection, U.S. Department of Energy, and U.S. Department of Defense.

Hwang, H. 1997. *TTR NESHAP Requirements for Reevaluation for Clean Slate 1*. Memorandum dated March 21, 1997 from Hue-Su Hwang, Sandia National Laboratories to Susan Lacy, Kirtland Area Office, U.S. Department of Energy. Sandia National Laboratories, Albuquerque, NM.

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APPENDIX A

ENVIRONMENTAL PROTECTION PLAN

ENVIRONMENTAL PROTECTION PLAN FOR CLEAN SLATE 1

1.0 INTRODUCTION

This is the Environmental Protection Plan (EPP) for the corrective action at the Clean Slate 1 (CS-1) Test Site on the Tonopah Test Range (TTR). The purpose of the EPP is to describe the methods and rationale to protect the environmental resources at CS-1 during corrective action activities of the low-level radioactive contaminated soil. This work is being performed under a DOE/NV Task Agreement Plan. This plan will provide site-specific information for the following:

- Preconstruction Survey
- Applicable Regulations
- Land Resources Protection
- Water Resources Protection
- Fish and Wildlife Resources Protection
- Air Resources Protection
- Archeological and Cultural Resources Preservation
- Corrective Action

This plan has been prepared and will be implemented in accordance with applicable federal, state, and local laws, regulations and permits for protection of the environment.

1.1 Site Location and Background

The CS-1 site is located in the central portion of the TTR, in Nye County, Nevada, approximately 224 kilometers (km) (130 miles [mi]) northwest of Las Vegas and approximately 64 km (40 mi) southeast of Tonopah, Nevada. The location of the site within TTR is shown on Figure 1-1 of the Corrective Action Plan (CAP).

Clean Slate 1 was one of four experiments that constituted Operation ROLLER COASTER. In May 1963, experiments were conducted at CS-1. The primary function of this project was to study the

dispersion of plutonium (Pu) from nonnuclear explosions of Pu weapons. The experiment required the detonation of various simulated weapons from a variety of near-surface structures.

The objectives of the CS-1 experiment were to evaluate the dispersal of radionuclides in the environment. The experiment scattered radioactive material, earth, and other material (concrete and metal) into the air. The debris and most of the dirt fell to earth at relatively short distances. However, some of the finer grained material was spread over a larger area downwind, south of ground zero (GZ). Contaminated surface soil in the vicinity of GZ reportedly was scraped to a depth of several inches and mounded, covered with clean dirt, and compacted. Except for these post event activities, no decontamination of the site was reported.

Based on a site characterization designed to adequately characterize the nature and extent of contamination at the CS-1 Test Site, specific conclusions identified in the characterization report were:

Contaminants of potential concern in soil at the CS-1 Test Site are americium-241 (^{241}Am) and Pu. Uranium and other non-radiological metals are present only in background concentrations.

In situ measurements indicate that typically most of the total transuranic activity is present within the top 3-5 cm (1-2 in) of the soil profile. Where significant amounts of Pu (greater than 1,000 pCi/g) are present, it can be assumed that the uppermost 5 cm (2 in) of the soil profile is contaminated. In the GZ area, radiologically-contaminated soil and possibly test debris are buried. The depth of contamination in the mound may be as thick as 2.5 m (8 ft).

The contamination of surface soil at CS-1 appears to have been caused by local fallout and debris from the experiment. Superimposed on this contamination pattern were small metallic fragments, which were the source of most of the radioactive hot spot activity identified during characterization.

The surface area with total transuranic activity greater than 200 pCi/g is approximately 30,100 square meters (m^2) (75,250 sq ft [ft^2]), based on an *in situ* radiological survey.

The best estimate of the volume of contaminated soil to be removed from CS-1 is 5,000 cubic meters (m³) (6,500 yd³), based on a cleanup level of 200 pCi/g. This estimate includes soil expansion of 22 percent during excavation.

Based on the contaminants present, soil from the CS-1 Test Site would be classified as low-level radioactive waste and not mixed low-level waste. Soil contaminated with ²⁴¹Am and Pu did not exhibit toxicity characteristic, based on Toxicity Characteristic Leachate Procedure (TCLP) data.

The metallic fragments outside of ground zero are containerized inside the exclusion zone within a designated radioactive materials area and represent a very small volume of transuranic material.

2.0 SITE CHARACTERIZATION SURVEY

Prior to beginning on-site construction activities, BN personnel and the appropriate U.S. government representatives or designee conducted several joint surveys on the condition of existing trees, shrubs, grassed areas, cultural resources, sacred sites, and wildlife immediately adjacent to the area which may be affected by construction activities, equipment and material storage areas, and access routes. No listed species, cultural resources, or sacred sites were recognized during these surveys in the immediate vicinity of the site.

3.0 APPLICABLE REGULATIONS

BN will comply with all applicable federal, state, and local laws and regulations to prevent unnecessary environmental damage arising from the clean-up of the low-level radioactive contaminated soil at the CS-1 Test Site. It is expected that the majority of these damages will be mitigated as part of the revegetation efforts.

3.1 Permitting

The permits which are applicable to this scope of work are as follows:

- State of Nevada Air Quality Operating Permits
- State of Nevada Surface Disturbance Permit

3.2 Waste Disposal

Radioactive wastes that may be generated during the remediation activities are compactable radioactive waste (booties, gloves, filters), bulk radioactive waste (concrete pad and oversized material), and packaged contaminated soil.

The contaminated soil will be screened and processed as described in the CAP, Section 2.1 in accordance with the NTSWAC (DOE, 1996). Debris present in the soil greater than 1.9 cm (0.75 in) will be screened and loaded separately.

Decontamination water that results from the washing of the equipment will be processed and filtered through a recycler. Recycled water will be tested for radioactive contamination before being evaporated.

Radiological surveys will be conducted to identify any contaminated areas within the fence line. Areas of contamination will be excavated until surveys indicate the area is below 200 pCi/g.

Hazardous waste is not expected to be generated on-site. However, if waste is generated it will be disposed of in accordance with applicable regulations. In the case of accidental hydrocarbon spills or leaks from equipment, the contaminated soils will be scooped up and stored in a lined 55-gallon drum. Any hydrocarbon waste will be taken to the Nevada Test Site (NTS) for disposal.

Household solid wastes will be stored on-site in a dumpster that will be emptied periodically and the trash disposed in the Sandia National Laboratories landfill. No other wastes are anticipated.

4.0 LAND RESOURCES PROTECTION

Except for designated work areas, storage areas, and access routes specifically assigned for use during construction activities, all land resources outside the limits for work will be preserved in their present condition. As much as practical, construction activities will be limited to areas defined by the plans and specifications. BN will provide wind erosion and rainwater controls for temporary stockpiles of low-level radioactive contaminated soil. Run-off controls may include the placement of covers with anchors (if needed) over the stockpiled material and chemical stabilizers in the excavated area.

Temporary equipment and materials storage areas are identified in the CAP. Site vehicles will remain on designated access roads and will be prohibited from driving on land areas outside the work zones. Designated access roads will be identified. BN personnel will not use any areas on base property other than those designated for site activities.

4.1 Protection of Facilities/Structures

On-site temporary electrical and mechanical services and facilities will be protected. No permanent services or facilities exist. Temporary covering of exposed areas as well as temporary services or connections will be provided by BN.

4.2 Protection of Trees and Shrubs

There are no significant trees, shrubs or bushes in the vicinity of the CS-1 Test Site. In any case, BN and subcontractor personnel will not deface, injure, or destroy trees or shrubs, or remove or cut them without prior authority from the appropriate U.S. government representative. No ropes, cables, or guy wires will be attached to any existing trees or shrubs for anchorage. Precautions that will be taken to minimize the impact of construction activities on the existing vegetation will include but not be limited to:

Utilization of existing or temporary construction roads only.

Closely supervised equipment operators with an emphasis placed on preservation of vegetation in nonwork areas and staying within flagged project boundaries.

Proper guidance of heavy equipment and truck operators by site personnel to minimize damage to adjacent vegetation not directly affected by construction activities.

Utilization of equipment appropriately designed and sized.

5.0 PROTECTION OF WATER RESOURCES

Water is approximately 50 m (150 ft) below grade and there are no known surface waters or springs in the area. Protection of water resources will be accomplished by ensuring that the contaminated water resulting from decontamination activities will not be a source of contamination. Decontamination water will be collected, processed, and reused.

6.0 PROTECTION OF FISH AND WILDLIFE RESOURCES

BN will take precautions at all times during remediation activities to minimize any disturbance to wildlife and their habitat adjacent to the project site. BN will minimize the actual work area as much as possible and conduct remediation activities within the project boundary.

There are no known listed or endangered species on the project site.

7.0 PROTECTION OF AIR RESOURCES

Personnel and ambient air monitoring will be conducted as necessary in order to determine airborne contaminant levels. This ensures that respiratory protection is adequate to protect personnel against the contaminants that are encountered as well to assure that harmful levels of airborne contaminants do not leave the site.

7.1 Dust Control

BN will make every effort to ensure that the spread of dust is controlled and minimized to avoid nuisance and/or hazard to workers and to the surrounding area. BN personnel and subcontractors will take appropriate measures to control and minimize dust emissions at the site during corrective action activities. Dust emissions will be monitored. Temporary dust control will be addressed as necessary by any of the approved methods including spraying with nonpotable water, chemical stabilizers, or stopping work.

8.0 CULTURAL AND AMERICAN INDIAN RESOURCES PRESERVATION

No cultural resources or resources important to American Indians are known to exist on site, nor are they expected to be encountered. BN will make every effort to carefully preserve and immediately report items that are discovered in the course of work having historical, archaeological, or Native American interest. Any employee may call a stop work to allow for investigation and protection of artifacts. The perimeter of the find as appropriately determined will immediately be delineated with caution tape to restrict access to the find site. The project manager will be responsible for contacting the DOE/NV cultural resources program manager if cultural resources are found during remediation activities. Field operations will not resume until the appropriate authority issues a written authorization to proceed.

9.0 CORRECTIVE ACTION

Should any of the preceding provisions not satisfy the standards established in the Scope of Work, BN will take prompt action to correct the situation upon receipt of notification from the appropriate official or BN's Quality Control Personnel. All corrective measures will be proposed in writing for review and approval prior to their initiation. Situations requiring immediate corrective action will be implemented as soon as possible. Written documentation of the action will be submitted within 24 hours of implementing the action. BN Quality Control Personnel may require that work be stopped to correct any violations of this plan.

APPENDIX B

TRANSPORTATION PLAN

TRANSPORTATION PLAN FOR CLEAN SLATE 1

To reach the Clean Slate 1 (CS-1) project site from Mercury, Nevada, travel north on Highway 95 approximately 150 miles, and east on Highway 6 for approximately 12 miles. Turn right at the Tonopah Test Range (TTR) sign onto State Route 504, and go approximately 18 miles to the entrance of TTR. Stop at the security guard gate, obtain an exchange badge, proceed south on Main Road for 15 miles. Turn left (east) on Browne Lake Road and proceed 3 miles to a dirt road (Denton Freeway) on the south side of the road. At the dirt road, turn right (south) and proceed approximately 0.5 mile to the project site. It is estimated that the route from Mercury will take no more than 4.5 hours. A TTR road map will be provided to the transportation subcontractor.

Two days prior to the beginning of transport, the Subcontractor will deliver twelve trailers to the project site. The trailers will be lined with 18-20 mil thickness polypropylene liners (known as burrito wrappers) that match the inside dimensions of the end-dump trailer. The flaps of the liner will overlap so that the wrapper will completely enclose the soil. Ten of these trailers will be filled with soil by the Contractor before the first day of transport. On the first day of transport, the Subcontractor will have ten tractors and ten additional trailers at the project site. The tractors will pick up the loaded trailers for transport to the Nevada Test Site (NTS). The ten empty trailers will be filled with soil during transport of the previously filled trailers. The two additional trailers will be used on-site as backup as needed. The ten tractors must arrive at the project site the first day between 7:00 and 10:00 am. The burrito wrappers will closed and secured and required shipping papers will be completed by the Contractor before the loads leave the area. In addition, the outside of the trailer will be swipe surveyed by BN prior to departure to determine if there is any external contamination.

The tractors with loaded trailers will proceed to Mercury using the route described above. Drivers shall conduct tire inspections every two hours or 100 miles of travel, whichever is less, in accordance with 49 CFR 397.17. On the first day of transport, the rigs will arrive in Mercury in the early afternoon with work completed for the day, which will allow the drivers to get into the proper sequence of beginning the work day in Mercury.

On the second and all subsequent days, the following sequence will be followed: the rigs will be cleared by BN Radioactive Materials Control at Guard Gate 100 and then proceed to the Area 3 Radioactive Waste Management Site (RWMS) for unloading. The rigs will depart in pairs every hour

starting at 6:00 am. The distance from Mercury to the Area 3 RWMS is approximately 35 miles and the trip is anticipated to take no longer than one hour.

At Area 3, the rigs will unload the soil by driving down into the disposal crater and discharging the load to the area designated by the Contractor. Following unloading, the rigs will be checked for contamination by Contractor personnel and all required paperwork will be completed. The unloading, RadSafe check, and paperwork are anticipated to take not longer than one hour for each pair of rigs. The rigs will then return to the CS-1 project site to pick up a loaded trailer.

At the CS-1 project site, the Subcontractor will exchange an empty trailer for a loaded trailer. The loaded trailers will have been previously filled by the Contractor. The required shipping papers and radiation checks will be completed by the Contractor before the load leaves the area. The process is estimated to take no longer than one hour for each two rigs.

The rigs will travel back to Mercury, park in the designated area outside Guard Gate 100, and spend the night. The total estimated time for the day's run is 12 hours, excluding breaks and meals. The routing calls for the drivers to spend the night in Mercury each night.

On the final trip, the drivers will deliver the trailers to the Area 6 Decontamination Facility for decontamination. Decontamination of the 22 trailers may take up to 5 working days. BN personnel will transport the B-12 boxes of oversized soil and the Sealand® container of bulk material to the NTS.

APPENDIX C

AIR MONITORING PLAN

WORK PLAN
for
Particulate and Meteorological Measurements at Clean Slate 1, TTR

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1. Introduction

Excavation of soil contaminated with plutonium (Pu) at the site on the Tonopah Test Range (TTR) of the Clean Slate 1 (CS-1) safety shots conducted as part of Operation Roller Coaster has been scheduled by Bechtel Nevada (BN) to begin May 1, 1997. From May 1 through 12, soil will be removed from the area affected by the safety shot to a nearby central processing location. From May 12 to June 7, 1997 soil will be processed for transport to a storage area.

This work plan describes the measurements of airborne particulate matter and meteorological variables that the Energy and Environmental Engineering Center (EEEC) of the Desert Research Institute (DRI) will make during and after remediation efforts. EEEEC/DRI personnel will be onsite to deploy and operate equipment during the excavation period.

2. During Excavation of Contaminated Soil

Portable particulate matter nominally 10 μm or less (PM_{10}) samplers will be deployed outside the exclusion zone area to collect samples of airborne particulate matter during excavation operations. The samplers will be placed the expected upwind and downwind sides of the exclusion area. The background monitoring conducted during the past year showed that the prevailing winds during the spring (April-May) tend to fall into two directions: northwesterly and southerly. It is expected that,

during both daytime and nighttime, the winds will be northwesterly about 60% of the time and southerly about 30% of the time. It is also expected that only minor wind shifts will occur during the morning transition between night and day once a particular direction sets up.

Samples of airborne particulate matter with aerodynamic diameters less than 10 μm (PM_{10}) will be collected during the time of operations, approximately 0700 to 1700 Pacific Daylight Time (PDT). A total of 12 portable PM_{10} samplers of the type used during background sampling will be deployed outside the radiation controlled area. The samplers will run in groups of six. Each sampler will run 12 hours on 2 consecutive days for a total sampling collection time on each filter of 24 hours. For each set of 6 samplers, three samplers will be placed along the southern edge of the exclusion area and two samplers will be placed along the northern edge of the exclusion area. The sixth sampler will be placed on the eastern or western side (away from the base camp) of the exclusion zone to collect a background sample that would be unaffected by the operations. These samplers are battery operated and will be programmed to collect samples at times coinciding with the operations on 2 consecutive days. Airborne particulate matter is collected on 47 mm diameter Teflon filters. At a flow rate of 5 l pm, these samplers collect enough mass to determine mass concentration but individual filters will probably not contain enough material to quantify the levels of radioactive materials. Filters will be later composited for analysis for Pu. Blank filters will also be exposed as a measure of filter handling contamination.

Meteorological equipment will be operated in the vicinity to collect wind speed, wind direction, temperature, relative humidity, and pressure. Data will be collected and stored as 15-minute and 1-hour averages in the data logger and in storage modules. Data will be downloaded periodically during the operations to ensure high data recovery.

Filters will be initially weighed in Reno and sent to the field in Petri dishes. Filters will be loaded into holders at TTR. During the excavation period, unexposed filters will be installed on the samplers before operations begin. The samplers will be programmed for multiple days to collect samples during operations. Filter holders will be removed from samplers after operations.

Bechtel personnel will perform field tests on the filter holders and samplers for the level of radioactivity. For those samples with acceptable levels of radioactivity, the exposed filters will be removed from holders, placed in Petri dishes, and returned to EEECD/DRI's Reno Laboratory for final

weighing. If the level of radioactivity is not acceptable, the samples and holders will have to be segregated for weighing at a location to be determined and decontamination.

Following net mass determination, concentration of airborne particulate matter will be calculated from mass loading, sampler flow rate, and elapsed time of the sample. Filters will be saved to be composited for further plutonium analyses.

A final report of the particulate and meteorological data will be generated. Included in the report will be particulate concentrations at the various locations during the operations along with winds during the time.

3. After Excavation at Clean Slate 1

After excavation of contaminated soil is completed at CS-1, portable PM_{10} samplers will be deployed in the vicinity to determine (1) the effect of the disturbed soil on the amount of airborne particulate matter and (2) the effectiveness of controls to stabilize the disturbed soil.

Two sets of 24-hour filter samples will be collected each week for 6 months. Samplers will be deployed to the north and south of the exclusion area to collect samples along the line of the predominate daytime and nighttime wind directions and to the east or west for background. A total of 7 filter samples will be collected each week: north and south samples on one day, north and south samples with one collocated sample on the other day, background samples on each day. An additional filter will be exposed to the air each week as a field blank. Filters will be weighed before exposure in EEECD/DRI's Reno Laboratory, loaded into filter holders, shipped to the TTR, exposed, shipped back to Reno, and weighed for net mass. Concentrations will be calculated from the net mass, flow rate, and exposure duration. Filters will be saved to be composited for Pu analyses.

Meteorological data will be collected as 15-minute and 1-hour averages in the data logger and in storage modules. Storage modules will be returned at regular intervals to Reno for processing, validation, and interpretation.

It is anticipated that TTR personnel will continue to operate the samplers as they have during previous monitoring. This will involve visits to the site, installation and removal filter holders, checks

of the operations of the samplers and meteorological equipment, and shipment of exposed filters. The site will require weekly visits to change filters.

Quarterly data reports of the particulate and meteorological data will be generated. Included in the reports will be particulate concentrations at the sample days and summarized meteorological data.

**Schedule for
Particulate and Meteorological Measurements at Clean Slate 1, TTR**

Dependent on Bechtel Schedule

Deploy equipment for collection during Excavation	April 29 - 30
Collect samples during Excavation	May 1 - 12
Move equipment for collection after Excavation	May 13
Collect samples after Excavation	May 16 - Nov 14

APPENDIX D

CHARACTERIZATION OF LARGE MATERIAL IN B-12 BOXES

CHARACTERIZATION AND OPERATION of the OVERSIZE MATERIAL DETECTOR SYSTEM

Purpose/Background

The oversize material from the Clean Slate 1 (CS-1) cleanup activities (greater than 1.9 cm (0.75 in) in size diverted from the conveyor belt system) will be loaded into B-12 boxes (about 1.2 m [4 ft] wide x 1.8 m [6 ft] long x 0.6 m [2 ft] high) for disposal at the Nevada Test Site (NTS) in parallel with the soil. A tripod-mounted germanium (Ge) detector system will be used to monitor the amount of radioactivity as the material is loaded in small, discrete layers into the boxes.

The number of 60-keV americium-241 (^{241}Am) gamma rays measured while the box is being filled is directly related to the amount of activity contained in the box. The plutonium (Pu) activity will be calculated based on the Am:Pu ratio calculated from the characterization work in April-May 1996. The boxes will then be taken to NTS for disposal.

Description of Material in Boxes

The tripod will sit at a fixed distance above each layer of material and collect a spectrum of the gamma rays emitted from the material. At the end of each normal work day, the daily accumulated oversize material will be loaded into the box in batches and spread evenly to a thickness of about one inch. The Ge detector will make a measurement over each half of the box and an incremental activity will be calculated for the box. When the time the box is filled, all of the incremental activities will be summed and an average activity per mass will be assigned to the contents of the box before it is shipped to NTS for disposal.

Requirements of the detector system can be summarized in the following items.

- (1) An earlier assessment of the activity at CS-1 indicated that the activity is comprised of ^{241}Am and several isotopes of plutonium as well as the naturally occurring radionuclides present in the soil. The ratio between the Pu and Am isotopes was determined as 16:1.

Therefore, the activity of the waste stream can be monitored by measuring the ^{241}Am isotope's gamma rays.

- (2) The detector system must be able to monitor the Am activity in a layer of material. The desired accuracy for these measurements changes as a function of the activity. The goal is to not have any boxes with activities greater than the TRU waste limit of 100,000 pCi/g. For measurements close to the limit, the system should have fairly tight accuracy, less than 10%. For low activity boxes, the uncertainty can be much higher, as much as a factor of 2.
- (3) The Am activity will be on the outside of the oversize items (rocks, concrete chunks, metal pieces, vegetation roots, etc.) -- probably only on one side of the item. However, the radiation cannot traverse the thickness of these items. Therefore, the orientation of the activity-laden side of each oversize item is assumed to be random; on some items, the activity will point directly up at the detector and on others, the activity will be pointing down. The 3.75 cm- (1.5 in-) thick soil layer was chosen to minimize the effects of gamma ray attenuation through the layer. For a distribution of Am which is uniformly distributed with depth, 50% of the emitted 60-keV gamma rays will reach the detector without being scattered.
- (4) The soil collected from the plume region consists primarily of sand and very fine gravel (typically less than 0.312 cm [0.125 in] diameter). Plant material from this region should be removed by the 1.9 cm (0.75 in) screen. Since the Kiwi detector system covered this area last year and the depth of excavation in this region is quite shallow, there can be only an exceedingly small probability of the material containing small pieces of Am-encrusted metal. Any Am from this region can be assumed to consist of fine particles uniformly distributed throughout the soil. Very little oversize material should occur from this excavated material.
- (5) The material collected from the mound area also consists primarily of sand and fine gravel, but has a higher probability of containing some larger gravel and/or small pieces of concrete. Since this area will be excavated to a depth of several feet, there is a high probability of finding small pieces of metal encrusted with Am. Most of the oversize material should originate from this area.

Characterization of the Ge Detector System

The Ge detector is an approximately 80-mm- (3.2-in-) thick by 70-mm- (2.8-in-) diameter crystal. The axis of the crystal will be pointed towards the material being measured. The detector is powered by an external HV supply and multichannel analyzer (MCA). This external unit will start and stop the counting and employs standard arithmetic peak extraction algorithms.

The detector system has been calibrated at a distance of one meter from a small ^{241}Am source. The response of the detector was measured with an ^{241}Am , cesium-137 (^{137}Cs), and an europium-152 (^{152}Eu) source to characterize the angle and energy dependence of the detector. The calibrations involve measuring the count rate for the point source as it is rotated about the axis of the detector at a constant one-meter distance. The angular dependence of the detector for the ^{241}Am gamma ray (along with three other energies) is shown in Figure D-1.

Based on these measurements, a conversion factor (C_{Ge}) is calculated which relates the measured count rate with the known activity of the sources. Then the conversion factor can be used to calculate the activity of the field sample from its measured count rate.

Operation and Analysis of the Ge Detector System

The amount of activity in a box is calculated by taking the total number of counts in the Am photopeak window, dividing by the time of the measurement, subtracting the background count rate (determined at the beginning of each day), and then dividing by the conversion factor (C_{Ge}). To compensate for the loss of gamma rays by attenuation in the 3.75 cm (1.5 in-) thick layer of material, this activity should be divided by 50% (0.50) as described in item (3) above. When this intermediate result is divided by the average mass of material passing the detector each second, the "nCi/g" value results.

$$y/\text{mass}(\text{nCi/g}) = \frac{\left[\frac{\text{net AM counts}}{\text{counting time}} - \frac{(\text{daily}) \text{ bkg counts}}{\text{bkg counting time}} \right] \times \frac{1}{C_{\text{Ge}}}}{\frac{\text{total mass of material}}{\text{counting time}}} \quad (1)$$

The minimum detectable activity (MDA) of this detector system can only be precisely measured when the system is operating in the field and looking at non-ameridium contaminated material. However, a reasonable estimate can be made from measurements in the lab. A 300-second background measurement collected 7,050 counts in the ^{241}Am window with 0 ± 113 net counts. If we take 3σ as our definition of the MDA, then we can calculate the minimum activity detectable with this system.

$$MDA(^{241}\text{Am}) = \frac{3 \times 113 \text{ counts}}{300 \text{ seconds}} \times \frac{0.828 \text{ pCi/g}}{\text{counts/second}} \approx 0.94 \text{ pCi/g} \quad (2)$$

The TRU limit (100,000 pCi/g) is about 100,000 times the MDA.

34IN30888, bare, 29-Mar-96 Effective Area Ratio vs. Angle – 4 Representative
Energies

Figure D-1. Angular dependence of the NaI detector for the ^{241}Am gamma ray.

APPENDIX E

CHARACTERIZATION AND OPERATION OF THE CONVEYOR BELT NaI DETECTOR SYSTEM

CHARACTERIZATION AND OPERATION of the CONVEYOR BELT NaI DETECTOR SYSTEM

Purpose/Background

The Clean Slate 1 (CS-1) remediation work will use a sodium iodide (NaI) detector system to monitor the amount of radioactivity traveling along a conveyor belt to the trucks for later disposal. The NaI detector has been calibrated for operation at a range of heights above a 3.75 cm- (1.5 in-) deep layer of soil on a 75 cm- (30 in-) wide conveyor belt.

The number of 60-keV americium-241 (^{241}Am) gamma rays measured while the truck is being filled is directly related to the amount of activity which passed under the detector. The Am activity loaded into each of the trucks will be measured and the plutonium (Pu) activity will be calculated based on the Am:Pu ratio calculated from the characterization work in April-May 1996. The trucks will then be taken to the Nevada Test Site (NTS) and the soil will be disposed of at the Area 3 Radioactive Waste Management Site.

Description of Material on Conveyor System

The conveyor system consists of several pieces of equipment which move the excavated material from the stockpile mound to the disposal trucks. The material is loaded into a variable speed feed hopper by a small front-end loader. A conveyor belt transports the material to a vibrating platform which sends any material larger than 1.9 cm (0.75 in) diameter to a separate stockpile. Soil and other material smaller than 1.9 cm (0.75 in) will continue onto another conveyor belt to the second feed hopper. The output stream from this hopper will be regulated so the material on the final conveyor belt is no more than 3.75 cm (1.5 in) high and will occupy the center 65 cm (26 in) of the width of the belt. The NaI detector system sits at the end of this conveyor (about 0.9 m [3 ft] before the material reaches the final conveyor belt).

Requirements of the NaI detector system can be summarized in the following items.

- (1) An earlier assessment of the activity at CS-1 indicated that the activity is comprised of ^{241}Am and several isotopes of Pu as well as the naturally occurring radionuclides present in the soil. The ratio between the Pu and Am isotopes was determined as 16:1. Therefore, the activity of the waste stream can be monitored by measuring the ^{241}Am isotope's gamma rays.
- (2) The NaI detector system must be able to monitor the Am activity in a layer of soil passing underneath as the soil is loaded into the trucks for later disposal. The desired accuracy for these measurements changes as a function of the activity. The goal is to not have any trucks with activities greater than the TRU waste limit of 100,000 pCi/g. For measurements close to the limit, the system should have fairly tight accuracy, less than 10%. For low activity shipments, the uncertainty can be much higher, as much as a factor of 2.
- (3) The Am activity is assumed to be dispersed throughout the soil mixture. Any chunks of material coated with Am (hot point sources) are assumed to be randomly distributed across the width of the conveyor belt. The 3.75 cm (1.5 in-) thick soil layer was chosen to minimize the effects of gamma ray attenuation through the soil. At this thickness, the gamma rays emitted from Am at the bottom of the layer will be attenuated by about half compared to those emitted at the top of the layer. For a distribution of Am which is uniformly distributed with depth, 70% of the emitted 60-keV gamma rays will reach the detector without being scattered.
- (4) The soil collected from the plume region consists primarily of sand and very fine gravel (typically less than 0.3 cm (0.125 in) diameter). Plant material from this region should be removed by the 1.9 cm (0.75 in) screen. Since the Kiwi detector system covered this area last year and the depth of excavation in this region is quite shallow, there can be only an exceedingly small probability of the material containing small pieces of Am-encrusted metal. Any Am from this region can be assumed to consist of fine particles uniformly distributed throughout the mixture.

- (5) The material collected from the mound area also consists primarily of sand and fine gravel, but has a higher probability of containing some larger gravel and/or small pieces of concrete. Since this area will be excavated to a depth of several feet, there is a high probability of finding small pieces of metal encrusted with Am such as what the ATV and Kiwi systems found on or near the surface. Small pieces may pass under the detector system; larger pieces will be diverted by the screening platform.

Characterization of the NaI Detector System

The NaI detector is a 5 cm- (2 in-) thick by 10 cm- (4 in-) wide by 40 cm- (16 in-) long crystal log. The long axis of the crystal will be placed parallel to the width of the belt, so the detector will present a rectangular cross section to the material it is measuring. It is surrounded (top and sides) by 0.1 cm (0.040 in) sheets of cadmium to shield its field of view. The detector, preamplifier, and shielding are surrounded by several inches of foam packing and housed inside a sturdy plastic case for protection from the weather. The detector is powered by an external HV supply and multichannel analyzer (MCA). This external unit will start and stop the counting and employs standard arithmetic peak extraction algorithms. The distance from the bottom of the crystal to the bottom of the case is 9.4 cm (3.75 in). In the discussion which follows, the height above the belt (source) always refers to the height of the bottom of the case.

The detector system has been calibrated at the operating height (75 cm [3 in]) above a small ²⁴¹Am source. The calibrations involve measuring the count rate for the point source at specific locations along the x- and y-axis. The response function of the system (Figure E-1) over the entire (x,y)-plane is then derived from these measurements. It should be noted that the material on the conveyor belt will occupy the center -25 cm (-10 in) to +25 cm (+10) in of the "Distance across belt" axis.

A uniform distribution of activity can be simulated from measurements of a single point source placed every 7.5 cm (3 in) within the field of view. The number of counts recorded in 30 seconds by an ²⁴¹Am source spaced every 7.5 cm (3 in) over the field of view of the detector can be correlated with an activity on a moving conveyor belt. This uniform distribution is the same as the

NaI Detector Response

Figure E-1: The response function of the system over the entire (x,y)-plane.

response function measurement discussed above, but with the width of soil on the belt and the front-back field of view truncating the edges of the function. At the planned installation height of 7.5 cm (3 in), the detector views the 65 cm (26 in) width of the material on the belt and views 60 cm (24 in) before and after its position along the belt. (The contribution at ± 60 cm [24 in] is so small [$<0.5\%$ of the count rate at 0 cm], that everything beyond this distance can be ignored.) The uniform source is approximated by 17 rows of 9 point sources across the belt. If the measurements are made with a $10.77 \mu\text{Ci}$ source ($10.9 \mu\text{Ci}$ on 1 January 1990) for 30 seconds in each position, then the total 5,829,160 counts are obtained from the total activity of $1,649 \mu\text{Ci}$.

$$= \frac{5,829,160 \text{ counts}}{30 \text{ seconds}} \times \frac{1}{17 \times 9 \times 10.77 \mu\text{Ci}} = 118 \frac{\text{counts/second}}{\mu\text{Ci}} = 0.118 \frac{\text{counts/sec}}{\text{nCi}} \quad (3)$$

Operation and Analysis of the NaI Detector System

The amount of activity in a truck is calculated by taking the total number of counts in the Am photopeak window, dividing by the time of the measurement, subtracting the background count rate (determined at the beginning of each day), and then dividing by the conversion factor (C_3). To compensate for the loss of gamma rays by attenuation in the 3.75 cm- (1.5 in-) thick layer of soil, this activity should be divided by 70% (0.70) as described in item (3) above. When this intermediate result is divided by the average mass of material passing the detector each second, the "nCi/g" value results.

$$ty/mass(\text{nCi/g}) = \frac{\left[\frac{\text{net AM counts}}{\text{counting time}} - \frac{(\text{daily}) \text{ bkg counts}}{\text{bkg counting time}} \right] \times \frac{1}{C_3} \times \frac{1}{0.70}}{\frac{\text{total mass of soil}}{\text{counting time}}} \quad (4)$$

For a uniform distribution, the speed of the belt will have no direct effect on the activity measurements. This factor enters the calculation through the amount of time required to fill the truck; a faster belt speed will decrease the amount of time spent counting, but the total number of counts will also be less. A uniform distribution of activity will produce the same counts/second

regardless of the speed of the belt. The startup and stopping speed nonlinearities of the belt motion are too small to consider since the belt quickly reaches its operating speed.

The 0.9 m (3 ft) of distance between the detector and the end of the conveyor belt is a source of error in the measurements. The 0.9-m (3-ft) distance represents a minuscule portion of the volume of soil which is loaded into each truck. (This small error is ignored in the calculations.)

The minimum detectable activity (MDA) of this detector system can only be precisely measured when the system is operating on the conveyor belt and looking at non-Am contaminated soil passing underneath. However, a reasonable estimate can be made from measurements in the lab. A 30-second background measurement collected $4,456 \pm 67$ counts in the ^{241}Am window with 0 net counts. If we take 3σ as our definition of the MDA, then we can calculate the minimum activity detectable with this system.

$$MDA(^{241}\text{Am}) = \frac{3 \times 67 \text{ counts}}{30 \text{ seconds}} \times \frac{\mu\text{Ci}}{118 \text{ counts/second}} \cong 0.057 \mu\text{C} \quad (5)$$

The MDA can be compared with the ^{241}Am activity in a (large Double Tracks) Supersack at the TRU waste limit (7,940 μCi of ^{241}Am). The TRU limit is about 140,000 times the MDA. The total activity in the trucks being used at CS-1 will be even higher (exact mass of soil in a truck is not presently known), making the "package" activity at least 1,000,000 times the system MDA.

APPENDIX F

REMOTE SENSING LABORATORY RADIOLOGICAL CLEANUP VERIFICATION PLAN

Remote Sensing Laboratory Radiological Cleanup Verification Plan

Purpose/Background

The DOE's Remote Sensing Laboratory (RSL), operated by Bechtel Nevada is responsible for surveying the site following soil removal to ensure that the area has been cleaned to below the designated activity levels.

The work will be accomplished using the Kiwi detection system and the Suburban mast-mounted germanium (Ge) detector system.

Kiwi Detection System

The Kiwi system is the result of mounting the detectors and data collecting system from our well-known aerial system onto a Chevrolet Suburban vehicle. Six 2-in x 4-in x 16-in NaI logs are housed in pods mounted on an angle-iron frame attached in place of the rear bumper. Signals from these detectors feed into a REDAR IV system bolted to the floor of the Suburban. Signals from the global positioning system (GPS) constellation of satellites, received by the antenna mounted above the detectors, are preprocessed by a John Chance unit before feeding into the REDAR system. In addition to the GPS signals, the antenna mounted on the roof of the Suburban receives a correction signal from a network of GPS stations around the country which is relayed through a dedicated satellite for John Chance subscribers. This correction signal reduces the uncertainty in positioning the vehicle to about 0.5 m (1.5 ft). The GPS data provides accurate location data for the radiological survey.

The Kiwi detectors are shielded on the back and sides with a sheet of cadmium, while the end-mounted photomultiplier tubes and the vehicle itself provides shielding to the front of the detectors. This shielding is more than adequate for attenuating the 60-keV gamma rays of ^{241}Am , but does not significantly affect the higher energy radiation from the natural radioisotopes. The shielding produces a well-defined footprint for making assessments of the americium concentration in a given volume of soil. Thus, the ^{241}Am footprint of the stationary Kiwi system is

about 3 m (10 ft) in width and 1.2 m (4 ft) long. With the Kiwi traveling at 2.2 m/s (5 mph; 7 ft/s), the footprint is about 3 m (10 ft) wide by 3.4 m (11 ft) long.

At the end of all excavation, packaging, and transportation operations, any soil which was excavated should have been removed from the site. In addition, all equipment will be removed from inside the fence. At this time, the Kiwi will conduct a survey over the whole area inside the fence to assess the levels of americium still remaining. The nominal line spacing will be 3 m (10 ft) and the speed around 2.2 m/s (5 mph; 7 ft/s). The Kiwi will need about two days to cover the area. Another day is needed to complete the analysis of the data. If the Kiwi finds areas of high activity, the excavation and soil removal operations will be brought back in to complete the work. Otherwise, if the levels are low, the equipment and crews will be released.

Suburban Mast-Mounted Ge Detector System

This measurement system consists of a collimated high-purity Ge detector suspended on a mast 7.5 m (25 ft) above ground level (AGL). The detector and mast are attached to a 4-wheel drive vehicle (Chevrolet Suburban). The collimated detector views a circular area with a diameter of approximately 13 m (43 ft).

This detector system will be used to make surveys after approximately 3.75 cm (1.5 in) thick lifts of soil have been scraped during the excavation phase. These measurements will provide a quick verification that the excavated areas are now below the cleanup level and that further scraping is not required.

Following all excavation and soil-moving operations at the site, the Suburban Mast-Mounted Ge Detector System will be used to make a series of measurements at the same locations outside the exclusion zone fence as were measured during the July 1995 site characterization activities. These measurements will be compared with those taken in July 1995 before the cleanup activities began and will be used to verify that the actions inside the fence did not increase the contamination outside the fence.

**Clean Slate 1
Corrective Action Plan
Distribution List**

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